SPEED OF WORD RETRIEVAL ACROSS NEUROTYPICAL AND APHASIC PARTICIPANTS: AN INVESTIGATION OF NOVEL ASSESSMENT AND TREATMENT METHODS

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List of Abbreviations

1b  First baseline (assessment)
1m  One month post-treatment (assessment)
1w  One week post-treatment (assessment)
2b  Second baseline (assessment)
ACC Accuracy
AoA Age of Acquisition
bc Between-cycles assessment
PI Proactive Interference
RISP Repeated Increasingly Speeded Presentation (method/items)
RT(s) Reaction Time(s)
SD Standard Deviation
SOA Stimulus Onset Asynchrony
SP Standard Presentation (method/items)
TOT Tip Of the Tongue (phenomenon/state)
UnRISP Untreated RISP items
UnSP Untreated SP items
WFD Word Finding Difficulties
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Abstract

Word finding difficulties (WFD) and slowing down both in linguistic comprehension and production are standard characteristics of people as they grow older. WFD also commonly occur in aphasia and are considered one of the most pervasive symptoms affecting stroke participants’ everyday communication. Research on older adults’ WFD has traditionally focused on production of single words when completing picture naming tasks, while very little is known about how much these WFD can compromise connected speech. Similarly, while picture naming tasks have typically been used for assessing and treating word finding problems in clinical practice, there is a dearth of studies in the aphasiological literature investigating the relationship between confrontation naming and connected speech tasks.

The thesis investigated whether a newly-developed method/treatment targeting both speed and accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming was more effective in (a) speeding up participants without compromising accuracy, and (b) improving the use of the trained/treated names in connected speech, compared to a standard method/therapy (‘standard presentation’ - SP) which targeted accuracy alone.

English-speaking, elderly participants (n=27 at Chapter 3, n= 21 at Chapter 4) and participants with aphasia of varying severity and subtype (n=5 at Chapter 5 and n=20 at Chapter 6) were asked to carry out picture naming tasks/picture naming treatments and composite picture description tasks where the composite pictures included the trained/treated items.

As for the neurotypical participants, words which were retrieved more quickly in picture naming tasks were also those which were more readily available and produced in connected speech tasks. Compared to SP, RISP was found to be significantly more effective in significantly reducing picture naming latencies without inducing a speed-accuracy trade-off and with lasting effects. Finally, SP was as effective in promoting retrieval in connected speech as RISP. As for the clinical population, compared to SP, RISP was significantly more effective in improving picture naming accuracy and in maintaining the reduced RTs in the long term. In comparison to the SP, RISP crucially led to significantly higher carry-over of targeted items to connected speech.

The thesis findings underlined the effectiveness of a more demanding single word training method/treatment in improving lexical retrieval in confrontation naming for neurotypical participants and in enhancing connected speech for participants with aphasia.
Declaration

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Dedication

To
my fiancé Christos
for his immense love and support along this journey
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Special thanks go to my parents, Ioannis Sotiropoulos and Alexandra Drosopoulou, for making sure that I feel their continuous understanding, support, and most of all love, besides I have been miles away.

This thesis would not have been possible without the unconditional support of my fiancé Christos Taratoris. Encouraging me and believing in me and this project has kept me motivated and inspired at even the hardest moments.
The Author

I graduated from The University of Patras in 2008 with a first class BA (Hons) in Linguistics. Two years later, I enrolled full time on a two-year MA in Theoretical and Applied Linguistics, again at the University of Patras. During my MA studies I became fascinated with research on the neurobiology of language and my masters research project investigated the linguistic and cognitive factors affecting word reading in post brain injury ‘neglect dyslexia’. My MA was funded by a bursary from the Alexander S. Onassis Public Benefit Foundation and a portion of the research for my masters research project was supported by an Erasmus Scholarship from the European Commission for a three-month visit at the Psycholinguistics /Neurolinguistics lab at the University of Potsdam, Germany. I graduated with a distinction in September 2012, whereupon I registered as a full-time PhD student at the University of Manchester.
CHAPTER 1

Introduction
1 Thesis Overview

This thesis is presented in alternative format, which means that core chapters are written in the style of journal articles. Within each of these self-contained chapters, the motivation for the work behind each study is outlined, a review of relevant background literature is presented, the research questions addressed and methods adopted are described, and an interim discussion of the results is provided. Chapter 1 provides a brief review of the theoretical context relevant to the thesis as a whole and outlines the key research questions the thesis aims to address. Chapter 2 provides a comprehensive review of the relevant literature and describes key theoretical and methodological issues which were taken into account in the process of conducting this research. Chapters 3-6 contain the reports of the four empirical studies which constitute the body of the thesis. An overview of the development and the methodological adaptation of a new intervention for word finding difficulties in both neurotypical and aphasic participants is presented in the final chapter (Chapter 7, page 239). Chapter 7 constitutes a general discussion of the research findings, their implications, as well as future directions for subsequent research.

1.1 Reasons for conducting this research

1.1.1 The variable of speed of naming

Speed of word retrieval is the time required for the initiation of a naming response after the presentation of the target picture, in the context of a picture naming task. It is distinct from the naming duration (see also Kello & Plaut, 2000). Along with accuracy, speed of naming is a critical variable for the response generation in naming, which is quite important for interpreting naming data and evolving theories about the underlying cognitive processes (e.g. Balota, Boland, & Shields, 1989; Lupker, Brown, & Colombo, 1997). Furthermore, given that neurologically intact speakers (herein ‘neurotypical participants’) do not generally produce erroneous responses in terms of accuracy in normal, non time-pressurised conditions, speed of naming may be an
informative window through which to more fully examine and understand word retrieval in neurotypical, and ultimately, aphasic participants.

As for clinical populations, Crerar (2004) outlined that focusing on accuracy data without reporting speed of patients’ performance gives an incomplete and maybe misleading picture of any cognitive function. A novel yet potentially key finding in the literature (Fillingham, Hodgson, Sage, & Lambon Ralph, 2003; Fillingham, Sage, & Lambon Ralph, 2005a, 2005b, 2006; Conroy, Sage, & Lambon Ralph, 2009a, 2009b, 2009c, 2009d) is that speed of naming is an important variable, not only within assessment tasks (McCall, Cox, Shelton, & Weinrich, 1997), but also within therapy tasks, warranting further investigation. Moreover, there is theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b).

Despite broad agreement about the importance of the variable of speed in lexical access, the facilitation of speed of word retrieval during picture naming and its impact on speech production has been a neglected area in the psycholinguistic and aphasiology literature (Crerar, 2004). For example, for the facilitation of word retrieval, Nippold (1992) stressed the clinical importance of the improvement on a number of factors (see Chapter 4), including naming accuracy and speed, yet he suggested that naming speed should not be prioritised as much as naming accuracy in clinical tasks administered to children and adolescents with word finding problems, because of the risk of pressurising participants. Other psycholinguistic studies have focused their research on specifying what variables (visual, semantic and lexical) can affect reaction times (RTs) in picture naming (described in greater detail in Chapter 2), while the vast majority of clinical studies have attempted to shed light on the pre- or post-treatment variables affecting picture naming speed in aphasia, either related to the treated items, or to participants with aphasia (see Chapters 2 and 5).

1.1.2 Word retrieval differences depending on the elicitation context

Confrontation naming and spontaneous speech are different contexts for word retrieval. Compared to retrieval of single words, access to lexical information in the context of connected discourse may prove to be either facilitated, if some words are primed, or impeded, because of the more complex task requirements (Feyereisen,
Neurotypical Participants

Although there is a considerable database on word retrieval in connected speech tasks performed by participants with language disorders (e.g. Nippold, 1992; Faust, Dimitrovsky, & Davidi, 1997), research on word production in neurotypical participants has produced a wide range of results in confrontation naming, i.e. on retrieving isolated words in experimental picture naming tasks. Although important findings have been established regarding the mechanisms underlying the isolated word production, very little is known about the use of these words in everyday life contexts of connected speech. The tendency in the literature to focus on the single word as the main item of analysis has been criticised in both the psycholinguistic literature (Bock & Griffin, 2000a) and the aphasiological literature (Ferguson & Armstrong, 1996). As Bock and Griffin (2000a, p. 25, 39) acknowledged “a connection from repeated production of specific words to production fluency of these words” is missing, yet “many laboratory tasks rely exclusively on the elicitation of single words that are rarely uttered alone”.

Whilst there are a few psycholinguistic studies pointing to discrepancies between performance in picture naming and naming in connected speech (e.g. Ferguson & Armstrong, 1996), there is an even greater paucity of information about the differences between different word retrieval contexts with respect to the variable of speed (for details see 2.2.2.1) and therefore further research is required to better delineate the contribution of speed to word retrieval in different contexts.

Aphasic participants

Word retrieval patterns have been shown to vary depending on the elicitation context in clinical studies. Error patterns of patients suffering from different subtypes of fluent aphasia (e.g. conduction aphasia and anomia) are not the same in picture naming and spontaneous speech. More specifically, in confrontation naming tasks lexical and sublexical paraphasias (e.g. van → bus and ghost → /goθ/ respectively) are produced by all aphasic patients independently of the specific aphasia impairment (Mitchum, Ritgert,
In spontaneous speech, however, different errors types are produced depending on the aphasia subtype: conduction aphasic patients produce primarily sublexical errors (mainly phonemic paraphasias), while anomic patients produce occasionally lexical errors (mainly semantic ones) and circumlocutions. These results are quite revealing in several ways. First, they indicate that naming and spontaneous speech make different linguistic and cognitive demands. Moreover, it becomes apparent that connected speech data (from both spontaneous speech samples and connected speech elicitation tasks) in comparison to naming provides more opportunities for avoidance of word retrieval, by using more familiar similar-synonym words, by making use of circumlocutions or even by choosing to convey a different message (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997).

There have been various studies which have examined the different patterns of word class retrieval (verbs vs. nouns retrieval) depending on the different elicitation context (confrontation naming/single word naming vs. sentences and/or connected speech). Some studies have suggested that the two different contexts have a direct (“one-to-one”) relationship (Berndt, Haendiges, Mitchum, & Sandson 1997; Herbert, Hickin, Howard, Osborne, & Best, 2008). However, other studies have reported that fluent aphasic patients are subject to different patterns of nouns’ and verbs’ retrieval depending on the retrieval context (Williams & Canter, 1987; Zingeser & Berndt, 1988; Berndt & Haendiges, 2000; Pashek & Tompkins, 2002; Mayer & Murray, 2003; Luzzatti, Ingignoli, Crepaldi, & Semenza, 2006). In particular, word class dissociations in different contexts have been associated with different types of impairment. According to Williams and Canter, relative to other aphasic patients (Broca’s, Wernicke’s, and conduction aphasic patients), anomic patients show the lowest association both between noun confrontation naming and noun retrieval in connected speech (Williams & Canter, 1982) and between verb naming and verb retrieval in connected speech (Williams & Canter, 1987). Furthermore, Williams and Canter (1987) reported that participants with Broca’s aphasia experienced less WFD in picture naming and the Wernicke’s group experienced less WFD in composite picture descriptions. Because of these results, the researchers proposed that aphasia type can be considered as a clinical marker denoting the association of word retrieval in different contexts.

Some striking results have also been produced in studies investigating the retrieval of stimuli belonging to a specific word class (either only nouns or verbs) in different contexts (described in greater detail in Chapter 2).
Irrespective of word class, some authors have reported better word retrieval for both nouns and verbs in confrontation naming rather in conversation (Manning & Warrington, 1996), and others have argued that both nouns and verbs are better retrieved in connected speech tasks and worse in confrontation naming (Mayer & Murray, 2003; Pashek & Tompkins, 2002; Williams & Canter, 1987).

Finally, with regard to post-therapy generalisation, the literature is equivocal regarding the effectiveness of the established single word naming treatments in promoting treated items’ carry-over to connected speech (dissociation in therapy’s effectiveness depending on the context - described below in 1.1.3 and later in Chapters 2, 3 and 4) (Zingeser & Berndt, 1988; Marshall & Cairns, 2005).

Given these word retrieval differences depending on the elicitation context (naming vs. connected speech), a method producing positive results in different contexts for both neurotypical and aphasic participants is imperative.

1.1.3 Word retrieval difficulties in different populations and interventions for addressing them

The ability to use words with ease and precision is pivotal in our everyday communication (Nippold, 1992). Unfortunately, word-retrieval difficulties commonly occur both in neurotypical (elderly) participants but also in participants with neurological impairments like aphasia. This section will provide a brief overview of research findings for both neurotypical and aphasic participants, along with the respective existent methods/treatments aiming to address these retrieval complications.

Neurotypical participants

Neurologically intact participants frequently produce tip of the tongue errors (TOT errors), indicating that the word's phonological form cannot be successfully retrieved despite that the speaker is aware of the existence of the word (Dell et al., 1997). These errors of neurotypical individuals are qualitatively similar to the patients’ errors, since they are attributed to similar mechanisms of the neurotypical speech production system (Dell et al., 1997). Tip of the tongue states (Rastle & Burke, 1996) and word finding difficulties (LaBarge, Edwards, & Knesevich, 1986) have been
particularly associated with ageing, while simultaneously slowing down both in linguistic comprehension and production is a standard characteristic of people as they grow older (e.g. Griffin & Spieler, 2006; Neto & Santos, 2012).

Given that neurotypical participants typically have more of a problem with speed rather than accuracy, most interventions have aimed to reduce participants’ picture naming latencies, through repetition priming or speed reduction methods like tempo naming (Kello & Plaut, 2000) and deadline naming (Stanovich & Bauer, 1978). In the literature, the most prevalent method in reducing latencies without over-emphasising speed is repetition priming. Repetition priming, however, is not a purely speed reduction method, since it refers to “the facilitation of naming by prior repeated production of the same word” (Wheeldon & Monsell, 1992, p. 723, 725). The two main speed reduction methods were initially developed for word naming, but tempo naming was later adapted to picture naming as well (Hodgson & Lambon Ralph, 2008). Both methods were administered to young or mid age adults, so their effects with older participants (over 60 years old) are completely unknown. The main drawback of both these methods, however, was that speed of response rather than naming accuracy was prioritised, which invariably resulted in inducing errors, and hence reducing accuracy, in neurotypical participants’ responses (“speed-accuracy trade-off” effect, Pachella & Pew, 1968; Wickelgren, 1977). A new method that would effectively reduce speed in picture naming without compromising accuracy would be useful to be developed and administered to older participants, who have the most severe word finding difficulties and the longest RTs within the neurotypical population.

**Aphasic participants**

Aphasia is a language deficit resulting from acquired brain injury which affects speech, comprehension, reading and writing. One of its most pervasive symptoms is word retrieval difficulties where even simple, everyday words cannot be produced easily or quickly (also known as ‘anomia’, Laine & Martin, 2006). Anomia is present in almost all aphasia subtypes, like Broca, Wernicke, Conduction aphasia etc. (Goodglass & Wingfield, 1997). Anomia can also be mild to severe, “affecting all aspects of everyday communication such as talking to a family member, conversing in social settings, using the telephone etc.”, and “dramatically reduces people’s quality of life” (Lambon Ralph, Snell, Fillingham, Conroy, & Sage, 2010, p. 290).
As for the speed variable in word retrieval, reduced response speed is a typical symptom of aphasia, even after standard therapies or rehabilitation. That is, people with aphasia may be competent in ‘exploiting’ metalinguistic skills to enhance their accuracy performance even many years post-CVA, but not sufficiently competent to achieve neurotypical speed scores too (Crerar, 2004). This is also indicated by the recovery patterns of aphasic individuals who show an identical performance to neurotypical participants at the linguistic tasks (Kertesz & McCabe, 1977), but the time they need for the accomplishment of the tasks can be double relative to the respective speed of neurotypical participants (Neto & Santos, 2012).

To date naming therapy studies (i.e. therapies targeting single word retrieval) have focused solely on improving accuracy (Nickels, 2002a). For both the assessment and treatment of aphasia, these accuracy-focused therapies have typically involved confrontation naming tasks, which made the assumption that performance in picture naming tasks would reflect, at least in broad terms, the ease and reliability of word retrieval in connected speech tasks and lexical retrieval within everyday communication. However, with regard to post-therapy generalisation, the literature is equivocal regarding the effectiveness of the established accuracy based treatments in promoting treated items’ carry-over to connected speech. Whilst several cases indicating dissociations in naming skills across different naming contexts (picture naming vs naming in spontaneous speech) have been recorded in the literature (Zingeser & Berndt, 1988; Marshall & Cairns, 2005), it has been argued that picture-naming accuracy significantly predicted naming in connected speech contexts, either in more constrained speech elicitation contexts (composite picture description, Maendl, 1998; narratives, Conroy et al., 2009d) or in conversations (Herbert et al., 2008; for a review about generalisation to conversation, see Carragher, Conroy, Sage & Wilkinson, 2012). The same non conclusive results have been reported regarding the generalisation from treated to untreated items (for different generalisation results produced by different types of treatments, see Best et al., 2013). Generally, there is a strong belief in the clinical literature that there is a lack of generalisation for standard therapies (Howard, 2000; Nickels, 2002a; Wisenburn & Mahoney, 2009), yet it is an underpowered field with not many participants involved in the studies and hence limited empirical evidence.

A novel yet potentially key finding in the literature (Fillingham et al., 2003, 2005a, 2005b, 2006; Conroy et al., 2009a, 2009b, 2009c, 2009d) is that speed of naming is an important variable, not only within assessment tasks (McCall et al, 1997), but also
within therapy tasks, warranting further investigation. There is also theoretical and clinical evidence that speed of naming may be a critical variable in determining whether words retrieved in isolation can also be retrieved within the time demands of fluent speech (‘generalisation’ from picture naming to spontaneous speech, Conroy et al., 2009b). From a clinical point of view, the items which are named more quickly at a post-therapy point are more expected to be named in connected speech contexts (Conroy et al., 2009d). As for therapies which aim at improvement of accuracy only, Conroy et al. (2009d) illustrated that the speed of picture naming after a cueing-only type of therapy (i.e. decreasing cue therapy) did not predict the extent to which items were named in more spontaneous connected speech tasks. Given that fluent connected speech requires not only accurate (production of no more than one or two errors per 1000 words, Levelt, 1989) but also quick lexical access (fluent speakers produce around 100 words per minute, equating to around half a second per word or 2 words every second e.g. on the Cookie Theft description, Levelt, 1989; Bird, Lambon Ralph, Patterson, & Hodges, 2000), it could reasonably be argued that therapy effects may be more likely to generalise to spontaneous speech if both accuracy and speed are improved. This is the basic hypothesis of the studies presented in this thesis and the central motivation for developing new assessment and treatment methods that will target both accuracy and speed of word retrieval.

1.2 Research questions to be addressed in the thesis

Four empirical studies are designed and presented in the thesis (Chapters 3-6), two of which pertain to neurotypical data of elderly neurotypical participants and the remaining two to clinical data of chronic stroke participants with aphasia. In these empirical studies, various novel methodologies have been utilised and their effect on different variables and tasks has been investigated. Specifically, these include: (i) the relationship between speed of word retrieval in confrontation naming tasks and vocabulary use in connected speech tasks is assessed using a timed naming and a set of composite picture description tasks; (ii) a novel training/therapy method for improving retrieval speed without a speed-accuracy trade-off is developed for neurotypical participants and chronic stroke participants respectively; (iii) this novel
method is compared to standard accuracy-focused methods on confrontation naming gains; and (iv) the impact of these methods on connected speech for both treated and untreated items is assessed. The first novel methodology is addressed in Chapter 3, while the last three aims are addressed in Chapter 4 for neurotypical participants and Chapters 5 and 6 for participants with aphasia.

Based on these issues, five key research questions are addressed in the thesis:

1. Is there any correlation between efficient naming (increased accuracy and short latencies) and efficient word retrieval (increased accuracy and early production) in connected speech tasks i.e. picture description?

2. Can a newly developed method/treatment targeting both speed and accuracy produce more marked and long lasting improvements in confrontation naming on both speed and accuracy, than a standard method/treatment targeting accuracy alone?

3. Can elderly neurotypical participants and participants with aphasia be trained to reduce picture naming latencies without a speed-accuracy trade-off and with lasting effects?

4. Can a newly developed treatment targeting both speed and accuracy be more effective for improving the use of treated items (carry-over effects for neurotypical and aphasic participants) and untreated items in connected speech (generalisation effect only for aphasic participants) and for maintaining this improvement in the long term, than a standard therapy targeting accuracy alone?

5. Can participants with aphasia tolerate a newly developed treatment targeting both speed and accuracy, and, if yes, do they evaluate this in a positive way and to what extent is the new therapy perceived as more or less preferable and effective compared to a standard therapy targeting accuracy alone?
1.3 Outline of thesis chapters

1.3.1 Literature Review

This chapter consists of a literature review which describes the theoretical background to word retrieval in the psycholinguistic literature. Initially the mechanisms engaged in picture naming are reported, and an overview of Levelt’s and Dell’s contributions to the theory of lexical access is provided. This theory provides a framework for understanding the underlying processes involved in spoken word production, not just in unconstrained word retrieval contexts of neurotypical participants but also when lexical access breaks down in aphasia. Moreover, the variables which can affect picture naming latencies are presented and the two main methods for the elicitation of quicker responses are described (i.e. deadline naming and tempo naming). The differences between different word retrieval contexts with respect to the variable of speed are also outlined. The review chapter also elaborates on the complications to lexical access and speed of word retrieval as caused by aphasia. Furthermore, the variables (both item-related and subject-related) affecting picture naming speed in aphasia are presented. Different patterns of word retrieval efficiency in aphasia depending on the elicitation context are reviewed and it is concluded that speed of naming may be a critical variable in generalisation from picture naming to connected speech. Also a review of the different speech therapy methods in aphasia is implemented and the potential effectiveness of errorless learning therapy in relation to the variable of speed of word retrieval is considered.

1.3.2 Chapter 3 abstract

Word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms affecting everyday communication. Both the assessment and treatment of aphasia typically involve confrontation naming tasks, which makes the assumption that performance in picture naming tasks reflects ease and reliability of word retrieval in connected speech tasks. While the aphasiology literature does contain some studies investigating the relationship between confrontation naming and
connected speech tasks, little consideration has been afforded to the key variable of naming latency as a possible factor in determining word availability in connected speech. Before investigating naming latency in clinical populations, this study sought to establish whether a statistically robust relationship could be found between naming latency and word retrieval in connected speech within the neurotypical population. 27 neurologically intact, monolingual, English-speaking, elderly participants were asked to carry out a composite picture description task (n=3) and a picture naming task (n=100) within one assessment session. A statistically significant negative correlation was found between picture naming latencies and accuracy in picture descriptions implying that words more quickly named in picture naming were more likely to be produced in picture descriptions. Speed of word retrieval is an important factor which has some measureable influence on the easy availability of words in connected speech in neurotypical language processing. This finding could have important implications for clinical assessment and treatment of anomia in aphasia.

1.3.3 Chapter 4 abstract

Healthy older adults frequently report experiencing greater word finding difficulties (WFD), compared to younger adults (Sunderland, Watts, Baddeley, & Harris, 1986). Research on older adults’ WFD has traditionally focused on production of single words when completing picture naming tasks (e.g. LaBarge et al., 1986; Burke, MacKay, Worthley, & Wade, 1991), while very little is known about how much these WFD can compromise connected speech. This study aimed to compare a standard priming method (‘standard presentation’- SP) against a method encouraging increasingly speeded production across repetitions (‘repeated increasingly speeded presentation’ - RISP) in terms of which would be more efficient in speeding-up participants, and what method would lead to more efficient use of primed words in connected speech. SP was applied to half the stimuli (n=40) and RISP to the other half of stimuli (n=40) in 21 healthy older adults. After completion of these tasks, participants were asked to complete composite picture description tasks (n=4), where the composite pictures included the primed items. RISP was found to be significantly more effective in reducing picture naming latencies without inducing a speed-accuracy trade-off. The reduction of latencies following RISP showed lasting effects. However, a reduction of
naming speed was not critical for retrieving words in connected speech, in that SP was as effective in promoting retrieval in connected speech. The findings highlight the critical role of speed of word retrieval and potentially provide methods for tackling WFD in clinical populations, such as stroke aphasia.

1.3.4 Chapter 5 abstract

Word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms affecting everyday communication. While picture naming tasks have typically been used for assessing and treating word finding problems in clinical practice, there is a dearth of studies investigating the relationship between confrontation naming and connected speech tasks. This study investigated whether a newly-developed treatment targeting both speed and accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming would be more effective for improving the use of the treated names in connected speech, than the standard therapy (‘standard presentation’ - SP) which targeted accuracy alone. Five participants with aphasia of varying degrees of severity and subtype took part in twelve therapy sessions over 6 weeks. In the baseline and post-treatment assessments, participants were asked to complete a composite picture description task and a picture naming task, the items of which were part of the composite pictures and constituted therapy targets. For the dependent variables of speed and accuracy in picture naming, speed-focused therapy was as effective as the standard therapy. The ‘carry over’ of the therapy items to connected speech was increased for all items relative to the baseline. Speed therapy, however, in comparison to the standard one, led to significantly higher generalisation of targeted items to connected speech. These findings suggest that a more demanding single-word therapy can promote strong generalisation effects to more linguistically and cognitively demanding connected speech production.

1.3.5 Chapter 6 abstract

Word finding problems constitute one of the most common but also most pervasive symptoms in aphasia. While picture naming tasks have typically been employed for the assessment and treatment of word-retrieval difficulties, very few
studies have investigated the relationship between confrontation naming and connected speech tasks in the aphasiological literature. This study investigated whether a newly-developed treatment targeting both speed and accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming would be more effective for improving the use of the treated names in connected speech, than the standard therapy (‘standard presentation’ - SP) which targeted accuracy alone. Twenty participants with aphasia of varying degrees of severity and subtype took part in twelve therapy sessions over 6 weeks. In the baseline and post-treatment assessments, participants were asked to complete a composite picture description task and a picture naming task, the items of which were part of the composite pictures and constituted therapy targets. For the dependent variables of speed and accuracy in picture naming, we found that, compared to the standard therapy, the speed-focused therapy was significantly more effective in improving picture naming accuracy and in maintaining the reduced RTs in the long term. The ‘carry over’ of the therapy items to connected speech was increased for all items relative to the baseline. RISP, however, in comparison to the SP, led to significantly higher generalisation of targeted items to connected speech. These findings suggest that a speed and accuracy focused naming therapy has advantages over a standard therapy and can promote strong generalisation effects to more linguistically and cognitively demanding connected speech production.

1.3.6 General Discussion

This final chapter presents an overview of findings from the literature review and the four empirical studies contained in the thesis. Then, the broader theoretical and clinical implications of these results are considered. Finally, the thesis limitations are discussed and potential directions for future research are described.
CHAPTER 2

Key theoretical and methodological considerations: A review of the relevant to the thesis literature
2 Overview

This chapter consists of a literature review which describes the theoretical background to word retrieval in the psycholinguistic literature. Initially the mechanisms engaged in picture naming are reported, and an overview of Levelt’s and Dell’s contributions to the theory of lexical access is provided. Moreover, the variables which can affect picture naming latencies are presented and the two main methods for the elicitation of quicker responses are described. The differences between different word retrieval contexts with respect to the variable of speed are also outlined. This review chapter also elaborates on the complications to lexical access and speed of word retrieval as caused by aphasia. Furthermore, the variables (both item-related and subject-related) affecting picture naming speed in aphasia are presented. Different patterns of word retrieval efficiency in aphasia depending on the elicitation context are reviewed and a review of the different speech therapy methods in aphasia is implemented.

2.1 Word retrieval

2.1.1 Introduction to theories of word retrieval

According to Miller’s (1991) estimations, the mental lexicon of a typical literate adult comprises about 50,000-100,000 words.

Theories of lexical access have primarily been informed by reaction time data, but also by speech errors produced by both neurologically intact (e.g. Fromkin, 1971; Garrett, 1975, 1980) and neurologically impaired individuals (Levelt, 2001). The analysis of spontaneous and experimentally elicited speech errors has been found to be an important source of information about the processes involved in lexical access during speech production (Fromkin, 1971, 1973; Garrett, 1980; Fay & Cutler, 1977; Martin, Weisberg, & Saffran, 1989; Stemberger, 1990; Dell, Juliano, & Govindjee, 1993; Martin, Cagnon, Schwartz, Dell, & Saffran, 1996).
Generally, the processes involved have been identified as:

- the translation of concepts and ideas into patterns of sounds produced by the articulatory organs,
- the retrieval of the suitable words for conveying the message,
- the combination of these words taking into account the grammatical constraints of the spoken language,
- at a final stage, the retrieval of information about how to articulate the selected words (Costa, Colomé, & Caramazza, 2000).

The processes involved in speech production for picture naming

Examining the mechanisms engaged in picture naming has been a way to investigate an oversimplified version of the processes involved in language production, as well as many of the processes involved in lexical access (Costa et al., 2000).

Generally speaking, picture naming involves the matching of a visual item with a conceptual representation, the retrieval of the phonological codes (word) matching with this conceptual representation and finally the articulation of that word (e.g. Potter & Faulconer, 1975; La Heij, 1988; Glaser & Glaser, 1989; Theios & Amrhein, 1989).

More specifically, during picture naming, the following major stages are involved in speech production:

- **Recognition of the picture**
- **Semantic system:**
  Related semantic/conceptual representations corresponding to the picture are activated, either because their semantic representations are interconnected (models of non-decompositional semantics, Levelt, 1989; Roelofs, 1992) or because they share some of their semantic features (models of decompositional semantics, Dell, 1986; Caramazza, 1997).
  e.g. for a picture depicting a ‘dog’, related animal semantic representations are activated i.e. dog cat mouse etc.
- **Lexical system:**
  Initially, depending on which semantic representations are activated, the corresponding lexical nodes (words) are also activated to some extent in the mental lexicon. This
activation which is spread between different levels of representation is called ‘spreading activation principle’ and it is generally agreed to be implemented between the semantic and the lexical level (Costa et al., 2000). Spontaneous semantic speech errors provide evidence for multiple lexical activation (Caramazza & Hillis, 1990). Subsequently, a lexical selection mechanism is needed in order to choose the proper lexical node (word) from among all the activated lexical nodes so that it will correspond to the picture (e.g. for a picture depicting a ‘dog’, the lexical ‘dog’ should be selected). The selection of the lexical node is based on its level of activation: the lexical node with the highest activation is selected, indicating the lexical competition between the target lexical node (e.g. dog) and its competitors (e.g. cat, mouse etc) (Costa et al, 2000). This stage is also called “grammatical encoding” because at this point words’ grammatical properties are retrieved (Bock & Levelt, 1994; Levelt, Roelofs, & Meyer, 1999).

- **Phonological system:**

At this level, the phonological segments (sounds) of the selected word (e.g. /d/, /o/, /g/) are retrieved. This process is called “phonological encoding”.

An important topic which has generated debate within the processing steps outlined relates to the nature of activation in terms of its direction and the nature of interaction between levels. There have been two main theories about the time course of lexical access in speech production (Costa et al., 2000).

a) The ‘*discrete models of lexical access*’, according to which the spreading activation principle is not applied to the phonological level, thus not allowing phonological activation of non-selected lexical nodes. Given that the activation of phonological segments is restricted to those of the selected lexical node, this activation cannot occur before the selection of the target lexical node (Levelt, 1989; Schriefers, Meyer, & Levelt, 1990; Levelt et al., 1991; Levelt et al., 1999). Among other supporting evidence, Levelt et al. (1991) conducted a lexical decision task and found that no cascade occurred with semantically weak alternates (e.g. phonological activation only of the segments of the target word *frog* and not of its weak alternate *snake* as well).

b) The ‘*cascade(d) models of lexical access*’, according to which the nodes of all the lexical access’ layers (semantic, lexical & phonological) receive some activation, no matter which is the primarily activated one. Given the “general spreading activation principle” and that normally only one of the competitive words is uttered, the activation of the phonological segments must occur before the selection of the lexical node (Stemberger, 1985; Dell, 1986; Dell & O’Seaghdha, 1991; Harley, 1993; Starreveld &
La Heij, 1995, 1996; Caramazza, 1997; Dell et al., 1997; Rapp & Goldrick, 2000; Navarrete & Costa, 2005). The cascaded system is an integral part of the interactive models of lexical access (e.g. Dell’s model). Peterson’s and Savoy’s (1998) experiment corroborated the findings of Levelt et al (1991) regarding the lack of cascade in semantically weak alternates (e.g. frog – snake) but they also found a different behaviour of semantically strong alternates (e.g. frog – toad) in that those alternates’ phonological segments received cascaded activation, as suggested by Dell’s model (Dell et al., 1997). According to Dell and O’Seaghda (1991), cascaded models postulate that the phonological forms of semantic alternates are strongly activated only when these alternates are considerably activated.

- **Articulation:**
  This final stage is affected by the phonological properties of the word to be named (e.g. the exact position of the muscles used in the speech production) (Costa et al., 2000).

Despite the general agreement on these general stages, there is disagreement between researchers on how these stages are implemented (Dell, 1986; Starreveld & La Heij, 1995; Caramazza, 1997; Roelofs, Meyer, & Levelt, 1998; Levelt et al., 1999).

Below we are going to elaborate on two approaches which have been milestones in the development of the theory of lexical access. Specifically, Levelt’s (1989) and Dell’s (Dell, 1986; Dell et al., 1997) contributions to the theory are considered to be invaluable and hence their approaches are going to be developed.

### 2.1.2 Theories of lexical access – Levelt’s and Dell’s models

**Levelt’s model**

**Levelt’s model - description**

According to Levelt’s model, the architecture of the lexical system about speech production has two major components (‘serial two-system architecture’, see Figure 2.1): a system for lexical selection, which precedes a second system for form encoding. The model holds that those systems are responsible for lemmas and lexemes respectively.
The whole system’s architecture is ‘serial’ in that there is an ordering restriction between the layers: lemma’s selection should precede word form retrieval (Roelofs et al., 1998).

1) The lexical selection system / The syntactic encoding system: This system is responsible for the selection of the target word from amongst the other words in the mental lexicon. Each of those words is referred to as a “lemma” which bears syntactic and semantic (related to meaning) information (Roelofs et al., 1998). Generally, lexical selection aims in selecting a single lemma, taking first into account the speaker’s intention (Levelt, 2001). To be more specific, the lexical selection system consists of two stages:

   (1a) Lemma activation: This is the first step in preparing to articulate a content word. During this process related lexical concepts are coactivated (usually capitals are used to denote lexical concepts) and in turn they activate their corresponding lexical items, the ‘lemmas’. These activated ‘lemmas’ are then competing each other for selection. e.g. when a picture depicting a horse has to be named, lexical concepts like HORSE, ANIMAL and STALLION are coactivated, thus activating the ‘lemmas’ horse, animal and stallion respectively (Levelt, 2001).

   (1b) Lemma selection: The more ‘lemmas’ are coactivated, the longer naming latencies are observed. The only exception where two lemmas can be selected is at the case of very close synonym words. After lemma selection, the access of its syntactic properties is available, involving access to its gender, number, person or tense. This is part of the procedure known as “grammatical encoding” (Levelt, 2001).

2) The form / morphophonological encoding system: This system is responsible for the preparation of the selected lemma’s articulation and it is linked to the “lexemes”, the words’ morphophonological forms (Kempen & Huijbers, 1983; Levelt, 1989; Roelofs, 1992) e.g. lemmas horse and hoarse have the same lexeme <horse> (Jescheniak & Levelt, 1994). Generally, form encoding results in the articulation of the selected item, taking first into account its context. To be more specific, the form encoding system consists of three stages:

   (2a) Retrieval of the morphemic and phonological codes: At this stage, a core assumption of the theory is that only one of the competing lemmas is selected and is then available for retrieval and activation of its phonological codes (Levelt et al., 1991). However, as indicated by speech error data, the only exceptional case where two lemmas can be selected is the one of synonymy; in this case both of the selected
lemmas’ phonological codes (e.g. ‘couch’ and ‘sofa’) can be concurrently retrieved and activated (Levelt et al., 1999). Moreover, two crucial factors in the course of accessing the phonological code is the lemma’s frequency and its age of acquisition (AoA); the higher the frequency of the word or the lower the age being acquired, the faster the process for its access. More importantly for our study, word frequency is crucial for the speed of getting from lemma to phonological code (Jescheniak & Levelt, 1994). As for the relationship between morphemic and phonological codes, “a phonological code is retrieved for each of the morphemes” (Levelt, 2001, p. 13465). This is the reason why the rule of retrieval of the phonological words as a whole is not applied to multimorphemic words; if a lemma has a multimorphemic code, then all its morphemes and their respective phonological codes should be retrieved separately and incrementally e.g. for the plural number of the lemma horse, both <horse> and <iz> should be retrieved (Levelt, 2001). Evidence for this rule has been provided by the “phonological facilitation effect”, according to which priming any of the phonological code’s part speed up the retrieval of the whole word. In particular, “phonological facilitation effect” adjudicate that auditory distracters (either words or nonwords) which are phonologically related to the target word, either in their initial phonemes (e.g. ‘boor’ and ‘book’) or in their final phonemes (e.g. ‘look’ and ‘book’), produce faster naming latencies than unrelated ones (Schriefers et al., 1990; Roelofs, 1997). This means that that the morphology of the word to be named is particularly important in phonological encoding. This is consistent with Levelt’s (1989) and other researchers’ (Shattuck-Hufnagel, 1979; Dell, 1988; Stemberger; 1990; Meyer & Bock, 1992) earlier proposal that once a lemma is selected, its morphological and phonological frame is constructed (e.g. “stem+affix+affix”). When the morphemic and phonological segments are retrieved, they are then inserted into that frame’s slots. Finally, it should be mentioned that neurologically the peak activity during lexical access has been observed in the course of phonological code retrieval at Wernicke’s area, a left posterior temporal region which is known as storage for phonological codes (Levelt et al., 1998).

(2b) Prosodification and syllabification: The phonological codes of the previous stage are incrementally composed to form syllables. Incrementality of encoding is a core characteristic of syllabification, since words can be prepared only from their beginning which serves as a prime (e.g. words cannot be primed by their last phonemes, Meyer, 1990, 1991). Syllabification is context dependent, in that an item’s syllabification is
created every time that the specific item needs to be produced and thus it is influenced by several syntactic and morphological properties of the target item (Levelt, 1989).

(2c) **Phonetic encoding**: Incrementally composed syllabic patterns of the previous stage form phonological words which are subject to phonetic encoding. These syllabic patterns emanate from a “mental syllabary”, which is a storage of highly exercised articulatory syllables (Levelt, 1992; Levelt & Wheeldon, 1994; Levelt et al., 1999). The phonetic encoded string of syllables, which is the output of the whole form encoding and the process of lexical access, is called “articulatory score” (Levelt, 2001).

**WEAVER++**

The computational implementation of the Levelt’s theory is provided by Roelofs (Roelofs, 1992, 1997; Levelt et al., 1999) and it is called ‘**WEAVER++**’. This computational simulation can predict the expected selection latency, by experimentally manipulating the lemmas coactivation.

One of those experimental manipulations employed has been so-called “semantic interference”. The semantic interference effect produces slower reaction times and therefore is more intense when the distracter word is semantically related to the target item (e.g. ‘goat’ and ‘horse’ respectively), rather when the distracter word is semantically unrelated to the target word (e.g. ‘sword’ and ‘horse’ respectively).

Participants have to name pictures presented with semantic distracter words, either in a printed form (Glaser & Düngelhoff, 1984; Roelofs, 1992) or auditorily in a spoken form (Schriefers et al., 1990). Other related experimental manipulations are the fluctuation of the SOA (Stimulus Onset Asynchrony) between the presentation of the distracter word and the picture to be named (Glaser & Düngelhoff, 1984) and the alteration of the task during the same experiment from naming to categorisation and vice versa e.g. as for the categorisation, the participant is instructed to name the superordinate term when seeing a picture (i.e. ‘animal’ for a picture depicting a horse) instead of naming the exact term of the item depicted (i.e. ‘horse’ for a picture depicting a horse) (for a review see Levelt et al., 1999). In gender-marking languages like German and Greek, lemmas competition could be induced by picking stimuli of different gender (stimuli with homogeneous gender, e.g. stimuli with both male and female gender) rather stimuli of the same gender (stimuli with heterogeneous gender, e.g. stimuli of only male gender). Specifically, according to Vigliocco, Lauer, Damian and Levelt (2002) latencies are significantly
shorter when the gender of the presented stimuli is homogeneous rather when it is heterogeneous, because in the homogeneous condition the repeated activation of the words’ same gender positively influence their retrieval (‘gender priming’).

*Other two-step models of word retrieval*

Except from the most-known Levelt’s model (Levelt, 1989; Levelt et al., 1991), other researchers incorporated in their approach the ‘two-step lexical access hypothesis’ as well (Fromkin, 1971; Garrett, 1975; Fay & Cutler, 1977; Kempen & Huijbers, 1983; Dell, 1986; Butterworth, 1989; Roelofs, 1992). What those approaches have in common is the hypothesis that lexical access comprises two steps: the first step is the lemma’s access, which is the process of mapping from a semantic representation to a lemma. Lemma is the intermediate layer’s “hidden” unit (Rumelhart, Hinton, & Williams, 1986) containing not only semantic but also grammatical information (e.g. the item’s syntactic category, the number of nouns etc). Crucially, lemmas also guide the manipulation of words as syntactic entities (Garrett, 1975; Levelt, 1989; Bock & Loebell, 1990; Bock & Eberhard, 1993).

The second step is the phonological form’s access, which is the process of mapping from the lemma to the phonological form. For example, Roelofs’ *network model* (Roelofs, 1992; Roelofs, Meyer, & Levelt, 1996) preserved the lemma-lexeme distinction. Roelofs, a proponent of the spreading-activation principle as well, developed a model which was similar to Levelt’s since it postulated that a word’s semantic and syntactic properties are linked through lemma whereas a word’s morphological and phonological properties are retrieved through lexeme (Roelofs et al., 1998). However no information spreads between those layers, since lemmas are morphologically and phonologically unspecified, and lexemes are semantically and syntactically unspecified.

*Evidence in support of the two-step models of word retrieval*

Evidence in support of the two-step models of word retrieval comes from:

- *Speech errors* in both neurotypical and aphasic participants (e.g. Garrett, 1975, 1980, 1984) (for participants with aphasia see 2.3.1).
- *Manipulation of the SOA condition* (“Time course of lexicalisation”): Many studies (e.g. Schriefers et al., 1990; Levelt et al., 1991) have reported that semantically
related words influence the lemma access procedure (Schriefers et al., 1990), while phonologically related words influence the later stages of word retrieval, namely the phonological access. This evidence is in line with the two-step hypothesis.

- **The tip of the tongue phenomenon (TOT):** The TOT phenomenon stems from a successful lemma access and a subsequent failure of phonological access. This TOT state indicates that although the speaker is aware of the existence of the word (because of the lemma’s successful retrieval) he/she cannot access the word's phonological form (Dell et al., 1997). The association of grammatical information with lemmas is even more distinct in studies about languages which have grammatical gender (e.g. Italian), in which it is reported that speakers know the gender of words they cannot name (Badecker, Miozzo, & Zanuttini, 1995; Vigliocco, Antonini, & Garrett, 1997). Moreover, TOT states share a lot of similarities with the aphasic neologisms (type of sublexical errors) in that both tend to preserve the access to the same information about the target’s word structure (target’s number of syllables, stress pattern and initial consonant, Ellis, Miller, & Sin, 1983; Miller & Ellis, 1987), and are usually produced when the target item is a low-frequency word (Burke et al., 1991).

**Dell’s model**

Dell’s model is again a two-step model (see Figure 2.1) but, in contrast to Levelt’s model, it adopts not only a “cascading” (feedforward) activation across the different levels of representation (semantic, lexical and phonological), but also a feedback interaction across them (‘interactive model’, Dell et al., 1997).

To be more specific, in Dell’s model there are three layers which are responsible for lexical knowledge: the semantic layer, the word layer (containing the lemma) and the phoneme layer (containing the phonological codes). The concept of pictured objects is represented by 10 units in the semantic layer, each of which is linked to the item’s word at the word layer by connections. Connections are also between the word and its corresponding phoneme nodes. All these connections are bidirectional, in that they run not only in top-down directions (feedforward/ downward/cascading activation, like in Levelt’s model) but also reversely, in bottom-up directions (feedback/upward activation), leading to an augmented spreading activation between the
nodes. This means that activation spreads from the semantic layer to the word layer and it continues down to the phonological layer and also in reverse direction, i.e. in a bottom-up direction (Dell et al., 1997).

With reference to lemma access, during this procedure the phonological nodes of the target word and of the target’s phonological neighbours will also be partially activated, thus affecting the activation of the word nodes as well. The selection at this point is based on the amount (“jolt”) of activation (‘weight’, see Figure 2.1) which is received by the target’s semantic and phonologically related neighbours. As with Levelt’s grammatical encoding and syntactic frame (Levelt, 1989), the slots being available at this frame are taken into consideration before the lemma selection i.e. the selected word nodes are those of the proper appropriate syntactic category (Dell, 1986; Dell et al., 1997). The syntactic processes administered at the ‘hidden layer’ of word nodes cause a non-linearity to the lexical access system (Dell et al., 1997).

As for phonological access, this commences when the selected word is given a high jolt of activation. The word receiving this jolt becomes much more activated than its competitors which allows the meaning-form mapping. Similarly with the lemma access, the activation spreads both in top-down and bottom-up direction, thus activating words linked to the target one as well. Moreover, through this spreading activation, the phoneme nodes are activated and linked to the slots of the phonological frame. In contrast to some other approaches (see Levelt, 1992 for a review), Dell’s model suggests that the phonological frame represent the word structure with respect to the word’s stress pattern, it’s number of syllables and the consonant-vowel sequence of each syllable. These phonological categories of the phoneme nodes (e.g. whether their onsets and codas consist from consonants or vowels) have a prominent role in phonological selection, like syntactic categories in lemma selection. In a final stage after the phonemes’ selection, a jolt to each phoneme occurs so that they can turn into articulatory words (Dell et al., 1997).

Finally, it should be outlined that the model’s interactivity (i.e. bi-directional flow of activation) is in line with not only neurotypical participants’ tip of the tongue errors and data from reaction time experiments (e.g. Cutting & Ferreira, 1999; Foygel & Dell, 2000; Ferreira & Griffin, 2003; Stemberger, 2004), but also with aphasic participants’ errors (for the latter see in more detail 2.3.1).
Figure 2.1 Illustration of the two most influential models of lexical access (Levelt et al. 1999; Dell et al., 1997). Taken from Schwartz et al. (2009) (p. 3413)

*Comparison between Levelt’s and Dell’s model*

One of the most notable differences between the two models is that in Dell’s model lexical nodes are linked directly to semantic features, hence not using the Levelt’s model concept/lemma distinction.

A common property between Levelt’s and Dell’s model about lexical access has been found to be that they both incorporate the two-step theories’ core association between lemmas and syntax (Garrett, 1980; Levelt, 1989; Jescheniak & Levelt, 1994) and hence that they involve a modular two-step approach (i.e. separate/distinct lemma access and phonological access) (e.g. Levelt et al., 1991, Dell et al., 1997). However, Dell’s model does not preserve the lexeme level as a distinct level that is separate from the lemma level since lexical nodes are linked directly to phonological features. That is, the respective to the Levelt’s lemma level (now called ‘lexical level’) can be considered a lexeme level as well due to feedback processing during phonological access. Caramazza and Miozzo (1997), proponents of the independent network model, were opposed to the lemma-lexeme distinction, mainly because there are instances that
different types of errors are produced by the same patients depending on the module (writing, speaking, or reading, Caramazza & Hillis, 1991) but also because of the independently preserved grammatical (e.g. gender) and phonological information in TOT states.

Moreover, while Levelt’s model assumes a top-down flow of activation (e.g. from lemma to lexeme), Dell’s model suggests bidirectional connections, hence an interactive, both top-down and bottom-up (upward), flow of activation during each step of the word production network (e.g. potential activation not only from lemma to lexeme, but also from lexeme to lemma or from segment to lexeme). In other words Dell’s model is assigned such network structure and parameters (Dell et al., 1997) that it combines the two-step theory (lemma access and phonological access) with an interactive spreading activation retrieval system. The spreading activation is interactive in that both semantic and phonological information of different layers can be simultaneously activated (Dell et al., 1997). Due to this combination, although Levelt’s two-system theory of lexical retrieval is a suitable framework for the explanation of paraphasias, Dell’s model is more consistent with evidence stemming from patients’ errors and the time course of processing during lexicalisation. Dell’s model is not only consistent with the ‘globally modular’ theories because of the spreading activation, but also with ‘locally interactive’ theories because of the serially ordered jolts constraining this interaction (for a specification of this terminology, see Dell & O’Seaghda, 1991). As for the latter property of the model, it implies that access to the word’s semantic properties exert only a mild effect at the phonological layer and reversely (Dell et al., 1997).

Taken together, these observations suggest that Dell’s model is mildly interactive combining elements of the modular two-step theories and strongly interactive approaches of lexical access, but not fully adopting any of them.

On the other hand, both Levelt’s and Dell’s models would be much more integrated if they had considered how the structure of the lexicon is linked to differences in response time among neurotypical and aphasic participants. For this reason, Dell et al. (1997) suggested that differences in individuals’ reaction times could stem from differences either in the number of word retrieval attempts or in the amount of difficulty for selection among the competitive words during lexical decision. However, no further details have been provided by the authors about the circumstances that could lead to
another attempt or to augmented selection difficulty (i.e. competitive mechanisms) respectively.

2.2 Speed of word retrieval

2.2.1 Speed of word retrieval for picture naming

There is a large volume of published studies describing the role of the variable of speed during reading in neurotypical participants (McRae, Jared, & Seidenberg, 1990; Wolf, 1991) and also in participants suffering from some type of dyslexia (Spring & Capps, 1974; Wolf, 1997; Wolf & Bowers, 1999). This reflects the crucial role of speed in the reading process and hence the functioning of this variable as a prognostic tool for reading disabilities (Spring & Capps, 1974; Wolf, Bally, & Morris, 1986; Ackerman & Dykman 1993; Badian 1995; Meyer, Wood, Hart, & Felton, 1998). Along with accuracy, speed of naming is a critical variable for the response generation in naming, which is quite important for interpreting naming data and evolving/developing theories about the underlying cognitive processes (e.g. Balota et al., 1989; Lupker et al., 1997).

Speed of word retrieval during picture naming is considered to be the time needed for the initiation of a naming response after the presentation of the picture-to-be-named and hence it is distinct from the naming duration (see also Kello & Plaut, 2000). Speed of word retrieval during speech production and especially during picture naming is a fairly neglected area in the extant literature. The only relevant evidence can be retrieved from the limited studies measuring the subjects’ naming latencies in response to the presentation of certain stimuli during naming tasks. The results of those studies are presented below.

The time course of word retrieval

Regarding the time course for lexical access, Levelt (2001, p. 13470) underlined that “the reaction time is the cumulative effect of no less successive operations”, i.e. of the lemma selection and the form encoding (see in detail the stages of the two systems
in 2.1.2). The time needed to elapse from the picture onset to the lemma selection is about 200ms (Damian, Vigliocco, & Levelt, 2001; Maess, Friederici, Damian, Meyer, & Levelt, 2002), while phonological encoding takes place 275-400ms after picture onset (Levelt et al., 1998) and thus 75-200ms after lemma selection. Hence, the latencies of correct naming from picture onset to the onset of the spoken response are typically 400-1500ms (Goodglass, Theurkauf, & Wingfield, 1984). To be more precise, taken together the findings of Van Turennout, Hagoort and Brown (1997) and Schmitt, Schiltz, Zaake, Kutas, & Minte (2001), a schematic representation about lexical access’ time course is shaped as shown below (Figure 2.2). However, Levelt (2001) highlighted that the comparison of reaction times at the end of lexical access procedure does not specify which stage contains the difference.

*Figure 2.2 Schematic representation about lexical access’ time course (Van Turennout et al., 1997; Schmitt et al., 2001)*

<table>
<thead>
<tr>
<th>Conceptual (80ms)</th>
<th>Gender (40ms)</th>
<th>First phoneme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focusing</td>
<td>Access</td>
<td>Access</td>
</tr>
</tbody>
</table>

*Variables affecting the picture naming speed*

The variables which can affect speed of picture naming belong to two main categories: word variables and subject variables.

A) **Word variables**

Regarding the word variables affecting the naming latencies, these can be classified in four distinct categories (for reviews see Kosslyn & Chabris, 1990; Johnson, Paivio, & Clark, 1996; Alario et al., 2004).

**Visual variables**: Visual complexity and image agreement are considered important in affecting the first stage of the picture naming process, i.e. the visual word recognition system.
In particular, the visual complexity factor, i.e. the amount of details in the picture’s drawing, is the most controversial regarding its significance, since some authors have suggested that visually complex objects produce longer latencies (Attneave, 1957; Berman, Friedman, Hamberger, & Snodgrass, 1989; Ellis & Morrison, 1998), while others have argued that visual complexity may not be that important (Snodgrass & Yuditsky, 1996; Cuetos, Ellis, & Alvarez, 1999; Bonin, Chalard, Méot, & Fayol, 2002), especially when the pictures-to-be-named are black-and-white (Biederman, 1987; Paivio, Clark, Digdon, & Bons, 1989).

Another visual factor is the image agreement of the participant’s mental image of an object to the object’s picture-to-be-named. According to Barry, Morrison and Ellis (1997), the higher the image agreement, the shorter the naming latencies.

**Semantic variables:** These variables are concept familiarity, imageability, concreteness, semantic category, prototypicality and [± living], all of which are related to the semantic system.

To be more specific, the familiarity of the concept depicted in a picture has been found to have some influence on speed of naming (i.e. the higher the value of this factor is, the faster the naming time of a picture will be) (Feyereisen, Van der Borght, & Seron, 1988; Snodgrass & Yuditsky, 1996; Ellis & Morrison, 1998; Cuetos et al., 1999).

As for imageability, i.e. the degree to which a concept is easy to visually depict, this has been found to significantly affect picture naming latencies (Ellis & Morrison, 1998; Bonin et al., 2002); once the range of imageability value is not overly-narrow (as in Morrison, Ellis, & Quinlan, 1992), then the higher the imageability value, the shorter the latencies of the responses.

Moreover, imageability is linked to concreteness: concrete words are characterised by high imageability values and are named faster, while abstract words by low imageability values, leading to longer naming latencies (Alario et al., 2004). Furthermore, it should be stressed that concreteness effect is affected by the word’s order of presentation: when blocks of concrete words precede blocks of abstract words, longer latencies are produced for concrete rather abstract words, but when the order of presentation is reverse, no difference at the naming latencies of the two types of blocks is observed (Kroll & Merves, 1986).

Semantic category is another important factor regarding the naming latencies in that slower responses are produced in recognising and naming items of different
semantic categories, e.g. natural category (‘lemon’, ‘apple’) or man-made category of objects (‘ball’, ‘cake’) (Morrison et al., 1992). As for prototypicality, i.e. the degree for which an item is a typical/prototypical or atypical/nonprototypical exemplar of one category e.g. natural or man-made, besides it is not a so investigated variable, Morrison et al. (1992) reported its correlation with picture naming latencies.

Finally, regarding the \([\pm \text{living}]) property of the items to-be-named, non-living items are named faster than living items, regardless of the elicitation method (Hodgson & Lambon Ralph, 2008). According to Rogers et al. (2004), living stimuli are structurally similar, because they are more tightly clustered in semantic space, and hence they are more likely to be confused, while non-living stimuli are structurally dissimilar, due to their relative isolation within semantic space, and hence they are less likely to be confused with other concepts.

**Lexical variables:** name agreement, frequency and age of acquisition (AoA), which are related to the lexical system.

Regarding name agreement, i.e. the number of different names that could be attributed to a certain picture, all the studies agree that pictures with higher name agreement are named faster than those with lower the value of this factor, even independently of other variables as age of acquisition and word frequency (Lachman, Shaffer, & Hennrikus, 1974; Paivio et al., 1989; Vitkovitch & Tyrrell, 1995; Snodgrass & Yuditsky, 1996; Barry et al., 1997).

As for the frequency it has been reported that the higher the frequency of the word depicted at the picture, the faster the naming latency will be (Oldfield & Wingfield, 1965; Carroll & White, 1973; Snodgrass & Yuditsky, 1996). This result was obtained even when concept familiarity and age of acquisition were not controlled (Barry et al., 1997; Ellis & Morrison, 1998, Bonin et al., 2002).

The variable of frequency has been strongly associated with the AoA, in that high-frequency words are usually acquired more early than low-frequency words, which tend to be acquired later. Some researchers have agreed that when age of acquisition is matched across stimuli then there is no need for the frequency to be controlled as well (Carroll & White, 1973; Morrison et al., 1992; Morrison, Chappell, & Ellis, 1997; Bonin et al., 2002), because age of acquisition effects are not always combined with frequency effects on picture naming latencies (e.g. Morrison et al., 1992). On the other hand, there are authors who argued that frequency and age of acquisition influence
independently naming latencies (Lachman, 1973; Lachman et al., 1974; Snodgrass & Yuditsky, 1996; Barry et al., 1997; Ellis & Morrison, 1998, Allario et al., 2004) and that age of acquisition produced a robust effect in picture naming (Meschyan & Hernandez, 2002; Lambon Ralph & Ehsan, 2006). Hence, frequency should not replace AoA, especially regarding the late-acquired words (Barry, Hirsch, Johnston, & Williams, 2001), and both of the variables should be independently controlled in picture naming tasks.

**Phonological variables:** The degree with which the word length affects the articulation / phonological system has been a highly debated issue, i.e. most of the researchers have not found length effects in picture naming tasks (Snodgrass & Yuditsky, 1996; Bachoud-Lévi, Dupoux, Cohen, & Mehler, 1998; Dell’Acqua, Lotto, & Job, 2000; Alario et al., 2004), yet some researchers have found faster naming responses for words with less syllables (Cuetos et al., 1999; Santiago, MacKay, Palma, & Rho, 2000). It has been suggested that certain other factors must affect the presence or not of a relevant effect, such as whether or not stimuli are mixed (longer and shorter words) or not (i.e. where effects are not observed in the mixed condition, Meyer, Roelofs, & Levelt, 2003), or the high or low frequency of the depicted words (i.e. where effects are observed only for low frequency words, Ferrand, 2000).

Generally, it is not very easy to discern which of the aforementioned variables are more primary related to the others (Gordon, 1997). However, taking into account the previously reported results, it can be concluded that the major variables in predicting picture naming speed are name agreement, visual complexity, image agreement, frequency and age of acquisition (Alario et al., 2004). The single most important variable in predicting the speed of word retrieval seems to be the name agreement, since it affects directly the word retrieval and not the prior object decision latencies (Johnson et al., 1996). For the same reasons, age of acquisition and frequency are particularly important at the speed of word retrieval: both of these variables affect the most essential level for word retrieval, namely the lexical level, and not so much the semantic and the phonological encoding/articulation level (Barry et al., 1997).
B) Subject variables

Subject variables have also been found to affect picture naming latencies. Psycholinguistic studies have indicated that the most important are age and education attainment: the younger a person is and the more the years of its education, the faster the naming speed will be (e.g. Neto & Santos, 2012, for a review see Griffin & Spieler, 2006). These two factors were considered as critical since they were directly related to the participant’s linguistic and cognitive abilities (Newman & German, 2005; Gollan & Brown, 2006).

Moreover, some information has become available on the way that age can correlate with the variables of frequency and AoA in picture naming. Regarding the first correlation, unfortunately there have been few studies probing how the interaction of age and frequency can affect the picture naming latencies. It might be expected that older adults are less sensitive to frequency effects, because of those persons’ increased use of the words (Gollan, Montoya, Cera, & Sandoval, 2008). However, the opposite tendency has been observed: older adults tend to be more susceptible to frequency effects (i.e. lower frequency words taking longer), as it is indicated by picture naming latencies (Chae, Burke, & Ketron, 2002). This effect may be due to other age effects which prevail over the effect of increased use of the words.

As for the second correlation between age and AoA, again studies have not been in agreement about how the interaction of those factors can affect picture naming latencies. While some studies report attenuated AoA effects for older adults (Morrison, Hirsh, Chappell, & Ellis, 2002), others find similar effects for both older and young adults (Barry, Johnston, & Woods, 2006). However, in both of these studies, older adults generally named pictures more slowly than the young adults.

Finally, studies investigating the correlation between education and frequency have reported that the more literate individuals are, the more attenuated the frequency effects will be (e.g. Tainturier, Tremblay, & Lecours, 1992).
Control mechanisms – The speed-accuracy trade-off

It seems reasonable to hypothesise that ‘the time course of processing can be shortened somehow’ as a result of time pressure (Kello, 2004, p. 942).

Many studies have reported that latencies decreased when instructions underlined speed but increased when instructions underlined accuracy. Hence, there is speed-accuracy trade-off (Pachella & Pew, 1968; Wickelgren, 1977), depending on whether the emphasis of the instructions given to participants is on speed or accuracy. In particular, the speed-accuracy trade-off is an effect that has been attributed to control over time course: it is observed in classical naming studies using the deadline naming method, according to which a control mechanism must be engaged to shorten the time course of processing when fast responses are required. In this context, Lupker et al. (1997) suggested that subjects set a time criterion to initiate naming, according to which they first set a time deadline adjust regarding the stimulus onset (Ollman & Billington, 1972), and if the representation of the word to be named is not available by that time, then the response is based on whatever representation is fully activated at that time. Moreover, given that there is a direct link between the difficulty of the stimuli and the respective speed of their naming, participants combine the time criterion with a judgement regarding the difficulty of the words to be named, in order to produce both accurate and speedy responses as much as possible (Kello & Plaut, 2000).

Elicitation methods for quicker responses

Methods designed for the elicitation of quicker responses invariably induce errors, and hence reduce accuracy, in neurotypical subjects’ responses.

Two mainly methods have been found in the literature: tempo naming and deadline naming, as presented below. Both of them were initially developed for word naming, but tempo naming was later adapted to picture naming as well (see 2.1.4.2).
Deadline naming method / Standard naming-to-deadline paradigm

The method was devised by Stanovich and Bauer (1978) and then it was developed by Vitkovitch and Humphreys (1991), Colombo and Tabossi (1992) and Vitkovitch, Humphreys and Lloyd Jones (1993).

The deadline naming method is typically implemented as follows. In each trial, subjects are presented with a stimulus (a word or a picture) for some time (e.g. for 300ms) and then a beep follows. This beep serves as the response deadline: participants’ task is to try to ‘beat the beep’ and name the item before the beep occurs. If the participant’s answer is slower than the preset deadline, he is asked to respond more quickly (Kello & Plaut, 2000). Thus, in this method, speed of response rather than naming accuracy is prioritised. In some of the early studies, faster responses were encouraged with more indirect incentives: the ‘reward’ for shorter latencies was monetary instead of the feeling of ‘beating the beep’ (Wickelgren, 1977).

Tempo naming technique

A) The standard tempo naming technique (Kello & Plaut, 2000)

Kello and Plaut (2000) introduced the tempo naming technique and conducted a series of experiments comparing this technique to the standard deadline naming paradigm under different conditions. The tempo naming technique was developed so that the mechanism of the subjects’ strategic control over the speed of responses would be investigated.

During tempo word naming, subjects are presented with a series of evenly spaced beeps (forming a steady rhythm), as well as with a decreasing visual cue on the computer screen. The complete letter string that has to be read is presented on the final beep and the task is to pronounce the letter string simultaneously with the beginning of the next beep, which is not actually produced. Implementing this method, participants’ naming times could be experimentally controlled by slowing or accelerating the tempo (Kello & Plaut, 2000).

Across the experiments, when the tempo increases, errors increase as well (Kello & Plaut, 2000; Kello, 2004), while, on the other hand, the response time and duration is
reduced (Kello & Plaut, 2003). In other words the tempo manipulation induces progressively faster responses but with more errors, indicating that very fast tempos induce a speed–accuracy trade-off (Kello, 2004). Stimulus type has been found to not affect latencies in the tempo naming task relative to the standard naming task (Kello & Plaut, 2000).

Kello and Plaut (2003) simulated the aforementioned effects of the newly introduced paradigm using a PDP model, and specifically by forcing an increased processing speed in the network (increasing the unit input gain function). This resulted in less controlled processing and hence in the increase of error rates.

Comparing the *tempo naming technique* with the more standard *deadline naming method*, Hodgson and Lambon Ralph (2008) suggested that participants can estimate better the time that they should begin a response in the tempo naming task, whereas in the deadline naming task subjects, which are not given a precise cue for when to initiate each response, seem to respond just as quickly as possible. However, deadline tasks have the advantage of eliciting faster reaction times and simultaneously less errors than the tempo tasks. According to the authors, these results are observed due to the dual-paradigm nature of the tempo naming paradigm: subjects are not only encouraged to name the pictures quickly but also to maintain a given tempo. These requirements are responsible for dividing, and thus reducing, general attention-executive resources (Hodgson & Lambon Ralph, 2008).

B) Picture version of the ‘tempo naming technique’ – Tempo picture naming technique (Hodgson & Lambon Ralph, 2008)

Hodgson and Lambon Ralph (2008) investigated the novel application of a picture version of the *tempo naming technique* by Kello and Plaut (2000). In contrast with Kello and Plaut’s method that adopted the tempo naming of words (tempo word naming technique), the paradigm used by Hodgson and Lambon Ralph made use of picture-based tasks. This technique constituted an experimental model of patients’ (i.e. semantically impaired stroke aphasic patients) naming errors and behaviour.

According to this method, a series of three beeps are produced to a given tempo and each of these beeps is accompanied by a fixation point on the screen. At the fourth
beep, instead of the fixation point, the picture to be named is presented on the screen, while at the fifth beep the participant is expected to name the item, so that his response would coincide with this last beep. As with the standard tempo technique, maintaining the tempo is underscored over accuracy of object naming.

As in Kello and Plaut (2000), it was not expected that the participants would be able to manage naming the items at the same time when hearing the fifth beep on every trial, but that their effort to achieve it would put them under pressure while responding, which was the desired effect of the method (Hodgson & Lambon Ralph, 2008).

Moreover, Hodgson and Lambon Ralph (2008) investigated the application of a picture version of the tempo naming technique not only making use of picture-based tasks, but also providing a correct or incorrect phonemic cue to neurotypical participants during the tempo picture naming task. Methodologically, the only difference with the aforementioned paradigm was that for each target item, participants heard a series of correct or incorrect phonemic cues or a series of neutral cues (beeps). As expected, reduced RTs and more importantly fewer errors occurred in the correct cue condition followed by the neutral and then the incorrect cue condition. Moreover, as in the standard technique, the slow tempo produced slower RTs and fewer errors compared to the fast tempo.

To sum up, tempo picture naming increases the error rate and therefore reduce semantic control, i.e. controlled speech production. However, this loss of control is regained if a correct phonemic cue is given (Hodgson & Lambon Ralph, 2008).

2.2.2 Speed of word retrieval in other forms of elicitation: Different patterns of word retrieval depending on the retrieval context

The aim of the present subsection is to present the findings of studies which seek to examine whether elicitation procedure, or context, has an effect on the speed of word retrieval.

Whilst there is a large volume of psycholinguistic studies pointing to the intense differentiation between picture naming and naming in connected speech (Ferguson & Armstrong, 1996), there is a paucity of information about the differences between different word retrieval contexts with respect to the variable of speed. Moreover, there
is a considerable database on the speed of word retrieval in connected speech tasks performed by subjects with language disorders (e.g. Nippold, 1992; Faust et al., 1997), but not on relevant tasks performed by neurotypical individuals.

Participants’ lexical access, and in particular lemma selection, is different depending on the length of the phrase to be produced. Specifically, when small phrases have to be produced (e.g. “the red car”), longer latencies are expected when a semantic distracter word related to the target noun is given to the subjects (e.g. “cow”) (Costa & Caramazza, 2002). However, in longer phrases containing more than one noun (e.g. “the baby is next to the dog”), this effect is not consistent in all the cases (Levelt & Meyer, 2000). Furthermore, for complicated utterances like the last example, other studies have reported faster latencies when the noun was phonologically primed (Wheeldon & Lahiri, 1997; Costa & Caramazza, 2002), while in other studies this effect was not observed (Schriefers, 1993; Schriefers & Teruel, 1999).

Furthermore, according to Dell’s model, the time-course of the per-step ‘jolt’/amount of activation depends on the context of the word to be named: if the word is going to be part of a sentence (like in connected speech tasks), the word is highly activated when it reaches the specific free slot of the syntactic frame, but when the word has to be named in isolation, it is activated immediately on its selection (Dell et al., 1997). In this way, the syntactic slot to which the selected word is linked is responsible for the jolt of activation (e.g., MacKay, 1982; Stemberger, 1985; Dell & O'Seaghdha, 1991), indicating that picture naming priming effects are attenuated in connected speech.

### 2.3 Complications to speed of word retrieval: Aphasia

Aphasia is an acquired language deficit resulting from acquired brain injury which affects speech, comprehension, reading and writing. One of its most debilitating symptoms is word retrieval failures where even simple, everyday words cannot be produced easily or quickly (also known as ‘anomia’, Laine & Martin, 2006). This “affects all aspects of everyday communication such as talking to a family member, conversing in social settings, using the telephone etc.”, and “dramatically reduces people’s quality of life” (Lambon Ralph et al., 2010, p. 290).
At this section, we will elaborate on the complications to lexical access and speed of word retrieval as caused by aphasia. Then, we will make a review of the therapy methods and their effectiveness regarding the variable of speed of word retrieval.

2.3.1 Lexical access in aphasic speech production

The information provided by aphasic’s speech errors

Generally, lexical access in aphasia is characterised by the same stages as those followed by unimpaired, neurotypical participants (see 2.1.2). This view is supported by aphasic speech errors, which simultaneously provide evidence for the two-step models of word retrieval (e.g. Garrett, 1975, 1980, 1984), as shown below:

a) sublexical errors can be attributed to an impaired phonological access. To be more specific, phonemic (a type of sublexical error) paraphasias stem from erroneous articulation of the phonological representations retrieved from the lexicon, and share similarity with errors in neurotypical participants’ segmental errors (e.g. slip of the tongue errors) (Buckingham, 1980; Garrett, 1984; Schwartz, 1987).

b) lexical errors can be attributed to an impaired lemma access. More specifically, semantic (type of lexical) errors can be interpreted as evidence for the parallel activation of the semantic and the phonological forms of all the words that are semantically similar to the target item (Howard & Orchard-Lisle, 1984; Caramazza & Hillis, 1990). However, these errors can be also explained in the context of the two-step system of lexical access through the “cascading” (feedforward) activation across the different levels of representation (semantic, lexical and phonological) (McClelland, 1979; Humphreys, Riddoch, & Quinlan, 1988).

c) mixed (semantic and phonological) errors provide evidence for the interaction of semantic and phonological information during word retrieval (Dell et al., 1997).
In contrast to Levelt’s model, Dell’s model, based on the spreading activation principle, has attempted to account for the errors’ distribution of not only neurotypical but also aphasic participants in picture naming tasks. The model has been parameterised in order to be consistent with both unimpaired and pathological picture naming data (Dell et al., 1997). For this reason, it brought to the fore the so-called “continuity thesis”, according to which errors of neurotypical participants, e.g. tip of the tongue errors (TOT errors) are qualitatively similar to the patients’ errors, as the aphasic paraphasias, since they are attributed to similar mechanisms of the neurotypical speech production system (Dell et al., 1997). In the context of lexical access, Dell’s model assumed that simple quantitative changes to the parameters of the neurotypical system can elucidate much of the aphasic error patterns (Dell et al., 1997). Hence a continuum emerges based on the variation of activation patterns within and among neurotypical and neurologically impaired speakers. The place of patients’ errors in that continuum is determined mainly by the severity but also by the type of each patient’s impairment. The “continuity thesis” has also been supported by the recovery data from aphasic patients, since “recovery is the movement of pathological parameters toward normal values” (Dell et al., 1997, p. 826).

This interpretation of language pathology in the context of neurotypical speech production through quantitative changes in the operation of neurotypical language system is consistent with PDP models of key processes such as reading (Patterson, Seidenberg, & McClelland, 1990; Plaut, McClelland, Seidenberg, & Patterson, 1996). The core characteristic of those models is the multiple versions of neurotypical subjects’ reading system, depending on the severity of dyslexia. Likewise Dell’s model assumes that the structure of the lexicon is linked to the severity of impairment causing the aphasic errors, in that severely impaired aphasic participants tend to produce more unrelated words and nonwords and more non-naming responses in comparison to participants with milder impairment (Mitchum et al., 1990). Moreover, like Dell’s model, PDP models assume that learning is responsible for the production of intermediate representations (“hidden units’ activation patterns”) (Plaut, 1996), which are similar to representations of the target’s both semantic and phonological/formal neighbours (e.g. the representation of cat have common units with dog and mat respectively, see Figure 2.1) (Dell et al., 1997). However, despite the hidden units’
common function in the two models, they differ in the distribution of the representations since PDP model suggests that the intermediate representations are distributed while Dell’s model is considered as “nondistributed” (Dell et al., 1997).

A drawback of Dell’s model is that it is not compatible with extreme dissociations in patients’ errors. Nevertheless, Dell et al. (1997) argued that many of these extreme cases arise from differences in the methodology being followed by the researchers. For example, they supported that regarding the self-correction cases, different outcomes arise depending on the answer that the researchers consider as correct, i.e. the first one, the second one, etc.

Dell’s approach to errors during lexical access – the model’s implications for error analysis

Dell’s model accounts for all the basic types of errors produced by aphaic individuals, namely:
1. semantically related word errors, which reflect trouble at the lemma access (Dell et al., 1997).
2. form-related errors: Regarding phonological errors, Dell’s model (Dell, 1988; Sevald & Dell, 1994; Dell et al., 1997) is more or less congruent with other researchers’ approaches, many of which are developed for the phonological access of neurotypical subjects (Shattuck-Hufnagel, 1979; Stemberger, 1990; Levelt & Wheeldon, 1994). Generally, form-related errors occur either during the lemma access or during the phonological access. In the first case, the errors usually follow the syntactic class constraint i.e. errors are of the same syntactic category with the target, while in the latter case the errors usually follow the phonotactic constraints as they are defined by the phonological frames and the phoneme nodes’ degree of activation.
3. mixed (semantic-formal) errors: they are consistent with the model’s assumption that semantic and phonological information are not independent but they can be active at the same time due to the bidirectional connections among the three layers. In contrast to this explanation, Levelt’s model attributes these errors to “the action of late editorial processes in production” (Levelt et al., 1991).
4. unrelated word errors: they arise during lemma access, at phonological access or when both semantic and phonological information are activated.
5. neologisms or nonwords: Depending on whether the neologisms/nonwords are similar to the target or not, they are considered to reflect trouble during phonological access, or during both lemma and phonological access respectively. Finally, specifically the errors during repetition tasks are attributed to a correct lemma access but it is assumed that errors occur during phonological access (Dell et al., 1997).

2.3.2 Speed of word retrieval in aphasia

Focusing on accuracy data without reporting speed of patients’ performance gives an incomplete and maybe misleading picture of any cognitive function (Crerar, 2004). However, references in the speed of word retrieval during both picture naming (2.3.2.1) and connected speech tasks (2.3.2.2) are strikingly absent from the aphasiological literature, as shown below.

Variables affecting the picture naming speed in aphasia (prior or after therapy)

Variables related to the items

One of the variables affecting the aphasic’s naming latencies is word class of target words: verb-naming times are overall slower relative to noun-naming times. This word-class effect can be attributed to the tendency of the verbs to be more complex (e.g. lower imageability, lower picture name agreement), thus demanding extra processing load along all levels of linguistic analysis (syntax, morphology and phonology, Bird, Lambon Ralph, Seidenberg, McClelland, & Patterson., 2003a; Conroy, Sage, & Lambon Ralph, 2006, 2009a). This is in line with the findings of other studies, which point to the post-therapy noun-naming, comparing to verb-naming, advantage both in accuracy and speed of naming and the subsequent difficulty in retaining improvements in verb naming after therapy ceases (Conroy et al., 2009b, 2009d). Another explanation is provided by Conroy et al. (2009b), who argued that the word-class effect may result from the verbs’ greater length rather than from word class per se.
Moreover, it has to be outlined that imageability is linked not only to concreteness, as mentioned in 2.2.1 about neurotypical participants, but also to the word class of the names: concrete words and nouns are characterised by high imageability values and are named faster, while abstract words and verbs by low imageability values, leading to longer naming latencies (Alario et al., 2004; Conroy et al., 2009b). Verbs’ lower imageability comparing to nouns (Bird et al., 2000) can be explained by the fact that the semantic level is the only level of linguistic analysis at which verbs prove to be less rich than nouns (Bird, Howard, & Franklin, 2003b). This discrepancy in verbs’ richness constitutes a problem from a therapy point of view (Conroy et al., 2006).

Finally, as for the items’ meaning, participants with aphasia can more easily retrieve literal meaning words than metaphorical meaning, because of an impairment in the process of linguistic analysis, i.e. difficulty to suppress the literal meaning of words (Papagno, Tabossi, Colombo, & Zampetti, 2004).

**Variables related to the participants with aphasia**

As well as item-related variables, participant-related variables can affect the speed of word retrieval.

One of the most important variables is participants’ varying linguistic, cognitive and neuropsychological profile, as well as their varying degree of baseline naming impairment (mild vs. severe) (Conroy et al., 2009b; Fillingham et al., 2003). For example, Crerar (2004) employed a written sentence comprehension task and pointed to the correlation between the severity of the impairment and the post-therapy speed of patients’ speech: the slower the patients had been initially, the more the speed of sentence processing decreased.

Furthermore, Conroy et al. (2009a, 2009d) suggested that, among others (comprehension and phonology), measures of naming at the baseline were likely to predict the therapy outcome. However, external factors, such as age, sex, premorbid intellectual level or occupation and motivation, have not been found to be predictive of the general therapy efficacy (Crerar, 2004).

Moreover, different aphasia subtypes have been associated with differences in the speed of word retrieval. For instance, Broca’s aphasic patients preserve the ability to
access lexical information automatically but only if they are given sufficient time to do so, while Wernicke’s aphasic patients show fast initial activation, like the neurotypical participants, but priming effects are observed after an abnormal delay of 300-1100msec (Prather, Zurif, Love, & Brownell, 1997).

Finally, while age is a major factor in naming speed of neurotypical subjects, evidence of the influence of age has not been found in subjects who have recovered from aphasia, since they were slower in processing and producing words comparing to the neurotypical population independently of age (Neto & Santos, 2012). However, to the best of our knowledge, no such dissociation has been reported for the variable of age and the neurotypical versus aphasic population, implying a need for further research.

In the same vein, although there is evidence that there is no relation between the time post-onset and the naming latencies produced by persons who have recovered from aphasia (Neto & Santos, 2012), no research has investigated the influence of time post-onset on the aphasic participants’ response speed. Hence this variable, which is pertinent to our study, needs further investigation.

**Speed of word retrieval in other forms of elicitation: Different patterns of word retrieval depending on the retrieval context**

Regarding the impaired population, confrontation naming and spontaneous speech are particularly different in terms of word retrieval. Compared to naming of single words, access to lexical information in the context of connected discourse may prove to be either facilitated, if some words are primed, or handicapped, because of the more complex task requirements (Feyereisen et al., 1991).

Generally, reduced response speed is a typical symptom of aphasia, even after standard therapies or rehabilitation. This derive from the fact that people with aphasia may be competent in ‘exploiting’ metalinguistic skills to enhance their accuracy performance even many years post-CVA, but not sufficiently competent to achieve neurotypical speed scores too (Crerar, 2004). This is also indicated by the recovery patterns of aphasic individuals who show an identical performance to neurotypical participants at the linguistic tasks (Kertesz & McCabe, 1977), but the time they need for
the accomplishment of the tasks is double relative to the respective speed of neurotypical participants (Neto & Santos, 2012).

Word retrieval patterns vary depending on the elicitation context. Error patterns of patients suffering from different subtypes of fluent aphasia (e.g. conduction aphasic individuals and anomic aphasic participants) are not the same in picture naming and spontaneous speech. More specifically, in confrontation naming tasks lexical and sublexical paraphasias (e.g. van → bus and ghost → /goʊ/ respectively) are produced by all aphasic patients independently of the specific aphasia impairment (Mitchum et al., 1990). In spontaneous speech, however, different errors types are produced depending on the aphasia subtype: conduction aphasic patients produce primarily sublexical errors (mainly phonemic paraphasias), while anomic patients produce occasionally lexical errors (mainly semantic ones) and circumlocutions. These results are quite revealing in several ways. First, they indicate that naming and spontaneous speech make different linguistic and cognitive demands. Moreover, it becomes apparent that connected speech data (from both spontaneous speech samples and connected speech elicitation tasks) in comparison to naming provides much more opportunities to the speakers for avoidance of the difficulty retrieved vocabulary, by using more familiar similar-synonym words, by making use of circumlocutions or even by choosing to convey a different message (Dell et al., 1997).

There has been a lot of work about the different patterns of word class retrieval (verbs vs. nouns retrieval) depending on the different elicitation context (confrontation naming/single word naming vs. sentences and/or connected speech). Some studies have suggested that the two different contexts have a direct (“one-to-one”) relationship (Berndt et al., 1997; Herbert et al., 2008). However, other studies have reported that fluent aphasic participants are subject to different patterns of nouns’ and verbs’ retrieval depending on the retrieval context (Williams & Canter, 1987; Zingeser & Berndt, 1988; Berndt & Haendiges, 2000; Pashek & Tompkins, 2002; Mayer & Murray, 2003; Luzzatti et al., 2006). In particular, word class dissociations in different contexts have been associated with different types of impairment. According to Williams and Canter, relative to other aphasic patients (Broca’s, Wernicke’s, and conduction aphasic patients), anomic patients show the lowest association both between noun confrontation naming and noun retrieval in connected speech (Williams & Canter, 1982) and between verb naming and verb retrieval in connected speech (Williams & Canter, 1987). Furthermore, Williams and Canter (1987) reported that participants with Broca’s
aphasia experienced less WFD in picture naming and the Wernicke’s group experienced less WFD in composite picture descriptions. Because of these results, the researchers proposed that aphasia type can be considered as a clinical marker denoting the association of word retrieval in different contexts.

Regarding verbs, Jonkers and Bastiaanse (1998) reported that verbs are better produced in connected speech rather in confrontation naming tasks. Hence, in contrast to confrontation naming, it becomes obvious that sentence frames can facilitate verb retrieval by aphasic patients (Marshall, Pring, & Chiat, 1998; Berndt & Haendiges, 2000). Consistent with aphasic patients’ relatively reliable word retrieval for verbs in connected speech tasks are the findings of Luzzatti et al. (2006), who found that aphasic patients retrieve the same or an even greater number of verbs in connected speech as neurotypical participants. However, the published studies have not provided a consistent answer in terms of whether those verbs are of smaller diversity than those produced by neurotypical participants (Bastiaanse, Edwards, & Kiss, 1996; Berndt et al., 1997; Bastiaanse & Jonkers, 1998; Edwards & Bastiaanse, 1998) or not (Luzzatti et al., 2006).

As for nouns, controversial results have been produced. Some studies have reported better object naming rather noun retrieval in connected speech tasks (Manning & Warrington, 1996; Schwartz & Hodgson, 2002), while others have reported the reverse results, i.e. worse noun retrieval in confrontation naming rather in connected speech tasks (Berndt et al., 1997; Zingeser & Berndt, 1988).

Irrespective of word class, some authors have reported better word retrieval for both nouns and verbs in confrontation naming rather in conversation (Manning & Warrington, 1996), and others have argued that both nouns and verbs are better retrieved in connected speech tasks and worse in confrontation naming (Mayer & Murray, 2003; Pashek & Tompkins, 2002; Williams & Canter, 1987).

Unfortunately, none of the established approaches can account for this phenomenon of word retrieval dissociations in different contexts: some researchers have assumed that nouns and verbs share the same semantic system (Moss, de Mornay Davies, Jeppeson, McLella, & Tyler, 1998), while others have suggested that nouns and verbs are organized and stored in different subsystems and do not share the same neural pathways for retrieving the phonological form (Caramazza & Hillis, 1991). The latter theories may go some way in explaining how the independent subsystems of verbs and nouns account for their different vulnerability in brain impairments, but not for their different vulnerability depending on the retrieval context.
With regard to post-therapy generalisation, verbs have been found to be as likely as nouns to generalise to connected speech, in spite of verbs’ more demanding processing, both linguistically and cognitively (Conroy et al., 2009d).

As for the variable of accuracy in the context of therapies, whilst several cases indicating dissociations in naming skills across different naming contexts (picture naming vs naming in spontaneous speech) have been recorded in the literature (Zingeser & Berndt, 1988; Marshall & Cairns, 2005), it has been argued that picture-naming accuracy significantly predicted naming in connected speech contexts, either in more constrained speech elicitation contexts (composite picture description, Maendl, 1998; narratives, Conroy et al., 2009d) or in conversations (Herbert et al., 2008; for a review about generalisation to conversation see Carragher et al., 2012).

Finally, regarding the variable of speed, there is theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b) yet naming speed has been a neglected area in the aphasiology literature (Crerar, 2004). From a clinical point of view, the items which are named more quickly at a post-therapy point are more expected to be named in connected speech contexts (Conroy et al., 2009d). As for therapies which aim at improvement only of accuracy and not of speed as well, Conroy et al. (2009d) illustrated that the speed of picture naming after a cueing-only type of therapy (i.e. decreasing cue therapy) could not predict the extent to which items are named in more spontaneous connected speech tasks. Given that fluent connected speech requires not only accurate (i.e. production of no more than one or two errors per 1000 words, Levelt, 1989) but also quick lexical access (i.e. fluent speakers produce around 100 words per minute, equating to around half a second per word or 2 words every second e.g. on the Cookie Theft description, Levelt, 1989; Bird et al., 2000), therapy effects may be more likely to generalise to spontaneous speech if both accuracy and speed are improved. This is the basic hypothesis of our study, and the basic incentive for developing a new method that will emphasise both accuracy and speed of word retrieval.
2.3.3 Aphasia treatment

To date naming therapy studies (i.e. therapies targeting word retrieval) have focused solely on improving accuracy. However, a novel yet potentially key finding in the literature (Fillingham et al., 2003, 2005a, 2005b, 2006; Conroy et al., 2009a, b, c, d) is that speed of naming may be an important variable, not only within assessment tasks (McCall et al, 1997), but also within therapy tasks, warranting further investigation.

Treatment interventions for aphasic participants

The most prevalent treatment tasks are the orthographic, phonological and semantic ones. However, it has also been used other tasks, which are related to semantic and/or phonological treatments. These tasks include gestures which are associated with both semantic and phonological tasks (Rose, Douglas, & Matyas, 2002), drawings, which are usually part of semantic treatments (Hillis, 1998), or even hypnosis, which is also associated with the semantic treatment (Thompson, Hall, & Sison, 1986). Finally, a therapy can be multicomponent in nature, i.e. involve orthography, phonology, and semantics (via presentation of a picture), and thus increase the possibilities of the language system’s recovery (Hickin, Herbert, Best, Howard, & Osborne, 2002).

Below we will elaborate on the prevalent treatment tasks and their implication in terms of accuracy and the generalisation to untreated items.

- **Orthographic treatment:** The patients’ knowledge of the words’ written form is utilised for the retrieval of the spoken form: the subject is either relearning the letter–sound correspondences (Nickels, 1992) or is listening to the initial letter’s phonemes as generated by a computer (Bruce & Howard, 1987; see also Best & Nickels, 2000). This type of therapy has been administered mainly with patients who perform better in written naming than in spoken naming (because of the subjects’ inability to convert letters to sounds) and it has benefits in both naming and reading (Bachy-Langedock & De Partz, 1989).

- **Semantic treatment:** Although semantic processing is involved in almost all type of tasks (see below at the phonological tasks), semantic tasks emphasise strengthening semantic information at the conceptual level. These tasks are generally word-picture matching tasks: the patient is given a spoken or written word or a definition and has to
select the semantically and functionally relative picture among a set of semantically related pictures, taking into account semantic features of stimuli within a particular superordinate category (Drew & Thompson, 1999; Kiran & Thompson, 2003). The basic technique on which are based most of the semantic treatments is the semantic feature analysis (SFA), which attempt to facilitate spreading activation of semantically related words. According to this technique, the aphasic patient is asked to name a picture and then to analyze its semantic features associated with its properties, use, action, location, and association (Boyle & Coelho, 1995; Lowell, Beeson, & Holland, 1995; Coelho, McHugh, & Boyle, 2000; Boyle, 2004).

The semantic treatment tasks are considered to be effective in terms of accuracy and have long-lasting results (e.g., Marshall, Pound, White-Thomson, & Pring, 1990; Nickels & Best, 1996). However, it remains controversial whether such treatment tasks lead to generalisation to untreated (semantically related) items or not (Drew & Thompson, 1999; Coelho et al., 2000; Kiran & Thompson, 2003) and whether they are effective if the word form is not provided (“pure” semantic tasks, Drew & Thompson, 1999).

- **Phonological treatment**: Phonological treatment essentially comprises tasks which particularly aim at the improvement of phonological processing. These tasks are mainly word repetition in the presence of a picture (Robson, Marshall, Pring, & Chiat, 1998) and picture naming with a phonological (and orthographic) cueing (Nickels, 2002a). Phonological treatment typically involves semantic processing, since phonological tasks like repetition would not be beneficial if repeated words were not understood.

As for phonological therapies’ effectiveness, they have been shown to have long-lasting effects on word retrieval (Davis & Pring, 1991; Raymer, Thompson, Jacobs, & Le Grand, 1993; Hickin et al., 2002; Rose et al., 2002). Nevertheless, it is not clear whether phonological treatments lead to generalisation to untreated items (Robson et al., 1998) or not (item-specific effects: Nettleton & Lesser, 1991; Hillis & Caramazza, 1994; Miceli, Amitrano, Capasso, & Caramazza, 1996). One possible explanation for this dissociation is that generalisation was observed in studies which comprised tasks involving both orthography and phonology (letters and sounds) and not only phonology (or whole word orthographic forms) (Nickels, 2002a). Moreover, an indisputable advantage of the phonological tasks is that they are effective in improving picture
naming for aphasic participants with not only phonological but also semantic errors in naming (Raymer et al., 1993; Nickels & Best, 1996).

However, this has also been the case for semantic treatments, since both semantic and phonological tasks have been used to enhance word retrieval in general and not specifically in patients with semantic and phonological impairments respectively (Nickels, 2002a). This is not the only common characteristic of semantic and phonological treatments: crucially, both of them are equally effective in terms of accuracy (Howard, 2000).

Given that both semantic and phonological tasks comprise both types of information (semantic and phonological), and that they both have therapy effects by strengthening the links between the semantic system and the phonological forms, it becomes more conceivable that the more effective word retrieval therapies are those that combine features of both the semantic and phonological tasks (Robson et al., 1998; Hickin et al., 2002).

**Therapies improving aphasic participants’ speed of word retrieval**

A therapy which has some evidence with respect to being effective in improving speed of word retrieval in aphasic participants is errorless learning (Conroy et al., 2009b). Pure errorless techniques in aphasia therapy are inclined to use word repetition as a phonological cue, the target picture as a visual cue, and the written target as orthographic cue (Fillingham et al., 2003; Abel, Schultz, Radermacher, Willmes, & Huber, 2005; Conroy et al., 2006). Especially for verbs, using errorless learning techniques can minimise the requirement for executive control and the cognitive demands required for verb processing (Fillingham et al., 2003, 2005a, 2005b, 2005c). This is extremely important for this type of therapy, if we consider the verbs’ critical role in sentence production and thus in connected speech (lexical hypothesis of agrammatic speech, Saffran, Schwartz, & Marin, 1980) (Marshall et al., 1998; Bastiaanse, Edwards, Maas, & Rispens, 2003). However, a question yet to be answered is whether consistently faster naming responses on the part of participants during errorless therapy is a corollary to the type of the therapy being administered or not (Conroy et al., 2009b).
Moreover, it should be stressed that errorful therapy technique is equally effective with errorless learning in terms of speed for verb and noun naming (Conroy et al., 2009c). However, errorless therapy has generally been found to be preferable by patients given that it is easier to engage with than trial and error naming and many find it more satisfying (Conroy et al., 2009b; Conroy et al., 2009c).

Specifically in the context of errorless learning, the decreasing cue therapy may be optimal in that it combines low error with sustained effort by gradually reducing initially substantial cues and was found to be as effective as increasing cues, in terms of both naming speed and accuracy (Conroy et al., 2009b).
CHAPTER 3

Speed of naming: Examining the relationship between naming latency and likelihood of retrieval in connected speech in neurotypical participants
3 Abstract

Word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms affecting everyday communication. Both the assessment and treatment of aphasia typically involve confrontation naming tasks, which makes the assumption that performance in picture naming tasks reflects ease and reliability of word retrieval in connected speech tasks. While the aphasiology literature does contain some studies investigating the relationship between confrontation naming and connected speech tasks, little consideration has been afforded to the key variable of naming latency as a possible factor in determining word availability in connected speech. Before investigating naming latency in clinical populations, this study sought to establish whether a statistically robust relationship could be found between naming latency and word retrieval in connected speech within the neurotypical population. 27 neurologically intact, monolingual, English-speaking, elderly participants were asked to carry out a composite picture description task (n=3) and a picture naming task (n=100) within one assessment session. A statistically significant negative correlation was found between picture naming latencies and accuracy in picture descriptions implying that words more quickly named in picture naming were more likely to be produced in picture descriptions. Speed of word retrieval is an important factor which has some measureable influence on the easy availability of words in connected speech in neurotypical language processing. This finding could have important implications for clinical assessment and treatment of anomia in aphasia.
3.1 Introduction

Word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms affecting everyday communication. Both the assessment and treatment of aphasia typically involves confrontation naming tasks (for pros and cons of picture naming tests, see Herbert et al., 2008), which makes the assumption that performance in picture naming tasks will reflect, at least in broad terms, the ease and reliability of word retrieval in connected speech tasks and lexical retrieval within everyday communication.

One variable which may be critical in determining whether words retrieved in isolation can also be retrieved within the time demands of fluent speech is naming latency, or speed of naming in confrontation naming (Conroy et al., 2009b, 2009d; Crerar, 2004). While some studies investigating the relationship between confrontation naming and connected speech tasks have been published in the aphasiological literature (Feyereisen et al., 1991), there is a dearth of studies probing this connection in unimpaired population (Bock & Griffin, 2000a). Speed of word retrieval during picture naming is considered to be the time needed for the initiation of a naming response after the presentation of the target picture and is distinct from the naming duration (see also Kello & Plaut, 2000). Along with accuracy, speed of naming is a critical variable for the response generation in naming, which is important for interpreting naming data and evolving theories about the underlying cognitive processes (e.g. Balota et al., 1989; Lupker et al., 1997). Furthermore, given that neurotypical speakers do not typically produce erroneous responses in terms of accuracy in normal, non time-pressurised conditions, speed of naming may be a helpful window through which to more fully examine and understand word retrieval in neurotypical, and ultimately, aphasic participants. Therefore, this study focused on investigating the effects of picture naming latencies on word access in connected speech samples. Specifically, a correlational study was designed in which we tried to establish the relationship between the likelihood of word retrieval in connected speech tasks and the picture naming latencies i.e. the speed of word retrieval in confrontation naming.
3.1.1 Speed of picture naming

There is a large volume of published studies describing the role of the variable of speed during reading in neurotypical (non-impaired) participants (McRae et al., 1990; Wolf, 1991) and also in participants suffering from some type of dyslexia (Spring & Caps, 1974; Wolf, 1997; Wolf & Bowers, 1999). This reflects the crucial role of speed in the reading process and hence the functioning of this variable as a prognostic tool for reading disabilities (Spring & Capps, 1974; Wolf et al., 1986; Ackerman & Dykman 1993; Badian 1995; Meyer et al. 1998). Despite broad agreement about the importance of the variable of speed in lexical access, speed of word retrieval during speech production and especially during picture naming is a fairly neglected area in the current literature.

3.1.2 Speed of word retrieval in other forms of elicitation: Different patterns of word retrieval depending on the retrieval context

When people speak fluently, they have to rapidly produce content words (nouns, verbs, adjectives and adverbs) in sentence frames, based on their resources (attentional, vocabulary access etc.). Whilst there is a large volume of psycholinguistic studies pointing to some discrepancies between performance in picture naming and naming in connected speech (Ferguson & Armstrong, 1996), there is a paucity of information about the differences between different word retrieval contexts with respect to the variable of speed. For example, regarding the issue of different patterns of word retrieval depending on the retrieval context, Costa and Caramazza (2002) reported that participants’ lexical access, and in particular lemma selection, is different depending on the length of the phrase to be produced. Specifically, when small phrases have to be produced (e.g. “the red car”), longer latencies are expected when a semantic distracter word related to the target noun was provided (e.g. “cow”). However, in longer phrases containing more than one noun (e.g. “the baby is next to the dog”), this effect is not consistent in all the cases (Levelt & Meyer, 2000). Furthermore, for complicated utterances like the last example, other studies have reported faster latencies when the noun is phonologically primed (Wheeldon & Lahiri, 1997; Costa & Caramazza, 2002), while in other studies this effect is not observed (Schriefers, 1993; Schriefers & Teruel,
1999). According to Dell’s model, the time-course of the per-step activation depends on the context of the word to be named: if the word is going to be part of a sentence (like in connected speech tasks), the word is highly activated when it reaches the specific free slot of the syntactic frame, but when the word has to be named in isolation, it is activated immediately on its selection (Dell et al., 1997). In this way, the syntactic slot to which the selected word is linked is responsible for the amount/jolt of activation (e.g., MacKay, 1982; Stemberger, 1985; Dell & O'Seaghdha, 1991).

Research on the issue of word retrieval in non confrontation-naming contexts has primarily focused on word retrieval in connected speech tasks performed by participants with language disorders (e.g. Nippold, 1992; Faust et al., 1997). Although some neurotypical studies examined the impact of psycholinguistic variables like frequency on sentence completion tasks, there is a paucity of neurotypical studies examining the influence of relative variables and especially of word retrieval speed on speech production when carrying out connected speech tasks (e.g. picture description or narratives). For instance, it has been found that word frequency (Griffin & Bock, 1998) and contextual constraints (i.e. predictability in the context) affected the time of production of words in sentence contexts (Goldman-Eisler, 1958), i.e. words were produced faster in sentences when they were of high frequency or when they were predictable in that context. However, the tasks performed by participants in these studies actually involved reading (i.e. reading isolated words coming up on screen and, at the end of each sentence, naming a picture in rebus fashion) rather producing spoken sentences and hence the results of these studies cannot easily be generalised to connected speech.

3.1.3 The cognitive processes involved in speech production

Examining the cognitive mechanisms in picture naming has been a way to investigate the processes involved in language production, as well as many of the processes involved in lexical access (Costa et al., 2000). Theories of lexical access have primarily been informed by reaction time data, but also by speech errors produced by both non-impaired (herein ‘neurotypical’) (e.g. Fromkin, 1971; Garrett, 1975, 1980) and impaired individuals (Levelt, 2001). The analysis of spontaneous and experimentally elicited speech errors has been found to be an important source of information about the
processes involved in lexical access during speech production (Fromkin, 1971, 1973; Garrett, 1980; Fay & Cutler, 1977; Martin et al., 1989; Stemberger, 1990; Dell et al., 1993; Martin et al., 1996).

Generally, the processes involved in lexical access have been identified as the translation of concepts and ideas into patterns of sounds produced by the articulatory organs, the retrieval of the suitable words for conveying the message, the combination of these words taking into account the grammatical constraints of the spoken language, and, at a final stage, the retrieval of information about how to articulate the selected words (Costa et al., 2000). As for picture naming, it involves the matching of a visual item with a conceptual representation, the retrieval of the phonological codes (word) matching with this conceptual representation and finally the articulation of that word (e.g. Potter & Faulconer, 1975; La Heij, 1988; Glaser & Glaser, 1989; Theios & Amrhein, 1989). However, the processes involved in lexical access during connected speech including additional cognitive challenges have received less attention. For example little is known about lexical access when describing a picture or in narratives, which require us to rely on attentional or memory resources respectively. This paper wants to investigate the different patterns of word retrieval depending on the elicitation context, by looking at the connection of confrontation naming variables to picture description lexical access data of accuracy and speed.

3.1.4 Research Questions / Hypotheses

One of the more significant findings to emerge from the studies mentioned before is that speed of naming is a potentially critical yet overlooked variable not only in word retrieval in neurotypical participants (non-impaired monolingual participants) but also in conditions causing complications to word retrieval, namely aphasia. Despite these important theoretical and clinical issues, naming speed has been a neglected area in the literature and this underlines the importance of implementing carefully designed experiments which will add substantially to our understanding of the impact of speed of naming on performance by neurotypical participants and participants with aphasia in both picture naming and connected speech tasks.
Research Question 1: Is there any correlation between efficient naming (short latency time) and the likelihood of word retrieval in connected speech tasks? I.e., does speed of retrieval of specific words in picture naming predict whether the same words are likely to be retrieved in connected speech?

Research Question 2: Can we relate RTs in naming with the time window of word retrieval in connected speech tasks which last several minutes? I.e., are the items named faster also quicker retrieved (within the first minutes) in connected speech tasks?

With regard to question 1, our hypothesis would be that there will be a measurable relationship between efficient picture naming and access in connected speech. The prediction would be that speed of picture naming relates directly to the likelihood of production in connected speech. That is, words which are retrieved more quickly and therefore easily in picture naming tasks are also those which are most readily available and produced in connected speech tasks.

For question 2, our hypotheses would be a stronger, related version of that for question 1. That is, the most rapidly retrieved words in picture naming tasks will be the most available words in connected speech tasks and this will be reflected in earlier retrieval in connected speech monologues. It has not been demonstrated if participants describe pictures following a specific, directional strategy, i.e. items may be mentioned early on because of visual or thematic prominence. But within this, items produced early on may also be those most available as represented by shorter picture naming latencies.

These hypotheses regarding the relationship of confrontation naming to speech production are worthy of investigation for two main reasons: a) they provide a novel experimental method for understanding the variables which influence word retrieval in speech production (specifically speed of retrieval) and b) this method may be extended to clinical research with participants with aphasia to examine, for example, issues such as generalisation of learning from picture naming to connected speech.
3.2 Method

3.2.1 Pilot experiment

Before the main experiment, a pilot study was conducted to establish reliability of stimuli across both picture naming and composite picture description tasks. The specific aims of this pilot study were:

1) to select among six composite pictures (i.e. busy social scenes with multiple characters engaged in a range of activities), the most suitable three pictures (n=3) for which descriptions would elicit imageable words covering a range of word retrieval likelihood, i.e. from low word retrieval likelihood - produced by only one pilot study participant (1/10) to high - produced by all participants (10/10). This meant that the relationship we were examining between speed of word retrieval in picture naming and retrieval in connected speech could be analysed across the spectrum of word retrieval difficulty. Furthermore, the selection of only 3 pictures for the main experiment would allow us to reduce the duration for the subsequent main experiment by at least 15 minutes (five minutes description per picture). This was crucial, given that the main experiment comprised two tasks (i.e. picture description and picture naming) which had to be carried out within one session by older adults.

2) to establish picture name agreement for a large corpus of words (n=100) used in the description of the 3 selected composite pictures to be included in the picture naming task of the main experiment.

Pilot picture description task

In order to elicit picture descriptions from non-impaired neurotypical participants, the use of composite multi-event picture stimuli was trialed. Six ‘Where’s Wally’ type pictures were selected (n=6) to be included in the pilot study, as they were potentially appropriate according to the following criteria: 1) they were of high-definition visually; 2) they were complex enough to elicit the production of a lot of words but also not too complex such that it would be difficult for participants to discern discreet parts or not be able to name highly infrequent vocabulary items; 3) they were reasonably culturally appropriate in that they were considered to be inoffensive and
non-controversial (e.g. pictures like ‘where’s Osama’ were excluded). The six pictures which served as stimuli for the picture description task were “where’s Fenton” pictures (pictures A, C, F), “where’s Waldo” pictures (pictures B, E) and a “where’s Wally” picture (picture D) (see Appendix 1).

Ten neurologically unimpaired people (mean age approx. 26 years old, mean years of education approx. 18) were asked to conduct a picture description task. Because the aim of the tasks was to provide general vocabulary measures of native speakers, the age and education of pilot study participants did not need to match the respective independent variables of participants in the main experiment.

Participants carried out the task in front of a computer desktop screen. They were informed that they were going to see six composite or ‘busy’ pictures and that the instructions for all the pictures were the same. They were asked to describe what they saw in a picture in as much detail as they could for 5 minutes. If they had not finished their verbal description in five minutes, they were informed that the time was up, but they would be given some limited extra time to complete their description. At the end of each sub-task they were given feedback regarding their consistency with the expected description time/deadline and they were prompted to be more succinct or elaborate. Participants had consented to being audio-recorded and were digitally audio-recorded with a voice recorder (Sony digital IC Recorder). The pictures were presented in random order, thus counterbalancing the effect of higher picture description difficulty in the pictures attempted to be described first.

Content words and especially common nouns were transcribed. This did not include common nouns (e.g. people, man, woman, guy, person, lady, gentleman, things, stuff, and situation) and proper nouns (e.g. Barack Obama, London, Cameron, William Hague, Nick Robinson). Verbs were not transcribed, neither main verbs (e.g. walk, fish etc.) nor light verbs (e.g. do, have, make, give, get, take etc.). The main reason for excluding verbs was verbs were less likely to produce consistent responses in the name agreement task at the second part of the pilot study because of their increased complexity, e.g., lower imageability, compared to nouns (Conroy et al., 2006).

From the transcribed nouns, some were then selected according to the following criteria:

a) they were imageable, i.e. easily depicted, so that they could be used in the picture naming task of the main experiment e.g. relatively abstract words like crowd and water were excluded from data.
b) had no synonyms or no equally frequent synonyms, which were used alternatively in the picture description task e.g. *dodgems* and *bumper cars* were excluded as well.

The relative number of selected nouns produced in descriptions of the six composite pictures then informed the selection of the most useful three composite pictures.

In order to select 3 out of the 6 composite pictures for the main experiment, based on the likelihood of word retrieval of all the selected nouns, the data were analysed by ‘Number of Participants’ who had produced each item in the picture description task, i.e. words being produced by all 10 participants, the same for 9 participants, 8 participants, 7, 6, 5, 4, 3, 2 participants and finally for 1 participant. When the same word appeared in different categories of ‘Number of Participants’ (e.g. *birds* were produced by 10 participants in picture A and by 7 participants in picture F), the optimal condition was considered the one with the highest score (e.g. the production of *birds* by 10 subjects in response to picture A).

Based on the number of these stimuli in the ‘Number of Participants’ categories across each of the six pictures, we chose the three pictures (A, B and F) that successfully gathered the most balanced distribution of stimuli across these levels of retrieval likelihood (Table 3.1).

We can see that that Pictures C and D were excluded from the main experiment because of the absence of words for the No of Participants categories 10 and 9 respectively. That is, no words were produced by all 10 participants in picture’s C description, while the same occurred (no word production) in picture’s D description but for the category of words produced by 9 participants. The opposite was observed for pictures A and F, whose description resulted in the production of more words per category, especially in the critical categories of higher No of Participants (No of participants 4-10). Among pictures B and E, the former was selected because its description produced more words (i.e. 5 words) in the No of Participants category 8 than picture E (i.e. 1 word). Hence the selected 3 composite pictures from which we selected our stimuli for the name agreement task and the subsequent picture naming of the main experiment were A, B and F.
Table 3.1 The distribution of the number of filtered nouns produced by different number of participants across all six composite pictures

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<td>D</td>
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<tr>
<td>E</td>
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<td>6</td>
<td>11</td>
<td>14</td>
<td>21</td>
<td>42</td>
</tr>
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</table>

Pictures whose numbers are in red were selected for the main experiment.

**Pilot picture naming task**

After the three composite pictures for the main experiment were chosen, nouns among those used in these pictures’ descriptions were selected so that name agreement could be established. More words than needed in the main experiment’s picture naming task (n=100) were selected, so that we could exclude some of them if high name agreement scores were not obtained.

Selection of items was on the basis of high name agreement but also two more criteria had to be covered:

1) participants must have used the names correctly and not erroneously to name an item e.g. antelopes instead of deer.
2) items needed to be clearly depicted in the composite picture. That is, we didn't include in the name agreement task words which were ambiguously depicted in the composite pictures and were not produced by many participants because of their uncertainty for this item e.g. money in picture B. However, we included such words when the depicted item was speculated by many participants e.g. pupils - scouts, toilet - lockers, towel - blanket.
The selected nouns in each ‘Number of Participants’ category were not matched for various psycholinguistic variables (e.g. frequency or age of acquisition) since the basic correlation we wanted to investigate is that of speed of word retrieval in picture naming and likelihood of word retrieval in connected speech. A separate meta-analysis could be conducted later to investigate whether psycholinguistic variables had been making a significant contribution to word retrieval in connected speech. 131 noun pictures (n=131) which had been named during the description of the three composite pictures were evaluated for name agreement.

Google images were used to obtain pictures representing these 131 nouns. All these images had high resolution and were selected to be as similar as possible to the presentation of the item in the composite picture. For example, if a target word had only been produced in plural form because more than one item was depicted in the original intricate picture, a picture depicting the word’s plural number was selected (e.g. swans, meerkats). However, the default number was singular, so if words were produced in both singular and plural number, pictures depicting the single version of the word were selected e.g. despite the production of both lion and lions in picture’s F description, a single lion was chosen for the picture naming task.

Having collated these picture stimuli, we edited them in order to depict only the target item and have as little visual distraction as possible. When the target item needed a context to support identification (e.g. moat), it was presented with its context (e.g. a castle in the center) and the target item was highlighted by a circle or arrow (see examples of the stimuli used in the picture naming task at Appendix 2).

The participants involved in the name agreement (second part of the pilot study) (n=10) were the same with those recruited for the picture description task, except from one person who, due to unavailability at the time, was replaced with another one of approximately the same age and years of education.

Participants sat in front of a computer desktop screen and were asked to name a set of single-item pictures presented on the screen. Participants were informed in advance that they were going to see only pictures whose names were nouns/objects, and that there was no deadline in naming the pictures. Participants were encouraged to produce a single word accurate and precise response, rather than alternative responses or elaborate descriptions.

The picture naming task lasted between 7-10 minutes, depending on the participants’ speed of naming. The images were presented in random order. Again,
participants’ verbal responses were audio-recorded using a voice recorder (Sony digital IC Recorder).

10 words for each of the 10 ‘No of Participants’ categories were selected (n=100) to be included in the picture naming task of the main experiment. All these words had high name agreement i.e. the pictures were accurately named with one word by at least 9 out of 10 participants in the name agreement task.

3.2.2 Main Experiment

The aim of the main experiment was to test the hypothesis that there would be a correlation between efficient accurate naming (short latency time) of the selected 100 pictures and the likelihood of retrieving these words in connected speech i.e. in the 3 composite picture descriptions.

In order to establish this relationship, two tasks were carried out in a single session with a 10 minute break in between tasks: a composite picture description task and a simple/single item picture naming task. Specifically, the three composite pictures selected at the first part of the pilot study (A, B, and F) were selected for sampling monologic descriptions, and then 100 pictures selected through the name agreement task (second part of the pilot study) and depicting items which were prominent within these composite pictures were presented to participants for naming. These two tasks amounted to approximately 30 minutes in total.

A different population from that of the pilot study was sampled for the main study. A random sample of neurologically healthy older adults (people over 60 years old) was recruited. Word finding difficulties (LaBarge et al., 1986) and tip of the tongue states (Rastle & Burke, 1996) have been traditionally associated with ageing. The selection of older adults was based on the vulnerability to decreased speed of word retrieval associated with age (e.g. Griffin & Spieler, 2006; Neto & Santos, 2012) and thus slower word retrieval within older neurotypical participants would provide a wider range of measures and hence more sensitive format for testing the study hypotheses.

27 healthy neurotypical participants were tested. All participants were right handed and they were aged between 64 and 85 at the beginning of the study (mean = 71, SD = 5).
Participants were given a ‘Study Information Sheet’ and then provided informed consent for taking part in the study under an already existing ethical approval (MREC ref: 01/8/94). In line with research group protocol, if participants had not completed the Addenbrooke’s Cognitive Examination (ACE) (Mathuranath, Nestor, Berrios, Rakowicz, & Hodges, 2000) within the last three years, they were asked to complete this test before commencing the main experiment. ACE included the Mini Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), so scores for both tests were obtained, providing a broad measure of cognitive functioning. These scores, along with participants’ demographic details are provided in Table 3.2.

Before commencing the main experiment, participants were informed about the general procedure: the number and type of tasks they would need to carry out, the scheduled breaks and the time anticipated to last the experiment (approx. 45 minutes).

Composite Picture Description

The stimuli for this task were the three composite pictures selected in the first part of the pilot study (A, B, and F).

To complete the task, participants sat in front of a computer desktop screen. They were informed that they were going to see three composite pictures and that the instructions for all the pictures were the same. So beginning with the first picture, they were asked to describe what they saw in the picture in as much detail as they could for 5 minutes. No guidance was provided as to where to start in picture description, as indicating to participants any direction for their description would be quite artificial and could have altered participants’ focus in terms of direction but probably not fluency (i.e. production of as many words as possible). Instead, participants were asked to describe the pictures within five minutes.

Picture description time was monitored using an online stopwatch. If participants had not finished within five minutes, they were informed that the time had lapsed but they were given some limited extra time if they wanted to complete their description. At the end of the picture description they were given feedback regarding their fluency and their accuracy on the expected description time/deadline and they were prompted to be more succinct or elaborate. The overall task lasted between 15-20 minutes, depending on participants’ performance.
Table 3.2 Participants’ demographic details and ACE/MMSE scores

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<tr>
<th>Initials</th>
<th>Age</th>
<th>Sex</th>
<th>School Leaving Age</th>
<th>MMSE scores (max: 30)</th>
<th>ACE scores (max: 100)</th>
<th>Order of composite pictures’ presentation</th>
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<tbody>
<tr>
<td>DR</td>
<td>74</td>
<td>m</td>
<td>18</td>
<td>29</td>
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<td>MA</td>
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MMSE = Mini Mental State Examination (cut-off score: 24/30), ACE = Addenbrooke’s Cognitive Examination (cut-off score: 82/100)

Participants’ responses were tape-recorded with a voice recorder (Sony digital IC Recorder) and they had consented to being recorded before commencing the experiment. Finally, the order of presentation of each picture was randomised across participants (Table 3), thus counterbalancing any effect of higher picture description difficulty in the pictures described first.
**Picture Naming**

Having completed the composite picture description task, participants took a 10-15 minute comfort break, following which they were presented with 100 simple pictures, depicting items included in the three composite pictures described above. These 100 pictures have been selected following the name agreement task (second part of the pilot study).

Naming latencies in the picture naming task were measured using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002). All images had been converted from jpeg to bmp to be compatible with the E-prime software and their dimensions were set to be 360 x 360 (width x height). Moreover, the voice key/microphone plugged in the response box (SRBOX) was adjusted so as to be quite sensitive to recognise the onset of words, but not be overly sensitive as this would result in registering not only the words’ onset but also other sounds before the onset, such as breathing, coughing or swallowing.

Some trial runs with E-prime were allowed but no participant had any difficulties with understanding or conducting the task. Participants sat approximately 80 cm from the computer screen and were informed that they were going to see some pictures and that the task was simply to name these pictures as accurately and quickly as they could. They were asked to name pictures’ most prominent item and be as precise as possible (e.g. *dalmatian* instead of the more general *dog*). When the non prominent item was the target in the picture, it was included in a circle or it was highlighted by an arrow. Participants were also informed that when naming a picture, the picture would disappear from the screen and they would be presented with the next picture. They were told not to feel stressed because of the rapid rate of changing pictures, because this is a result of their speedy responses and not of a default setting in the computer. A picture would not disappear from the screen until their response was given. However, it was explained to them that the computer could not recognise which response was the correct one for the presented picture so it registered the reaction time for the first sound being heard after the picture’s presentation and presented the next picture. For this reason, they were advised to avoid self-corrections, production of sounds indicating uncertainty like ‘eh’, ‘mm’ etc. or sounds stemming from coughing or swallowing, if possible.
A) Picture Naming – Practice Trials

Participants were generally familiar with the use of computers, as indicated by the frequent use of their email accounts through which they were contacted for recruitment. However, because of the potential complications caused by the E-prime restrictions (i.e. those related to the voice key sensitivity mentioned above), we aimed for optimal participant familiarisation with the picture naming task, by giving a session of practice trials. Hence, participants were informed that they could complete as many practice trials as they wanted in order to be familiarised with the task and feel confident before proceeding to the main experiment.

Practice trials constituted a separate experiment. A single block of trials has been presented in E-prime. This block included 15 pictures, which were presented to participants in random order. All pictures were different from those used in the main picture naming task.

The number of practice trials was determined during testing. If participants were producing any other sound before or instead of the target word, they were encouraged to produce only the name of the picture and only when it was their final response. If erroneous responses were repeatedly produced, then participants were asked to repeat the practice trials until they would clearly understand the task. Once participants became familiarised with the E-prime procedure, then they were encouraged to try to name the presented pictures more quickly.

B) Picture Naming - Main Experiment

Given that the experiment would require participants’ sustained attention for responding as quickly and accurately as they could and that it would be conducted with older adults, it was considered essential that the picture naming task take place over two sessions. The total 100 pictures were split into two sets of 50 items per block and each of the blocks was preceded by some practice trials (Figure 3.2). To be more specific the procedure followed was as presented below:

- Before the first block of trials, participants were presented with the same 15 stimuli of the practice trials, so that the experiment would start more easily.
- Then participants were presented with the first block of trials (n=50 items).
- After being presented with the first half of the pictures, participants were informed that they had completed half of the task and that they would have a break. Then they were asked to press a button when they were ready to proceed to the second part of the picture naming.

- Before the second block of trials, subjects were presented with 3 extra pictures.

- The second set of 50 pictures had followed.

Each of the two main blocks of trials consisted of 5 words for each of the 10 ‘No of Subjects’ categories: 5 words produced by 10 subjects in the pilot study, 5 words produced by 9 subjects, 5 words by 8 subjects etc. All words were presented in a random order.

In each trial, participants were initially presented with a fixation point for half of a second. This fixation mark was used to indicate the place that the participant should be looking when the trial began, while also it was used as a warning signal so that the participant would get ready for the trial. Subsequently, participants were presented with a blank screen for another half second. This brief delay before the target presentation (‘foreperiod’) was the same for all trials. At the end of the foreperiod, the target picture was presented. The minimum presentation time of the stimulus was set at ½ second (500msec), and its maximum presentation time at 4 seconds (4000msec). Once the picture was named, it disappeared from the screen. The range in the target’s presentation time would allow the participant to move on quickly to the next trial if the picture was easily named, or to have enough time to retrieve the word (up to 4 sec), if the word to be named was difficult to retrieve. The minimum time for picture presentation was set at half of a second, meaning that the voice key would be triggered after ½ second had elapsed. The reason for that was that in this ½ second the subject may have produced accidentally a sound other than the target picture’s name and we didn’t want this erroneous production to be registered. The maximum presentation time was set at 4 sec because of the maximum time of retrieval of low frequency words in the pilot study i.e. more than 3 seconds.

Finally, between the end of one trial and the beginning of the next one, a blank screen was presented for half second (fixed ‘inter-trial interval’) (Figure 3.1).

No feedback as to accuracy was provided at the end of each trial, as this would undermine the importance of timing in the experiment. Also participants did not receive feedback as to speed, in order to avoid speed-accuracy-trade-off types of problems.
The whole task i.e. practice trials and main picture naming task, lasted 10-15 minutes, depending on participants’ need of repeating practice trials and their speed of naming.

*Figure 3.1 Trial design*

- fixation point (half second)
- blank screen (half second, fixed foreperiod)
- picture/target (min. stimulus display set at ½ second, max. at 4 seconds)
- separate blank screen (half second, fixed inter-trial interval)

*Figure 3.2 Method of the main experiment*
3.3 Results

Reliable data was obtained from 24 of the 27 participants who took part in the main experiment. The reasons for not including the 3 participants’ data related to frequent error production affecting the timing data obtained by E-prime. The dependent variables in both picture naming and composite picture description were accuracy and speed/reaction time (RT). For each of these two variables, two measures per target word were computed. This resulted in four measures, two for each task:

a) accuracy in picture naming: this related to accuracy in confrontation naming for each item (i.e., either 1 for accurate or 0 for inaccurate) as measured by the proportion of participants who named the word correctly e.g. 9/24 participants.

b) speed of picture naming/latencies (in ms): for each correctly named item we collated reaction times (in milliseconds, as provided by the E-prime software). RTs for some items were excluded from the statistical analysis, if for example the item was not accurately produced or because the registered RT was erroneous, typically due to noise/hesitation sounds produced before the word. Very early responses (below 400msec) were also removed from the dataset, as latencies of correct naming from picture onset to the onset of the spoken response are typically 400-1500ms (Goodglass et al., 1984).

c) accuracy in picture description: this related to accurate production of a word (i.e., again, either 1 for accurate or 0 for inaccurate) within a composite picture description task.

d) speed/time of word retrieval (in seconds) in picture description: this related to the time point within a description when items were initially correctly produced. This was measured as the time elapsing from the onset/beginning of the picture description to the time of production of the target word in picture description. This was initially calculated in minutes/seconds (e.g. 2.08 minutes) and then converted time to seconds (e.g. 128 seconds). While self-corrections were not considered as accurate productions in the picture naming task, they were accepted in the picture description task once the self-correction did lead to accurate retrieval.
3.3.1 By-items analysis

A by-items analysis was first utilised in order to address the original research questions.

Descriptive statistics

The key descriptive statistics of these data included mean, median, SD, minimum and maximum (also skewness and kurtosis in Table 3.3) as follows:

- picture naming accuracy across the 100 word set across the 24 participants had a mean value of 19 participants, SD 5.390, min 3, max 24. That is, the mean number of participants producing correctly a word in picture naming was 19 participants (with margin of ± 5 participants). The minimum number of participants naming accurately a word (i.e. word with very low accuracy in picture naming) was 3 and the maximum number of participants naming accurately a word (i.e. word with very high accuracy) was 24, i.e. word named by all participants.

- picture description accuracy across the 100 word set across the 24 participants had a mean value of 11 participants, SD 7.309, min 0, max 24. That is, the mean number of participants producing a word in picture description was 11 participants (with margin of ± 7 participants). The mean minimum number of participants retrieving a word in picture description was 0 (i.e. word that no one produced in picture naming) and the mean maximum number of participants retrieving a word in picture description was 24 (i.e. word produced in picture description by all participants).

- picture naming speed across the 100 word set across the 24 participants has a mean value of 1029 milliseconds, SD 319.771, min 670.96, max 2390.17. That is, the mean RT of an item in picture naming was approximately 1 second (with margin of ± 320msec). The mean minimum speed in naming a picture was 671 msec (i.e. word with the shortest mean RT) and the mean maximum picture naming latency was approximately 2390 msec (i.e. word with the slowest naming latency).

- picture description speed across the 100 word set across the 24 participants has a mean value of 163.87 seconds (~ 2.7 minutes), SD 61.444 (~1 minute), min 35.18 (~0.58
minutes), max 356.50 (~5.9 minutes). That is, the mean time of an item’s production in picture description was approximately 2.7 minutes after the picture description’s onset (with margin of ± 1 minute). The mean minimum time of word retrieval in description was approximately half minute (i.e. word retrieved earliest in the picture description) and the mean maximum time of word retrieval in description was approximately 6 minutes (i.e. word retrieved latest in the picture description).

The mean is different from the median indicating a skewed/asymmetrical distribution. Also, the median is lower than mean indicating that data were positively skewed and the tail spreads out towards higher values. The absence of normal distribution is finally indicated by the kurtosis value (not zero). Because of this non-parametric relationship, we decided to carry out a Spearman’s correlation test.

Table 3.3 Descriptive statistics – By items analysis

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pic. Naming Accuracy</td>
<td>19.44</td>
<td>5.39</td>
<td>3</td>
<td>24</td>
<td>-1.42</td>
<td>1.09</td>
</tr>
<tr>
<td>Pic. Naming Speed Mean</td>
<td>1029.36</td>
<td>319.77</td>
<td>670.96</td>
<td>2390.17</td>
<td>1.71</td>
<td>3.26</td>
</tr>
<tr>
<td>Pic. Naming Speed Median</td>
<td>967.23</td>
<td>307.93</td>
<td>674.50</td>
<td>2359</td>
<td>2.17</td>
<td>5.45</td>
</tr>
<tr>
<td>Pic. Description Accuracy</td>
<td>11.01</td>
<td>7.31</td>
<td>0</td>
<td>24</td>
<td>0.29</td>
<td>-1.20</td>
</tr>
<tr>
<td>Pic. Description Speed Mean</td>
<td>163.87</td>
<td>61.44</td>
<td>35.18</td>
<td>356.50</td>
<td>0.31</td>
<td>0.11</td>
</tr>
<tr>
<td>Pic. Description Speed Median</td>
<td>149.38</td>
<td>72.58</td>
<td>15</td>
<td>356.50</td>
<td>0.35</td>
<td>-0.25</td>
</tr>
</tbody>
</table>

Correlation Results

In order to investigate the correlation between the four measures mentioned above, we used Spearman’s correlation. One correlation table was produced (Table 3.4), giving a correlation matrix.
The main research question was to ascertain whether there was a statistically significant correlation between the speed of naming and the likelihood of word retrieval in connected speech. The most striking result to emerge from the data was the significant negative correlation between picture naming latencies and accuracy in picture descriptions which gave a Spearman’s correlation coefficient of –0.320 and a significant p value of 0.01. This meant that words with shorter RTs (more quickly named in picture naming) were more likely to be produced in picture descriptions. In other words, the lower the RT in picture naming, the higher the probability of production in connected speech.

These data also allowed us to evaluate if accuracy (as opposed to latency) in picture naming predicted likelihood of word retrieval in picture descriptions. The results, as shown in Table 3.4, indicated that there was a significant positive correlation between the two measures: it gave a Spearman’s correlation coefficient of 0.378 and a significant p value \((p < .0005)\). This confirmed the more obvious hypothesis that accuracy of retrieval in picture naming is aligned with accuracy of retrieval in composite picture description.

We also found a statistically significant positive correlation between mean picture naming latencies for 100 items across 24 participants and mean retrieval latencies within composite picture descriptions across these items and participants \((r = 0.202, p = 0.047)\). This indicated that words produced faster in picture naming were also produced earlier in picture descriptions, i.e. within the first minutes.

Within these data, there was also a highly significant correlation between speed and accuracy within the tasks. Namely, there was a highly significant negative correlation between accuracy in picture naming task and speed in picture naming \((r = -0.650, p < .0005)\), while also a highly significant negative correlation between accuracy in picture descriptions and time of word retrieval in picture descriptions \((r = -0.382, p < .0005)\). In the first case, this confirmed that items which were more likely to be produced accurately in picture naming were also more quickly produced within the same task, and in the latter correlation, that items which were more likely to be produced in picture descriptions, were produced earlier in picture descriptions.

Finally, as expected, no significant negative correlation was found between picture naming accuracy and the time of word retrieval in picture descriptions \((r = -0.150, p = 0.121)\). That is, words tending to be named accurately in picture naming were
not always produced earlier in picture description, but sometimes were retrieved later within the description.

Table 3.4 Spearman’s correlation for speed and accuracy in picture naming and in picture description – By items analysis

<table>
<thead>
<tr>
<th></th>
<th>Pic. Naming Speed</th>
<th>Pic. Naming Accuracy</th>
<th>Pic. Description Speed</th>
<th>Pic. Description Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pic. Naming Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>1.000</td>
<td>-.650**</td>
<td>.202*</td>
<td>-.320**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>&lt; .005</td>
<td>.047</td>
<td>.001</td>
</tr>
<tr>
<td>Pic. Naming Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>-.650**</td>
<td>1.000</td>
<td>-.159</td>
<td>.378**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>&lt; .005</td>
<td>.</td>
<td>.121</td>
<td>&lt; .0005</td>
</tr>
<tr>
<td>Pic. Description Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>.202*</td>
<td>-.159</td>
<td>1.000</td>
<td>-.382**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.047</td>
<td>.121</td>
<td>.</td>
<td>&lt; .0005</td>
</tr>
<tr>
<td>Pic. Description Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>-.320**</td>
<td>.378**</td>
<td>-.382**</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
3.3.2 By-subjects analysis

A by-subjects analysis was then conducted.

Descriptive statistics

Descriptive statistics included mean, median, SD, minimum and maximum (also skewness and kurtosis at Table 3.5) as follows:
- picture naming accuracy across the 24 participants across the 100 word set has a mean value of 81 words, SD 5.421, min 67, max 91. That is, the mean number of words produced correctly in picture naming was 81 words (with margin of ± 5 words). The minimum number of words named accurately by a participant (i.e. participant with very low picture naming accuracy) was 67 and the maximum number of words named accurately by a participant (i.e. participant with very high picture naming accuracy) was 91.
- picture description accuracy across the 24 participants across the 100 word set has a mean value of 45 words, SD 7.014, min 32, max 57. That is, the mean number of words produced correctly in picture description was 45 words (with margin of ± 7 words). The minimum number of words produced accurately by a participant in description (i.e. participant producing very few target words in picture description) was 32 words and the maximum number of words produced accurately by a participant in description (i.e. participant producing many target words in picture description) was 57 words.
- picture naming speed across the 24 participants across the 100 word set has a mean value of 973 milliseconds, SD 114.967, min 778.51, max 1249.96. That is, the mean RT of a participant in picture naming was approximately 1 second (with margin of ± 115msec). The minimum speed in naming a picture was 778 msec (i.e. participant with the shortest mean RT) and the maximum picture naming latency was approximately 1250 msec (i.e. participant with the slowest naming latency).
- picture description speed across the 24 participants across the 100 word set has a mean value of 145 seconds (~ 2.4 minutes), SD 32.315 (~0.54 minutes), min 66.34 (~ 1.11 minutes), max 215.81 (~ 3.60 minutes). That is, the mean time of items’ production in picture description by a participant was approximately 2.4 minutes after the picture description’s onset (with margin of ± 1 minute). The minimum time of items’ retrieval
in description was approximately half minute after the picture description’s onset (i.e. participant retrieving words earliest in the picture description) and the maximum time of items’ retrieval in description was approximately 3.6 minutes after the picture description’s onset (i.e. participant retrieving words latest in the picture description).

Table 3.5 Descriptive statistics – By-subjects analysis

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pic. Naming Accuracy</td>
<td>81</td>
<td>5.42</td>
<td>67</td>
<td>91</td>
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</tr>
<tr>
<td>Pic. Naming Speed Mean</td>
<td>973.38</td>
<td>114.97</td>
<td>778.51</td>
<td>1249.96</td>
<td>0.55</td>
<td>-0.04</td>
</tr>
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<td>Pic. Naming Speed Median</td>
<td>858.87</td>
<td>92.45</td>
<td>697</td>
<td>1092</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>Pic. Description Accuracy</td>
<td>45.87</td>
<td>7.81</td>
<td>32</td>
<td>57</td>
<td>-0.09</td>
<td>-1.32</td>
</tr>
<tr>
<td>Pic. Description Speed Mean</td>
<td>145.55</td>
<td>32.31</td>
<td>66.34</td>
<td>215.81</td>
<td>-0.12</td>
<td>0.67</td>
</tr>
<tr>
<td>Pic. Description Speed Median</td>
<td>128.73</td>
<td>35.94</td>
<td>50.50</td>
<td>184</td>
<td>-0.32</td>
<td>-0.66</td>
</tr>
</tbody>
</table>

Correlation Results

In order to investigate the correlation between the four measures mentioned above, we used Spearman’s correlation. One correlation table was produced (Table 3.6), giving a correlation matrix.

In contrast to the by-items analysis, the by subject analysis did not produce significant results regarding the main research questions. No correlation was found between picture naming speed and picture description accuracy, i.e. likelihood of retrieval in connected speech ($r = -0.300, p = 0.154$), between picture naming speed and time of retrieval in picture descriptions ($r=0.090, p = 0.677$) nor between picture naming accuracy and picture description accuracy ($r=0.067, p = 0.754$). Finally, as expected, no
significant correlation was found between picture naming accuracy and the time of word retrieval in picture descriptions ($r = 0.084$, $p = 0.696$).

*Table 3.6* Spearman’s correlation for speed and accuracy in picture naming and in picture description – By-subjects analysis

<table>
<thead>
<tr>
<th></th>
<th>Pic. Naming Speed</th>
<th>Pic. Naming Accuracy</th>
<th>Pic. Description Speed</th>
<th>Pic. Description Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pic. Naming Speed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>1.000</td>
<td>-.249</td>
<td>-.090</td>
<td>-.300</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.241</td>
<td>.677</td>
<td>.154</td>
</tr>
<tr>
<td><strong>Pic. Naming Accuracy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>-.249</td>
<td>1.000</td>
<td>.084</td>
<td>.067</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.241</td>
<td>.</td>
<td>.696</td>
<td>.754</td>
</tr>
<tr>
<td><strong>Pic. Description Speed</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>-.090</td>
<td>.084</td>
<td>1.000</td>
<td>.375</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.677</td>
<td>.696</td>
<td>.</td>
<td>.071</td>
</tr>
<tr>
<td><strong>Pic. Description Accuracy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>-.300</td>
<td>.067</td>
<td>-.375</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.154</td>
<td>.754</td>
<td>.071</td>
<td>.</td>
</tr>
</tbody>
</table>
3.3.3 Results’ verification

We were aware of a potential confound with the design of the main experiment relating to the possibility of exposure to the composite picture stimuli in the first half of the main experiment leading to priming effects for specific word targets in picture naming in the second half of this experiment. For example, having described a ‘lion’ in a zoo within a composite picture several minutes previously may have primed retrieval of ‘lion’ in a picture naming task. Intuitively, this appeared to an unlikely confound given both the sheer quantity of content words produced in response to the three composite pictures and the 100 items requiring naming in the picture naming task later on. However, the alternative hypothesis that the significant correlational results were affected by picture description priming was tested post-hoc.

Participants were asked to come back for another experiment at a later date (i.e. approximately 2 months after the end of the first experiment). Participants (n=21) were asked to name 80 of the previous items in a picture naming task, identical to the one of the first experiment. To explore whether latencies of the two picture naming tasks (the main experiment and the follow-up two months later) were different, we conducted the nonparametric Wilcoxon matched-pairs test. A two-tailed hypothesis was tested: that speed of word retrieval was no different when picture naming occurred either before or after composite picture description within a single testing session.

No significant difference between the conditions was found, as expected in our hypothesis (z = .441, N – Ties = 80, p = .659, two-tailed). That is, there was no priming effect of preceding composite picture descriptions on picture naming speed.

This result implied that picture description did not exert a lexical priming effect on picture naming. This is a quite striking finding, given that priming can occur even when the priming manipulation is covert, as in structural priming cases (Bock & Griffin, 2000b). However language/sentence comprehension studies have found that priming vanished in sentence contexts, when words of these sentences were presented first in isolation (Williams, 1988; Hess, Foss, & Carroll, 1995). Also our finding was in line with previous psycholinguistic experiments, which found that the priming effect was larger in the condition where the primes were of the same type with the targets (picture + picture priming condition), rather when the primes were of a different type (word + picture condition) (Wheeldon & Monsell, 1992). The absent priming effect of
composite picture descriptions on picture naming speed can be theoretically explained by the transfer appropriate processing principle: the principle pertains memory tasks and it suggests that the effect of priming on memory processing depends on how similar are the retrieval operations involved in the two types of tasks (Srinivas & Roediger, 1990).

3.4 Discussion

This study was designed to evaluate whether there was a correlation between efficient naming (short latency time) and the likelihood of word retrieval in connected speech tasks.

Within by-item analyses, a negative correlation was found which implied that words more quickly retrieved in picture naming were more likely to be produced in picture descriptions. This corroborated our hypothesis that there is a measurable relationship between efficient picture naming and access in connected speech. This outcome is both theoretically and clinically important. Theoretically, it indicates that speed of word retrieval is an important factor which has some measureable influence on the easy availability of words in connected speech. Moreover, it highlights the need to explore the under-researched area of speed of word retrieval in more detail, in different populations, for instance in both bilinguals and participants with aphasia. As for the clinical outcomes, we believe that this can contribute to establish greater clarity in understanding the relationship between improvements in picture naming (in terms of speed and accuracy of word retrieval) and functionally beneficial gains in the quality of participants’ expressive language. That is, if we develop a novel therapy designed to improve aphasic patients’ retrieval speed in picture naming (i.e. make them name the pictures faster), we now have some evidence, at least from neurotypical data, to justify the hypothesis that this will support use of words in connected speech. Furthermore, speed of picture naming in itself could be a reasonable therapy target for vocabulary which is retrieved accurately but inefficiently. This is also consistent with theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b).
Furthermore, the experiment verified our hypothesis that the most rapidly retrieved words in picture naming tasks would be produced earlier (i.e. within the first minutes) in connected speech tasks. A corollary of the findings is that words with inefficient latencies in picture naming are either less likely to be produced in connected speech, i.e., possibly not at all, and if produced, will occur later on within the available window for speech production. This was a surprising finding given there was no attempt to influence where participants started in composite picture description or to guide their visual attention during the task. Furthermore, if we make the assumption that words produced first in picture description and named faster in picture naming are more easily retrieved than those produced later or named slower, the above statistically significant correlation indicated that the impact of pragmatic factors (e.g. attention or attraction to specific stimuli) on word retrieval during composite picture description may be less important than the influence of the purely linguistic factor of ease of word retrieval. That is, when describing a picture we will tend to describe not only things that grab our attention but also things that can be more easily named in terms of lexical retrieval. Therefore, the results of our experiment suggest that even computational models that are solely focused on content selection for reference production need to pay more attention to linguistic variables affecting the lexical choice, as these two things appear to be more closely related than most existing models recognise (Viethen, Goudbeek, & Krahmer, 2012; Viethen & Dale, 2006). That is, people often mention something when describing a picture (or in narratives) not only for its discriminatory power and its high semantic significance in the picture related to other items, but also because it is easily available linguistically i.e. in terms of word access and production.

The outcome which was not included in our hypotheses and was quite striking in terms of the strength of the apparent link was the highly significant correlation between speed and accuracy within the tasks. This outcome demonstrated robustly that items which were more likely to be produced accurately in picture naming were also more quickly produced within the same task, and items which were more likely to be produced in picture descriptions, were produced earlier in picture descriptions i.e. within the first minutes. This within-task correlation is in line with observations in the literature about the critical role of both accuracy and speed for the response generating in picture naming (Balota et al., 1989; Lupker et al., 1997). What was striking was that this correlation between accuracy and speed also occurred in connected speech. The evidence reported here allows us to infer that people tend to produce first words which
can be easily retrieved, trying to avoid or postpone for a later time point words that cause them difficulty in terms of retrieval.

As for the by-subjects analysis, the absence of significant correlations and the subsequent contrast to the by-items analysis may be due to the restricted power of the by-subjects analysis stemming from the confined number of participants (n=24) as opposed to the larger number of items (n=100) which could be addressed by replicating this study with substantially more participants. Our ultimate goal is to understand the role of naming latency within clinical assessment and treatment of anomia. Establishing clear and statistically significant relationships between latency and likelihood of retrieval in connected speech for neurotypical participants is a useful building block towards that clinical goal.
CHAPTER 4

Effects of standard versus speeded presentation on lexical access in picture naming and connected speech in older adults
Abstract

Healthy older adults frequently report experiencing greater word finding difficulties (WFD), compared to younger adults (Sunderland et al., 1986). Research on older adults’ WFD has traditionally focused on production of single words when completing picture naming tasks (e.g. LaBarge et al., 1986; Burke et al., 1991), while very little is known about how much these WFD can compromise connected speech. This study aimed to compare a standard priming method (‘standard presentation’ - SP) against a method encouraging increasingly speeded production across repetitions (‘repeated increasingly speeded presentation’ - RISP) in terms of which would be more efficient in speeding up participants, and what method would lead to more efficient use of primed words in connected speech. SP was applied to half the stimuli (n=40) and RISP to the other half of stimuli (n=40) in 21 healthy older adults. After completion of these tasks, participants were asked to complete composite picture description tasks (n=4), where the composite pictures included the primed items. RISP was found to be significantly more effective in reducing picture naming latencies without inducing a speed-accuracy trade-off. The reduction of latencies following RISP showed lasting effects. However, a reduction of naming speed was not critical for retrieving words in connected speech, in that SP was as effective in promoting retrieval in connected speech. The findings highlight the critical role of speed of word retrieval and potentially provide methods for tackling WFD in clinical populations, such as stroke aphasia.
4.1 Introduction

Word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms affecting everyday communication. Both the assessment and treatment of aphasia typically involves confrontation naming tasks (for pros and cons of picture naming tests see Herbert et al., 2008), which make the assumption that performance in picture naming tasks will reflect, at least in broad terms, the ease and reliability of word retrieval in connected speech tasks and lexical retrieval within everyday communication.

One variable which may be critical in determining whether words retrieved in isolation can also be retrieved within the time demands of fluent speech is naming latency, or speed of naming in confrontation naming (Conroy et al., 2009b, 2009d; Crerar, 2004). While some studies investigating the relationship between confrontation naming and connected speech tasks can be found in the aphasiology literature (Feyereisen et al., 1991), there is relative dearth of studies probing this connection in unimpaired population (Bock & Griffin, 2000a). It would make sense to demonstrate this relationship in neurotypical data to establish its robustness and, by extension, whether this is also reflected in clinical data with participants with aphasia.

Speed of word retrieval during picture naming is considered to be the time needed for the initiation of a naming response after the presentation of the target picture and is distinct from the naming duration (see also Kello & Plaut, 2000). Along with accuracy, speed of naming is a critical variable for the response generation in naming, which is important for interpreting naming data and evolving theories about the underlying cognitive processes (e.g. Balota et al., 1989; Lupker et al., 1997). Furthermore, given that neurotypical speakers do not generally produce erroneous responses in terms of accuracy in normal, non time-pressurised conditions, speed of naming may be an informative window through which to more fully examine and understand word retrieval in neurotypical, and ultimately, aphasic participants. Therefore, this study focused on developing a method that would effectively reduce speed in picture naming and subsequently on investigating the effects of picture naming latencies’ reduction on word access in connected speech samples.
4.1.1 Speed and speeding-up in picture naming

There is a large volume of published studies describing the role of the variable of speed during reading in healthy neurotypical participants (e.g., McRae et al., 1990; Wolf, 1991) and also in participants suffering from some type of dyslexia (Spring & Caps, 1974; Wolf, 1997; Wolf & Bowers, 1999). This reflects the crucial role of speed in the reading process and hence the functioning of this variable as a prognostic tool for reading disabilities (Spring & Capps, 1974; Wolf et al., 1986; Ackerman & Dykman 1993; Badian 1995; Meyer et al. 1998). The importance of speed has also been underlined from picture naming tasks administered in developmental studies. Wiegel-Crump and Dennis (1986) reported that both accuracy and speed contributed to improved word retrieval as children progressed through development until adolescence, with accuracy crucially plateauing by age 10 years, while speed improvements continued to occur until age 14 years. From a developmental perspective, German (1990) added that accuracy is increased and speed is reduced in picture naming until the age of 40 years, after which both accuracy and speed gradually deteriorate.

Despite broad agreement about the importance of the variable of speed in lexical access, the facilitation of speed of word retrieval during picture naming and its impact on speech production has been a fairly neglected area in the current literature. As for the facilitation of word finding, Nippold (1992) stressed the importance of the increase of:

1) word knowledge, which is related to memory and storage capacity,
2) storage strength, by repeated exposure to the target stimuli,
3) naming accuracy and speed,
4) retrieval strength, by frequent practice of the words
5) the use of strategies, as the categorical organisation of each word’s information (e.g. words’ organisation into semantic categories) and the attention to external cues, by improving participants’ metalinguistic and metacognitive skills. Surprisingly, while all factors received equal attention and extensive reference, Nippold (1992) suggested that naming speed should not be prioritised as much as naming accuracy in clinical tasks administered to children and adolescents with word finding problems, at least not in the first stage of an intervention, because of the risk of overly-pressurising participants.

Other studies have focused their research on specifying what variables (visual, semantic and lexical) can affect RTs in picture naming (for reviews see Kosslyn & Chabris, 1990; Johnson et al., 1996; Alario et al., 2004).
4.1.2 Elicitation methods for quicker responses

It seems reasonable to hypothesise that ‘the time course of processing can be shortened somehow’ as a result of time pressure (Kello, 2004, p. 942). Two main speed reduction methods have been found in the literature: deadline naming and tempo naming. Both methods were administered to young or mid age adults, so their effects with older participants (over 60 years old) are completely unknown.

The *deadline naming method* (*standard naming-to-deadline paradigm*) was devised by Stanovich and Bauer (1978) and then it was developed by Vitkovitch and Humphreys (1991), Colombo and Tabossi (1992) and Vitcovitch et al. (1993). The method is typically implemented as follows. In each trial, subjects are presented with a stimulus (a word or a picture) for some time (e.g. for 300ms) and then a beep follows. This beep serves as the response deadline: participants’ task is to try to ‘beat the beep’ and name the item before the beep occurs. If the participant’s answer is slower than the preset deadline, the participant is asked to respond more quickly (Kello & Plaut, 2000). In some of the early studies, faster responses were encouraged with more indirect incentives: the ‘reward’ for shorter latencies was monetary instead of the feeling of ‘beating the beep’ (Wickelgren, 1977).

The *tempo naming technique* was introduced by Kello and Plaut (2000) who conducted a series of experiments comparing this technique to the standard deadline naming paradigm under different conditions. The *tempo naming technique* was developed so that the mechanism of the subjects’ strategic control over the speed of responses would be investigated. During tempo word naming, subjects were presented with a series of evenly spaced beeps (forming a steady rhythm), as well as with a decreasing visual cue on the computer screen. The complete letter string that had to be read was presented on the final beep and the task was to pronounce the letter string simultaneously with the beginning of the next beep, which was not actually produced. Implementing this method, participants’ naming times could be experimentally controlled by slowing or accelerating the tempo (Kello & Plaut, 2000). Although the tempo naming technique was initially developed for word naming, as the deadline naming technique, it was later adapted to picture naming as well (Hodgson & Lambon Ralph, 2008).
The main drawback of both these methods was that speed of response rather than naming accuracy was prioritised, which invariably resulted in inducing errors, and hence reducing accuracy, in neurotypical participants’ responses. This “speed-accuracy trade-off” effect (Pachella & Pew, 1968; Wickelgren, 1977) depends on whether the emphasis of the instructions given to participants is on speed or accuracy. In particular, the speed-accuracy trade-off is an effect that has been attributed to control over time course: it is observed in classical naming studies using the deadline naming method, according to which a control mechanism must be engaged to shorten the time course of processing when fast responses are required. In this context, Lupker et al. (1997) suggested that subjects set a time criterion to initiate naming, according to which they first set a time deadline adjust regarding the stimulus onset (Ollman & Billington, 1972), and if the representation of the word to be named is not available by that time, then the response is based on whatever representation is fully activated at that time. Moreover, given that there is a direct link between the difficulty of the stimuli and the respective speed of their naming, participants combine the time criterion with a judgement regarding the difficulty of the words to be named, in order to produce both accurate and speedy responses as much as possible (Kello & Plaut, 2000).

In the literature, the most prevalent method in reducing latencies without over-emphasising speed is repetition priming. Repetition priming is not a purely speed reduction method, since it refers to “the facilitation of naming by prior repeated production of the same word” (Wheeldon & Monsell, 1992, p. 723, 725). Picture naming priming describes how the reaction time in picture naming can be reduced by prior naming of the same picture. The latency reduction can be as much as half of that observed before the repeated presentation of the pictures (Lachman & Lachman, 1980). Usually the benefit of repetition in naming latencies is seen in comparing the first and second presentations of pictures (Oldfield & Wingfield, 1965). This facilitation effect lasts for two weeks or more after the repeated presentations (Lachman & Lachman, 1980).

Regarding the locus of this facilitation, repetition priming facilitates either the retrieval of the target word’s semantic characteristics or the process of lexicalisation, i.e. the mapping of semantic characteristics to their related phonological representation. However, repetition priming does not facilitate the retrieval of the phonological representation per se, since it has been found that production of target’s homophones cannot effectively facilitate the retrieval of the target item (Wheeldon & Monsell, 1992).
Primed conditions may consist of either a word in print or a picture. Lags of intervening items and time lags are usually manipulated. According to Durso and Johnson (1979) the priming facilitating effect was larger when the primes were pictures (picture + picture naming), rather when the primes were words (word + picture naming).

4.1.3 Different patterns of word retrieval depending on the retrieval context

Research on word production has produced a wide range of results on confrontation naming, i.e. on retrieving isolated words in experimental picture naming tasks. Although important findings have been found regarding the mechanisms underlying the isolated word production, very little is known about the use of these words in everyday life contexts of connected speech. The tendency in the literature to focus on the single word as the main item of analysis has been criticised in both the psycholinguistic (Bock & Griffin, 2000a) and the aphasiological literature (Ferguson & Armstrong, 1996). As Bock and Griffin (2000a, p. 25, 39) acknowledged “a connection from repeated production of specific words to production fluency of these words” is missing, yet “many laboratory tasks rely exclusively on the elicitation of single words that are rarely uttered alone”. Among the very few studies in the field, are some neurotypical studies examining the impact of psycholinguistic variables like frequency on sentence completion tasks. For instance, it has been found that word frequency (Griffin & Bock, 1998) and contextual constraints (i.e. predictability in the context, Goldman-Eisler, 1958) affected the time of production of words in sentence contexts, i.e. words were produced faster in sentences when they were of high frequency or when they were predictable in that context. However, the tasks performed by participants in these studies actually involved reading (i.e. reading isolated words coming up on screen and, at the end of each sentence, naming a picture in rebus fashion) rather producing spoken sentences and so these results cannot easily be generalised to connected speech.

Whilst there are a few psycholinguistic studies pointing to discrepancies between performance in picture naming and naming in connected speech, there is an even greater paucity of information about the differences between different word retrieval contexts with respect to the variable of speed. For example, regarding the issue of different patterns of word retrieval depending on the retrieval context, Costa and Caramazza (2002) reported that participants’ lexical access, and in particular lemma
selection, was different depending on the length of the phrase to be produced. Specifically, when small phrases have to be produced (e.g. “the red car”), longer latencies are expected when a semantic distracter word related to the target noun was provided (e.g. “cow”). However, in longer phrases containing more than one noun (e.g. “the baby is next to the dog”), this effect was not consistent in all the cases (Levelt & Meyer, 2000). Furthermore, for complicated utterances like the last example, other studies have reported faster latencies when the noun is phonologically primed (Wheeldon & Lahiri, 1997; Costa & Caramazza, 2002), while in other studies this effect was not observed (Schriefers, 1993; Schriefers & Teruel, 1999). The former results were also comparable to those of Rastle and Burke (1996), who found that recent production of a word (single repetition priming) increased its likelihood of retrieval in response to a general knowledge question. As was noted in the findings reported in Chapter 3, there has been some evidence of a correlation between picture naming speed and the likelihood of word retrieval in connected speech tasks. In the previous chapter, picture description priming effects were attenuated in confrontation picture naming, compared to the priming effect of the same task (repetition priming from picture naming). This was in line with previous psycholinguistic experiments, which found that the priming effect was larger in the condition where the primes were of the same type with the targets (picture + picture priming condition), rather when the primes were of a different type (word + picture condition) (Wheeldon & Monsell, 1992).

### 4.1.4 The cognitive processes involved in speech production

Theories of lexical access have primarily been informed by reaction time data, but also by speech errors produced by both non-impaired (herein ‘neurotypical’) (e.g. Fromkin, 1971; Garrett, 1975, 1980) and impaired individuals (Levelt, 2001). The analysis of spontaneous and experimentally elicited speech errors has been found to be an important source of information about the processes involved in lexical access during speech production (Fromkin, 1971, 1973; Garrett, 1980; Fay & Cutler, 1977; Martin et al., 1989; Stemberger, 1990; Dell et al., 1993; Martin et al., 1996).

Generally, the processes involved in lexical access have been identified as the translation of concepts and ideas into patterns of sounds produced by the articulatory organs, the retrieval of the suitable words for conveying the message, the combination
of these words taking into account the grammatical constraints of the spoken language, and, at a final stage, the retrieval of information about how to articulate the selected words (Costa et al., 2000). Picture naming involves the matching of a visual item with a conceptual representation, the retrieval of the phonological codes (word) matching with this conceptual representation and finally the articulation of that word (e.g. Potter & Faulconer, 1975; La Heij, 1988; Glaser & Glaser, 1989; Theios & Amrhein, 1989). However, the processes involved in lexical access during connected speech include additional cognitive challenges and have received less attention. For example little is known about lexical access when describing a picture or in narratives, which require us to rely on attentional or memory resources respectively. This study aimed to investigate the different patterns of word retrieval depending on the elicitation context, by looking at the connection of confrontation naming variables to picture description lexical access data of accuracy and speed.

4.1.5 Research Questions

The present study aimed to build on the findings of Chapter 3 in which a robust relationship was found between picture naming latency and likelihood of retrieval in connected speech. Specifically, this investigation sought to establish if manipulation of picture naming latency would lead to related changes in word retrieval in connected speech. In doing so, the following research questions were identified:

Can older neurotypical participants be trained to reduce picture naming latencies without a speed-accuracy trade-off and with lasting effects?

Does the reduction of picture naming latencies increase the likelihood of production of these words in connected speech?

Aside from accuracy in picture descriptions, is there a benefit for time of retrieval (early or late) within the descriptions for trained items?
4.2 Method

4.2.1 Participants

A random sample of neurologically healthy older adults (people over 60 years old) was recruited. The selection of older adults was based on the vulnerability to decreased speed of word retrieval associated with age (e.g. Neto & Santos, 2012; Griffin & Spieler, 2006) and thus slower word retrieval within older neurotypical participants would provide a wider range of measures and hence more sensitive format for testing the study hypotheses. Previous studies have suggested that word retrieval of common names (i.e. names of objects) becomes significantly problematic when people reach approximately 70 years old (Albert, Heller, & Milberg., 1988; Au et al., 1995; Maylor, 1995; Nicholas, Obler, Albert, & Goodglass, 1985). However, other studies have indicated that older adults (55-75 years) named pictures of objects equally fast to young participants (18-34 years) (Evrard, 2002), maybe because of older adults having a mean age 64 years and not 70 or over 70 years. Based on these findings, the age of participants in this study is expected to give rise to interesting speed reduction patterns and provide informative data regarding the potential of speeding up this already speed-sensitive population.

21 healthy neurotypical participants were tested. All healthy participants had participated in the baseline study reported in Chapter 3. Out of the 27 participants involved in the baseline study, three were not asked to participate in this project because they did not provide reliable data in the previous study (i.e. frequent error production affecting the timing data obtained by E-prime), while other three participants could not come back for additional testing due to health reasons. All 21 participants were right handed and they were aged between 64 and 85 at the beginning of the study (mean = 70, SD = 5).

Participants were given a ‘Study Information Sheet’ and then provided informed consent for taking part in the study under an already existing ethical approval (MREC ref: 01/8/94). In line with research group protocol, if participants had not completed the ACE test (Mathuranath et al., 2000) within the last three years, they were asked to complete this test before commencing the main experiment. ACE included the MMSE, so scores for both tests were obtained, providing a broad measure of cognitive
functioning. These scores, along with participants’ demographic details are provided in Table 4.1.

Table 4.1 Participants’ demographic details and ACE/MMSE scores

<table>
<thead>
<tr>
<th>Initials</th>
<th>Age</th>
<th>Sex</th>
<th>School Leaving Age</th>
<th>MMSE scores (max: 30)</th>
<th>ACE scores (max: 100)</th>
<th>Speeded Set</th>
<th>Order of composite pictures’ presentation</th>
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<tr>
<td>CL</td>
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<td>m</td>
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<td>30</td>
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MMSE = Mini Mental State Examination (cut-off score: 24/30), ACE = Addenbrooke’s Cognitive Examination (cut-off score: 82/100)

4.2.2 Stimuli

Pilot experiment

Before the main experiment, a pilot study was conducted to establish reliability of stimuli across both picture naming and composite picture description tasks (for more details, see Chapter 3).

The specific aims of this pilot study were:
1) to select among six composite pictures (i.e. busy social scenes with multiple characters engaged in a range of activities), the most suitable three pictures (n=3) for which descriptions would elicit imageable words covering a range of word retrieval likelihood, i.e. from low word retrieval likelihood - produced by only one pilot study participant (1/10) to high - produced by all participants (10/10). This meant that the relationship we were examining between speed of word retrieval in picture naming and retrieval in connected speech could be analysed across a spectrum of word retrieval difficulty. Furthermore, the selection of only 3 pictures for the main experiment would allow us to reduce the duration for the subsequent main experiment by at least 15 minutes (five minutes description per picture). This was crucial, given that the main experiment comprised many tasks (i.e. a series of picture naming tasks and then a picture description task) which had to be carried out within one session by older adults.

2) to establish picture name agreement for a large corpus of words (n=100) used in the description of the 3 selected composite pictures to be included in the picture naming task of the main experiment.

**Main Experiment**

**Composite Picture Description Task**

The stimuli for this task were the three composite multi-event pictures (i.e. ‘Where‘s Wally’ type pictures) selected in the first part of the pilot study (A, B, and F). These three composite pictures were selected to elicit a language sample and provided us with the stimuli used in the picture naming task.

**Picture Naming Task**

100 pictures were inserted into the Match program (Van Casteren & Davis, 2007). All pictures depicted nouns which were prominent within the three composite pictures and were selected through the name agreement task (second part of the pilot study). The aim was to select 80 stimuli across 2 matched sets of 40 items. The matching relationship between pairs implied that each value in one set was paired with a corresponding value in the other set. Words of each set were matched for mean picture
naming speed of the 100 items across participants, sum/total of picture naming accuracy, mean picture description production time, sum/total of picture description production accuracy. Accuracy and latencies in the two tasks (picture naming and picture description) had been established in the Chapter 3 study (hereafter Study 1 or S1), in which the same 21 participants had named all 100 pictures and had described the 3 composite pictures. The two sets were also matched for frequency and length. Frequency values were extracted from the British National Corpus (BNC) (Davies, 2004). Because of the first four variables’ values high importance, their matching weight across the 2 sets was set to be higher (i.e. 3) compared to frequency and length, which had the default weight (i.e. 1). Also, mutation rate (i.e. the probability of a mutation, that doesn’t affect the speed of the Match program, but has an effect on the quality of the solution) was set at 0.3 (default value).

80 items were matched (see Appendix 3) and were selected to constitute the stimuli of the picture naming task.

### 4.2.3 Procedure

A comparison of ‘standard presentation’ (SP) for 40 items versus ‘repeated increasingly speeded presentation’ (RISP) for the matched 40 items was implemented in order to evaluate effects on retrieval latency in confrontation naming and likelihood of retrieval in connected speech.

Measurement of baseline performance and training to reduce picture naming latency were carried out within one session with each participant.

**Baseline Performance/Naming**

Firstly, picture naming accuracy and latencies were collated for each participant with feedback on accuracy provided. By providing feedback on all items, we aimed to eliminate production errors across both sets so that they could be comparable in terms of baseline accuracy in connected speech and any potential difference in their use in connected speech could be attributed only to naming speed (because of the RISP method applied only to one set, see below) and not to accuracy.
Participants were presented with items of both sets (n=80) once. The total 80 stimuli were split in two blocks of 40 items with a resting pause between them. Participants sat approximately 80 cm from the computer screen and were informed that they were going to see some pictures on the screen. Participants were asked to name the pictures as accurately and quickly as they could without making a mistake (i.e. avoid self-corrections) and to avoid, as far as possible, coughs, false starts, hesitations (e.g., “uhmm”), articles, or any other extraneous material (e.g. “a lion” or “That’s a lion”). When a non-prominent item was the target in the picture, it was included in a circle or it was highlighted by an arrow. Participants were also informed that they were going to receive verbal feedback on their responses at the end of each block.

To familiarise participants with the experiment, a practice set of 10 pictures not included in the main experiment were given as examples in object naming. The number of practice trials was determined during testing. If participants were producing any other sound before or instead of the target word, they were encouraged to produce only the name of the picture and only when it was their final response. If erroneous responses were repeatedly produced, then participants were asked to repeat the practice trials until they would clearly understand the task.

Naming latencies in the picture naming task were measured using E-Prime software (Schneider et al., 2002). In each trial, participants were initially presented with a fixation point for half of a second. This fixation mark was used to indicate the place that the participant should be looking when the trial began, while also it was used as a warning signal so that the participant would get ready for the trial. Subsequently, participants were presented with a blank screen for another half second. This brief delay before the target presentation (‘foreperiod’) was the same for all trials. At the end of the foreperiod, the target picture was presented. The minimum presentation time of the stimulus was set at ½ second (500msec), and its maximum presentation time at 4 seconds (4000msec). Finally, between the end of one trial and the beginning of the next one, a blank screen was presented for half second (fixed ‘inter-trial interval’).

Feedback was verbally provided on all (set A and B) items at the end of each block. The reason for not providing the feedback at the end of each trial was that it could distract participants and increase the speed of naming of the following item, resulting in disrupted fluency of picture naming. Feedback was either positive or negative, i.e. correction was provided only for incorrect responses at the end of each block, while it was pointed out that all the other, non-corrected responses, were
accurate. In this way, baseline accuracy was established for both sets from the very beginning, before proceeding to the more demanding speeded (RISP) method and hence focusing on RTs.

**Speeded Picture Naming Training Condition: Repeated Increasingly Speeded Presentation (RISP)**

Having completed the simple picture naming task, participants took part in the training phase of the session which aimed to speed up picture naming. To achieve the maximum speed reduction without a speed-accuracy trade-off, a combination of the deadline naming technique and the repetition priming method was made. Furthermore, primes were pictures and not words, so that the priming facilitating effect would be the largest possible. The tempo naming was not used, because the speed control would be prioritised over the speed reduction. Picture naming latencies were manipulated and measured using E-Prime software (Schneider et al., 2002).

Only one of the two matched sets of stimuli was included in this task (either Set A or Set B). That is, half of the participants (n=11) were trained on the production of the items of one set (Set A) and the other half of participants (n=10) on the other set (Set B) (Table 4.2). Each of the sets were subject to different manipulations and two conditions emerged: (1) *Condition A* - standard presentation (SP), (2) *Condition B* - standard presentation (SP) + RISP (x5). Condition A, therefore, included the primed set, consisting of single exposure items, i.e. items being presented to participants only one time, and without using deadline conditions (simple picture naming / simple presentation paradigm). Condition B consisted of items to which participants were exposed one time at the first place (standard presentation), but were additionally subject to some form of demanding manipulation at a later point (RISP task) (Table 4.2). The two conditions/interventions (SP and RISP) were not counterbalanced in the number of presentations because the aim of the study was not to compare the two interventions’ effectiveness in speeding up neurotypical participants but to investigate if speeding up participants by employing the RISP method (i.e. increased number of presentations compared to SP) would increase the likelihood of retrieval of RISP items in connected speech. Furthermore, the aim of establishing a baseline naming accuracy across all items (SP and RISP) so that their accuracy could be comparable in connected speech as well, could be accomplished by a single presentation for SP items in neurotypical
participants (contrary to aphasic participants, see methodological adaptation of equal number of presentations for SP and RISP items in Chapters 5 and 6).

Conditions A and B were counterbalanced across participants, as shown below:

1st Participant → Condition A: Set A, Condition B: Set B
2nd Participant → Condition A: Set B, Condition B: Set A etc.

The RISP condition combined a repeated presentation (x5) of the target stimuli with an errorless deadline method which aimed to reduce latencies. The RISP method made use of the deadline naming to verbally encourage quicker picture naming responses and employed repeated presentations (multiple repetition priming) to increase accuracy and avoid a speed-accuracy trade-off. Deadline naming was selected over tempo naming, because of the latter’s tendency to produce many mistakes in accuracy (robust speed-accuracy trade-off). Participants were repeatedly exposed, i.e. 5 times, to the items of one of the two sets, while simultaneously they were carrying out a deadline picture naming task. At the end of the allotted time window, the picture disappeared as a beep sound was produced by the computer. Participants heard the beep sound and they were simultaneously presented with a question mark at the centre of the screen for 2000msec. At the end of each trial participants were presented with a positive or negative feedback screen informing them about the speed of their response. If a quick response was given within the time window, the positive feedback was “Well done! You beat the beep by x msec!” in blue font. However, if no response was given within the time window the negative feedback was “Bad luck, slightly too long. You missed it by x msec” in red font. Because of the input being given through the microphone, the feedback on accuracy was verbally provided by the experimenter. In this way participants were encouraged to speed up a bit more in every of these 5 repetitions but also preserve the accuracy. To proceed to the next trial, a button had to be pressed, so that participants would be able to control the flow of the pictures’ presentation. Having completed the first two repetitions, participants took a 10-15 minute comfort break, following which they continued with the rest three RISP repetitions.

Presentation time was reduced across the 5 RISP trials. To set the initial presentation time, the baseline data from a previous experiment were used (Chapter 3). The initial picture exposure time was adapted to the mean of the maximum picture naming speed across participants in Chapter 3 /S1 study (i.e. ~1800msec), so that participants’ first naming attempt would feel fairly natural even for low frequency items. In the following 4 trials, the target naming time was shortened in a controlled
fashion: naming times were iteratively reduced initially by 400msec for every of the first two repetitions and then by 150msec for every of the following two repetitions. That is, an uneven amount of msecs was lopped off per trial i.e. participants started with a large time window (1800ms) and then they were gradually allotted 1400ms, 1000ms, 850ms and finally 700ms, which was slightly above the mean of the minimum picture naming speed across participants in the Chapter 3 study. This speed-reduction pattern was piloted first with two native speakers to investigate the feasibility of the allotted time limits. Because of the narrow time frame, RTs were measured not only during the picture presentation but also during the subsequent question mark presentation and production of the beep sound. In this way, RTs of relatively ‘slow-namers’, were still measured, even when their responses were not produced within the allotted time window.

The presentation of each picture is presented schematically below:

blank screen (1000msec) → fixation (500msec) → blank screen (500msec) → picture exposure (1800msec-700msec, RTs are measured) → question mark (?) + simultaneous beep sound (2000msec, RTs are measured) → feedback screen on speed and verbal feedback on accuracy (a button had to be pressed to proceed to the next trial).

In order to familiarise participants with the procedure, a practice trial was exercised before commencing the main RISP task. This trial involved 10 novel items which were different from the items of the main picture naming task. These items were also placed for naming at the beginning of each of the next five RISP presentations, in order to secure a smoother transition to the trials’ increased speed demands. Participants were informed that they would be first presented with some practice items and that they had to try to say the name as quickly and accurately as they could. Participants were told that “speed is very important so they should try to say the name before a question mark comes up on the screen along with a beep sound, and so try to beat the beep and name the picture when it is still on screen”. After the first practice trial, participants were informed that they were going to see half of the items they had already named in the simple picture naming task (i.e. baseline naming), and that the same set of items would be presented to them 5 times, with a reducing deadline each time. It was also specified that it was investigated if they could get “quicker and quicker”. Then they were given the same instructions as in the practice trial.
### Table 4.2 The two experimental conditions along with their respective manipulations

<table>
<thead>
<tr>
<th>Conditions</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Items</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Items’ characteristics</td>
<td>Matched: a) slow and fast b) Psychol. variables</td>
<td>Matched: a) slow and fast b) Psychol. variables</td>
</tr>
<tr>
<td>Method</td>
<td>‘standard presentation-untrained’ (SP) → presented once with feedback</td>
<td>‘trained’ (RISP) → presented once with feedback + repeated presentation with deadline</td>
</tr>
</tbody>
</table>

#### Composite Picture Description

Having completed the speeded picture naming, participants took a 10-15 minute comfort break, following which they were presented with 3 composite pictures that contained various common objects and activities. These pictures were depicting both single primed items (included in the SP task), and repeatedly produced (6 times in total), speeded items (included in both the SP and RISP task). These 3 composite pictures were selected in the first part of the pilot study (A, B, and F).

The main purpose of the study was to answer the main research question regarding the contribution of speed in the carry over into connected speech and more specifically to investigate the degree of generalisation into connected speech of items with different exposure (single vs. repeated exposure items). Hence, the picture description task would allow us to compare likelihood of word retrieval and time of target words’ retrieval in connected speech between baseline (picture description data from Chapter 3) and post-RISP training. These two picture description tasks were comparable because of the identical design characteristics (i.e. participants, stimuli and instructions).
To complete the task, participants sat in front of a computer desktop screen. They were informed that they were going to see three busy pictures and that the instructions for all the pictures were the same. So beginning with the first picture, they were asked to describe what they saw in the picture in as much detail as they could for 5 minutes. No guidance was provided as to where to start in picture description, as indicating to participants any direction for their description would be quite artificial and could have altered participants’ focus in terms of direction but probably not fluency (i.e. production of as many words as possible). Instead, participants were asked to describe the pictures within five minutes.

Picture description time was monitored using an online stopwatch. If participants had not finished within five minutes, they were informed that the time had lapsed but they were given some limited extra time if they wanted to complete their description. At the end of the picture description they were given feedback regarding their fluency and their accuracy on the expected description time/deadline and they were prompted to be more succinct or elaborate. The overall task lasted between 15-20 minutes, depending on participants’ performance.

Participants’ responses were tape-recorded with a voice recorder (Sony digital IC Recorder) and they had consented to being recorded before commencing the experiment. Finally, the order of presentation of each picture was randomised across participants (Table 4.1), thus counterbalancing any effect of higher picture description difficulty in the pictures described first. Participants were also presented with a different picture presentation order from the one they were presented in the Chapter 3 study.

The questions we wanted to address were whether there was any generalisation to connected speech for the single exposure set and if the likelihood of word retrieval was significantly increased especially for the repeatedly exposed items.

**Simple picture naming**

After the composite picture description task and a 10 minute break, picture naming latencies were reassessed with a simple picture naming task, including no intervention methods i.e. use of the same target items of both Set A and B (n=80) but with no repetitions or deadlines. The task’s design, stimuli and instructions were
identical to the first, natural picture naming task (SP) conducted at the beginning of the session.

The aim here was to reassess lexical retrieval of both single exposure and repeated items and so compare picture naming latencies from baseline (standard priming data) to the end of this interventional experiment ("quantification of priming"). Using this design, we could better ascertain if the priming effect of the first task (SP) and the subsequent intervention task (RISP) had persisted long enough through the period doing the picture descriptions and the break.

An overview of the tasks performed with participants is provided in Table 4.3.

*Table 4.3 Experimental design – order of the tasks*

<table>
<thead>
<tr>
<th>Duration</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 minute</td>
<td><strong>Picture naming:</strong> Practice Trial items [10]</td>
</tr>
<tr>
<td>10 minutes</td>
<td>Picture naming: SP of all items (practice items [10] + Set A items [40] + practice items [3] + Set B items [40])</td>
</tr>
<tr>
<td>1 minute</td>
<td><strong>RISP:</strong> Practice Trial items [10]</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Practice Trial items [10] + RISP of Set A or B items [40]</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Practice Trial items [10] + RISP of Set A or B items [40]</td>
</tr>
<tr>
<td><strong>BREAK</strong></td>
<td></td>
</tr>
<tr>
<td>5 minutes</td>
<td>Practice Trial items [10] + RISP of Set A or B items [40]</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Practice Trial items [10] + RISP of Set A or B items [40]</td>
</tr>
<tr>
<td><strong>BREAK</strong></td>
<td></td>
</tr>
<tr>
<td>15 minutes</td>
<td>Composite <strong>picture description</strong> [3] in order to elicit Set A and Set B items.</td>
</tr>
<tr>
<td><strong>BREAK</strong></td>
<td></td>
</tr>
<tr>
<td>10 minutes</td>
<td><strong>Picture naming:</strong> SP of all items (practice items [10]+ Set A items [40] + practice items [3] + Set B items [40])</td>
</tr>
</tbody>
</table>
4.3 Results

All 21 participants who took part in the main experiment produced reliable data that was entered for statistical analyses.

This study employed a within-subject or repeated measures design. Speed manipulation (speeded vs. non speeded items) and presentation number (‘Time Point’ of the task in the study) were within-subjects factors. Participants had been exposed to 40 speeded and 40 non speeded pictures, with speeded pictures seen seven times in the course of the experiment: 1 standard presentation/natural naming (NN) + 5RISP + 1 simple naming/natural naming (NN). Each non speeded picture had been seen twice in the course of the experiment: 1NN at commencement + 1NN at the end. Picture naming and picture description comparisons had been made at different time-points: Chapter 3 NN (baseline data), Chapter 4 (present study) 1st NN prior the training/intervention and Chapter 4 2nd NN after the intervention. The apparent advantage of the repeated measures design was that the effect of the experiment was more likely to be attributed to the manipulation and not to unknown/random factors or characteristics of people allocated to different comparable groups.

The dependent variables in both picture naming and composite picture description were accuracy and speed/reaction time (RT). For each of these two variables, two measures per target word were computed. This resulted in four measures, two for each task:
a) accuracy in picture naming: this related to accuracy in confrontation naming for each item (i.e., either 1 for accurate or 0 for inaccurate) as measured by the proportion of participants who named the word correctly e.g. 9/21 participants. Self corrections were not considered correct at any part of the experiment (natural naming 1 and 2, or RISP presentations).
b) speed of picture naming/latencies (in ms): for each correctly named item we collated reaction times (in milliseconds, as provided by the E-prime software). RTs for some items were excluded from further analysis if the target picture name was not accurately produced or produced disfluently or if the voice key was not validly triggered. Very early responses (below 400msec) were also excluded if their latencies were less than
400 ms, as RTs of correct naming from picture onset to the onset of the spoken response are typically 400-1500ms (Goodglass et al., 1984).

c) accuracy in picture description: this related to accurate production of a word (i.e., again, either 1 for accurate or 0 for inaccurate) within a composite picture description task.

d) speed/time of word retrieval (in seconds) in picture description: this related to the time point within a description when items were initially correctly produced. This was measured as the time elapsing from the onset/beginning of the picture description to the time of production of the target word in picture description. This was initially calculated in minutes/seconds (e.g. 2.08 minutes) and then converted to time to seconds (e.g. 128 seconds). While self-corrections were not considered as accurate productions in the picture naming task, they were accepted in the picture description task once the self-correction did lead to accurate retrieval.

4.3.1 Effectiveness of RISP method in speeding up picture naming

The first question we wanted to address was about the effectiveness of the RISP method in speeding up participants. To answer this question, a one-way within-subjects ANOVA was conducted. The single within-subjects factor ‘No. of Presentation/Repetition’ (RP) had 6 levels, i.e. 6 presentations (Chapter 3/S1 study NN and 5 repetitions in this study/S2). The dependent variable was the total time taken in milliseconds (ms) to name the pictures (n=40) included in the speeded production (RISP) and the Natural Naming of Chapter 3 study (S1). The hypothesis was that there would be an effect of RISP method on performance i.e. faster picture naming.

As for the by items analysis, there was a significant effect of the RISP method, F(5,395) = 110.830, p < .0005, partial η² = .58. Also there was a significant linear trend, F(1,79) = 215.832, p < .0005, partial η² = .73, over the mean values for each level of the factor, i.e., S1 NN items took the longest time to be named and naming latencies got gradually shorter across subsequent repetitions. Finally, there was a significant quadratic trend, F(1,79) = 36.240, p < .0005, partial η² = .31.

In the by subjects analysis, there was again a significant effect of the RISP method, F(5,100) = 88.144, p < .0005, partial η² = .81. As in the by items analysis, there was a significant linear trend, F(1,20) = 258.186, p < .0005, partial η² = .93, over the
mean values for each level of the factor. Finally, a significant quadratic trend, $F(1,20) = 14.350$, $p < .0005$, partial $\eta^2 = .42$, was observed. In both the by items and the by subjects analyses, the mean RT for each level was calculated (Table 4.4).

Finally, in order to better illustrate the speed reduction pattern of the RISP items, latencies were plotted across all time points. That is, it was considered optimal to plot the RISP item RT data of all 8 presentations, i.e. Natural Naming in the first empirical study/Study 1 at Chapter 3 (Study 1/S1 NN), 1st NN of this Study (S2 1st NN), all 5 RISP Repeated Presentations (S2 1-5 RP), and 2nd NN of this Study (S2 2nd NN). This provided us with an overview of the overall latency changes between each presentation (Figure 4.1).

Importantly, not only was the method very effective in speeding people up, but it was accepted by elderly participants with great enthusiasm in the spirit of a game of beating the computer. The task had not caused confusion, frustration or distress in any instance.

*Table 4.4 Descriptive statistics for RISP method’s effectiveness in reducing latencies*

<table>
<thead>
<tr>
<th>Time Point</th>
<th>By Items</th>
<th></th>
<th></th>
<th>By Subjects</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SD</td>
<td>N</td>
<td>mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>S1 NN</td>
<td>1015.23</td>
<td>325.97</td>
<td>80</td>
<td>964.51</td>
<td>130.43</td>
<td>21</td>
</tr>
<tr>
<td>S2 1st NN</td>
<td>856.49</td>
<td>148.49</td>
<td>80</td>
<td>850.26</td>
<td>81.89</td>
<td>21</td>
</tr>
<tr>
<td>S2 2nd NN</td>
<td>750.99</td>
<td>114.27</td>
<td>80</td>
<td>749.52</td>
<td>61.93</td>
<td>21</td>
</tr>
<tr>
<td>S2 3rd NN</td>
<td>695.17</td>
<td>98.59</td>
<td>80</td>
<td>695.37</td>
<td>56.59</td>
<td>21</td>
</tr>
<tr>
<td>S2 4th NN</td>
<td>678.07</td>
<td>103.20</td>
<td>80</td>
<td>678.05</td>
<td>52.39</td>
<td>21</td>
</tr>
<tr>
<td>S2 5th NN</td>
<td>629.76</td>
<td>79.52</td>
<td>80</td>
<td>629.32</td>
<td>39.11</td>
<td>21</td>
</tr>
</tbody>
</table>

NN: Natural Naming/no manipulation, S1: Chapter 3 baseline study/Study 1, S2: Chapter 4 study/Study 2
4.3.2 Effectiveness of RISP method in generating persisting priming effects

Another question related to the effectiveness of the RISP method was whether priming effects (i.e. latencies reduction) persisted long enough, through the period doing the picture descriptions, to influence word retrieval in the final, post-intervention, picture naming. To answer this question, the RISP priming effect was compared to the single presentation (SP) effect, by comparing latencies of the RISP items and the SP items in 2 time points, from the beginning of the study (baseline latencies 1\textsuperscript{st} NN) to the end of the interventional experiment (2\textsuperscript{nd} NN). A 2*2 within-subjects ANOVA was conducted. Each factor had 2 levels; the first was Time Point (1\textsuperscript{st} NN in this study vs. 2\textsuperscript{nd} NN in this study) and the second was the Speed Manipulation (speeded vs. not speeded items). All participants were tested under each possible combination of the two
factors. The dependent variable was the total time taken in milliseconds (ms) to name the pictures included in the Natural Naming tasks (NN). The hypothesis tested was a null hypothesis for the non speeded items; latencies of not speeded items were not expected to be significantly different between the two presentations/NNs, while RISP items’ latencies were expected to be shorter in the 2nd compared to the 1st NN.

In the by items analysis, the main effect of ‘Time Point’ was significant: F(1,78) = 146.827, p < .0005, partial $\eta^2 = .65$, indicating that all items (speeded and not speeded) were named faster in this study’s last NN compared to its first NN. Moreover, the main effect of ‘Speed Manipulation’ was also significant: F(1,78) = 19.585, p < .0005, partial $\eta^2 = .20$, implying that speeded items were retrieved faster than the non speeded items in the 2nd NN. Finally, there was a significant interaction between ‘Time’ and ‘Speed Manipulation’: F(1,78) = 38.758, p < .0005, partial $\eta^2 = .33$. This interaction is displayed in Figure 4.2, showing that, as well as the generally quicker naming of all items in the 2nd NN and despite the time elapsed between the 2 NNs because of the composite picture descriptions, RISP items were produced even quicker than the non speeded items.

An overview of speeded and non speeded items’ latencies in this type of task (NN) across all time points is presented in Figure 4.3.

As for the by subject analysis, it was significant both the main effect of ‘Time’: F(1,20) = 109.558, p < .0005, partial $\eta^2 = .85$, and the main effect of ‘Speed Manipulation’: F(1,20) = 27.823, p < .0005, partial $\eta^2 = .58$. Finally, there was a significant interaction between ‘Time’ and ‘Speed Manipulation’: F(1,20) = 30.399, p < .0005, partial $\eta^2 = .60$. This interaction is displayed in Figure 4.4.
**Figure 4.2** Distribution (by items) of Reaction Time in Natural Naming (NN) by Time Point and Speed Manipulation

NN: Natural Naming/no manipulation

**Figure 4.3** Distribution (by items) of Reaction Time by Time Point and Speed Manipulation for Chapter 3 study’s (S1 study) and Chapter 4 study’s (S2 study) Natural Naming (NN)

NN: Natural Naming/no manipulation, S1: Chapter 3 baseline study/Study 1, S2: Chapter 4 study/Study 2, RP: Repetition Priming
4.3.3 Effectiveness of RISP method in establishing picture naming accuracy

In order to address this issue, a comparison of accuracy for speeded and non speeded items between the 1st NN and the 2nd NN in Chapter 4 study was made. In the 2*2 within-subjects ANOVA, each factor had 2 levels: the first was Time Point (1st NN in Chapter 4 study/Baseline ACC (accuracy) vs. 2nd NN in Chapter 4 study/Post Speed Manipulation ACC) and the second was the Speed Manipulation (speeded vs. non speeded).

As for the by items analysis, the main effect of ‘Time Point’ was significant: F(1,79) = 25.749, p < .0005, partial $\eta^2$ = .25. This indicated that ACC in 2nd NN was significantly different from ACC in 1st NN for all items (speeded and non speeded), implying that participants significantly improved their accuracy when naming pictures by the end of the experiment’s session. Most importantly, there was a statistically significant interaction between ‘Time’ and ‘Speed Manipulation’: F(1,79) = 7.200, p = .009, partial $\eta^2$ = .08. This interaction is displayed in Figure 4.5, showing that the RISP
The method was effective in increasing accuracy from NN1 to NN2, while single presentation did not have such a strong impact on improving picture naming accuracy.

As for the by subject analysis, the main effect of ‘Time Point’ was again significant: $F(1,20) = 76.722$, $p < .0005$, partial $\eta^2 = .79$. Finally, there was a significant interaction between ‘Time Point’ and ‘Speed Manipulation’: $F(1,20) = 7.678$, $p = .012$, partial $\eta^2 = .28$. This interaction is displayed in Figure 4.6.

*Figure 4.5 Distribution (by items) of accuracy in picture naming (NN) by Time Point and Manipulation*

![Figure 4.5](image)

NN: Natural Naming/no manipulation, S2: Chapter 4 study/Study 2
Figure 4.6 Distribution (by subjects) of accuracy in picture naming (NN) by Time Point and Manipulation

4.3.4 Correlation of picture naming speed with likelihood of production in connected speech

Another research question was the extent to which the likelihood of producing certain words in picture description is improved by manipulating and reducing the speed of naming of those items. A comparison between accuracy (ACC) in composite picture descriptions in Chapter 3 study and accuracy in those in Chapter 4 study (i.e. after the RISP intervention) for both speeded and non speeded items was made. For this purpose a 2*2 within-subjects ANOVA was conducted. Each factor had 2 levels; the first was Time (Chapter 3-Study 1 study/Baseline ACC vs. Chapter 4-Study 2 study/Post Intervention ACC) and the second was the Speed Manipulation (speeded vs. non speeded). All participants were tested under each possible combination of the two factors. The dependent variable was the likelihood of word retrieval as a sum of instances of correct target items’ production in descriptions. The hypothesis tested was that there would be an interaction between speed of word retrieval and likelihood of
production in descriptions for certain items. As for the by items analysis, the main effect of the ‘Study’ factor was significant: F(1,79) = 81.738, p < .0005, partial $\eta^2 = .51$, indicating that all target items (speeded and not speeded) were more likely to be produced in Study 2 than in Study 1 descriptions. However, there was a non significant interaction between ‘Study’ and ‘Speed Manipulation’: F(1,79) = 3.220, p = .077, partial $\eta^2 = .04$. This interaction is displayed in the Figure 4.7, showing that speeded items were not more likely to be produced in descriptions than the non speeded items from Study 1 to Study 2, i.e. the above mentioned general increased likelihood of target items’ word retrieval in Study 2 was not due to the speed manipulation but it pertained all items (speeded and non speeded).

As for the by subject analysis, the main effect of the ‘Study’ factor was again significant: F(1,20) = 102.782, p < .0005, partial $\eta^2 = .84$ but the interaction between ‘Study’ and ‘Speed Manipulation’ was non significant: F(1,20) = 3.570, p = .073, partial $\eta^2 = .15$. This interaction is displayed in the Figure 4.8, showing that participants were not more likely to produce speeded rather non speeded items in descriptions.

Figure 4.7 Distribution (by items) of likelihood of target items’ retrieval in picture descriptions by Time Point and Speed Manipulation

Study1: Chapter 3 baseline study, Study 2: Chapter 4 study
Figure 4.8 Distribution (by subjects) of likelihood of target items’ retrieval in picture descriptions by Time Point and Speed Manipulation

Study 1: Chapter 3 baseline study, Study 2: Chapter 4 study
4.3.5 Correlation of picture naming speed with time of production in connected speech

In order to investigate the extent to which items named more quickly in picture naming would be produced earlier in picture descriptions, a time of retrieval comparison between Study 1 and Study 2 picture descriptions (i.e. pre and post speed manipulation respectively) was made. To this purpose a 2*2 within-subjects ANOVA was conducted. Each factor had 2 levels; the first was Time (Study 1/Baseline Time of Retrieval in descriptions vs. Study 2/Post Speed Manipulation Time of Retrieval in descriptions) and the second was the Speed Manipulation (speeded vs. non speeded). The hypothesis tested was that items trained to be named faster in picture naming would also be more likely to be produced earlier in composite picture descriptions.

As for the by items analysis, the main effect of ‘Time’ was significant: F(1,69) = 4.968, p < .05 (p = .029), partial $\eta^2$ = .07. To be more specific, all target words (speeded and non speeded) were more likely to be produced later in Study 2 picture descriptions compared to descriptions produced in Study 1. Finally, there was a non significant interaction between ‘Time’ and ‘Speed Manipulation’: F(1,69) =.248, p = .620, partial $\eta^2$ = .004. This interaction indicated that speeded items were not more likely to be produced earlier in descriptions compared to the non speeded items from study 1 to study 2.

As for the by subject analysis, the main effect of the ‘Time’ factor was again significant: F(1,20) = 4.837, p < .05 (p=0.40), partial $\eta^2$ = .19, indicating that participants were more likely to produce the target items later in Study 2 picture descriptions than in the respective descriptions of Study 1. Finally, there was a non significant interaction between ‘Time’ and ‘Speed Manipulation’: F(1,20) = .808, p = .379, partial $\eta^2$ = .04. This means that the above mentioned general increased likelihood of target items’ retrieval later in Study 2 picture descriptions was not due to the speed manipulation but it pertained all items (speeded and non speeded).
4.4 Discussion

We have presented an experiment in which we examined if naming speed could be manipulated in older adults over and above standard priming effects (i.e. attainment of maximum RTs’ reduction without a speed-accuracy trade-off), and whether reduced picture naming latencies would lead to more accurate and earlier production of trained words in connected speech.

4.4.1 Effectiveness of RISP method in speeding up picture naming

The RISP method was found to be extremely effective in reducing picture naming latencies, in that it reduced the mean RT from approximately 1 second at the beginning of the study to ~ 630 msec at the final repetition (Table 4.4), which was below the mean minimum RT at the beginning of the study (668msec by items and 770msec by subjects). This highlighted that the combination of repetitions and time pressure, as exerted in the task through the reducing deadline, was very beneficial in terms of speed of lexical retrieval. This finding is even more striking because of the age of the recruited participants (Hodgson & Ellis, 1998), given that slowing down both in linguistic comprehension and production is a standard characteristic of people as they grow older (e.g. Griffin & Spieler, 2006; Neto & Santos, 2012).

4.4.2 Effectiveness of RISP method in having persistent priming effects

Another important finding was that RISP method’s strong priming effects did persist long enough even after participants conducting another task. That is, latencies were significantly reduced compared to the 1st NN of the study, even after participants performing the picture description task and after having a comfort break of approximately 10 minutes. So the RISP method speeded up items to a great extent; even after the time period needed for the picture description, latencies for the trained items were still significantly faster than those of the untrained items (by ~110msec), yet
slower than the respective latencies of the RISP items in the 5th repetition (with mean RT ~700msec and so 70msec slower).

Most surprisingly, the same speeding up effect was observed for the non trained-single primed items, which were named significantly faster in the 2nd NN after only one presentation in the 1st NN and a potential second production in the picture description (i.e. significant latencies reduction between the 1st and the 2nd NN). So the single repetition could promote fast latencies, but not as much as the RISP method, which could also help to preserve reduced speed to a great extent even after the picture description task. While this result was expected for the 5 times repeatedly presented speeded items, it was not expected for the non trained/standard primed items.

We cannot, on the basis of our results, offer any conclusive explanations for the statistically significant speeding up of the non trained items. We will, therefore, limit ourselves to making two tentative suggestions. One possible account of this effect is that the behavioural style of responding increasingly quickly for the trained (RISP) items carried over to the non-trained (SP) items. Namely, this robust generalisation effect can be attributed to the RISP method and it can be considered as an additional indication of the developed method’s effectiveness, i.e. the RISP method is sufficient to speed up participants overall picture naming within tasks carried out about the same time. On the other hand, the speeding up of untrained items could have just been a pure repetition priming effect. The single presentation at the beginning of the study could have been sufficient to increase speed of naming for the untrained items (i.e. significant difference between the 1st and the last NN) but it did not suffice to speed up items equally to the RISP method (significant difference between RISP and SP items in the last NN). These interpretations are not mutually exclusive.

The validity of the first interpretation could not be tested because of the absence of a completely untreated set. If we had a set of items which would be included only in the Chapter 3 study NN and the 2nd NN in this study and latencies for this set in this study’s 2nd NN were faster than the respective latencies in Chapter 3 NN, we would then be able to attribute this effect to a behavioural style of speeding up when naming pictures.

The second interpretation’s validity was tested by making a purely post-hoc analysis, which compared the untrained items’ latencies in the 2nd NN to the RISP items’ latencies in the 1st (1RP) and the 2nd repetition (2RP).
As for the first comparison (2NN untrained/SP Items vs. 1RP trained/RISP Items), it was hypothesised that if the speeding up of the non trained items is attributed merely on the single repetition, then the latencies of these untrained items in the 2nd NN would not be significantly different from the latencies of the trained items in the 1st repetition. This is because the 1st repetition/RISP was the stage at which the trained items were presented for the second time to participants, as the untrained items in the last NN (2NN).

A paired t-test was conducted to test this hypothesis. Latencies of speeded items in the 1st Repetition were compared with latencies of the same items but in the untreated condition in the 2nd NN (i.e. latencies produced for the same items but from different groups of people). On average, trained items were named significantly slower in the 1st Repetition (1RP) when doing the RISP task (M = 856.49, SE = 16.60), than untrained items in the last Natural Naming (2NN) (M = 810.75, SE = 18.58), t(79) = 3.28, p < .005 [p=.002], r = .69. The difference between conditions was significant in the by subjects analysis too (t = 3.099, df = 20, p < .005, one-tailed). This implies that the 2NN fast RTs for the untrained items cannot be considered as a single priming effect, since the single repetition did not have the same effect on RTs of trained items. As presented in the Figure 4.9, there is some overlap between the two bars for each condition but the extent of the overlap is moderate.

A second comparison between 2NN untrained/SP items and 2RP trained/RISP items can be made, because of the intervening picture description task which could be considered as an extra exposure of participants to the untrained items. Given that a picture description task cannot significantly affect/reduce picture naming latencies (see Chapter 3), it was hypothesised that the picture description task could exert a smaller to picture naming priming effect, which would be sufficient to accumulate with the 1NN priming effect and reduce the untrained/SP items’ latencies in the final/2 NN. A paired t-test was conducted to test this hypothesis. Latencies of speeded items in the 2nd Repetition were compared with latencies of the same items but in the untreated condition in the 2nd NN, as produced by different participants. Contrary to the results of the previous comparison (1RP vs. 2NN), the mean time to name pictures was longer in 2NN (M = 810.75, SE = 18.58) than in 2RP (M = 750.99, SE = 12.78), t(79) = -4.62, p < .005, r = .72. The difference between conditions was significant in the by subjects analysis too (t = 3.598, df = 20, p < .0025, one-tailed [p=.002, 2-tailed]). Although not a clear-cut outcome for the relationship between the 2NN untreated items’ RTs and the
2RP treated items’ latencies, the result above can be considered as an *accumulative priming effect* of the single Natural Naming task presentation at the beginning (1NN) and the composite picture presentation later on, with the composite picture not exerting such a strong priming effect as the isolated picture presentation of the 2\(^{nd}\) RP (i.e. that’s why at the 2NN we have a weaker accumulative effect for the untreated items than the 2RP for the treated items). Specifically, the mean 2NN RT for untrained items overlaps with the mean RT of the 1\(^{st}\) and a half RP (in the middle of the 1\(^{st}\) and the 2\(^{nd}\) RP) for these items when they are trained, i.e. it is like the picture description task has half the priming effect of a proper picture naming repetition effect. As presented in the Figure 4.10, there is some overlap between the two bars for each condition but the extent of the overlap is moderate.

The by Items and by Subjects analyses in both the above comparisons allow the inference that fast latencies in 2NN for untrained items can be attributed to the accumulative effect of the single picture naming presentation (1NN) at the beginning of the study and the weaker picture description priming, which equals to approximately half of a confrontation naming priming effect.

*Figure 4.9 Distribution of Reaction Time (95% CI) in the 1st Repetition for Speeded Items and in the 2nd Natural Naming for Non Speeded Items*
4.4.3 Effectiveness of RISP method in establishing picture naming accuracy

It was also found that picture naming accuracy was significantly improved for all items (trained and untrained) by the end of the experiment’s session, but this difference was even more robust for trained (RISP) items, i.e. compared to the SP items, RISP items were retrieved significantly more accurately in the last NN. This result indicated the effectiveness of the RISP method in supporting not just quicker but also more accurate word retrieval in confrontation naming. The absence of a speed-accuracy trade-off was unsurprising because participants had firstly been familiarised with the items through repeated presentations before reaching the shortest deadline condition of 700msec. Studies deliberately aiming to the production of errors in naming (Dell, 1990) had set the deadline on 600msec (fast deadline condition) or on 1000msec (slow deadline condition) after the end of the target items’ presentation. However, standard speeding up methods could not avoid a speed-accuracy trade-off, especially when the speed reduction was very large, as in our case.
4.4.4 Correlation of picture naming speed with likelihood of production in connected speech

As expected, all target items (speeded and not speeded) were more likely to be produced in the post-manipulation picture descriptions (Chapter 4 descriptions) than in baseline picture descriptions (Chapter 3 descriptions), either because all stimuli were primed at least once before the picture description task (either single priming for SP items or repetition priming for RISP items) or because of generalisation effects of the RISP method (i.e. effectiveness for both trained and untrained items). This finding is in line with what was expected from studies on lexical priming in sentence contexts, and specifically sentence production (Bock & Griffin, 2000a, 2000b). However, our finding was contrary to that of Hess et al. (1995), who found that single presentation of the target items did not benefit comprehension of the same words included in sentences. Besides that the difference between that and our study is striking, the difference in modality (production vs. comprehension) could account for this discrepancy. This finding, together with this of Bock’s and Griffin’s (2000a, 2000b) study, strongly suggests that single-word primes are central to the selection of words for production in connected speech. However, given that untrained items had a statistically significant increase on both speed and accuracy in the final NN, we cannot draw conclusions on which variable (i.e. increase in speed vs. increase in accuracy) contributed more to the general increase of likelihood of retrieval in descriptions. Taken into account the correlation found in Chapter 3, speed reduction and accuracy increase may have had an accumulative effect in producing more target words (both produced once and repeatedly) in descriptions. That is, the accurate, and to some extent quick, activation of the target word may have had a large impact on lexical selection and word retrieval preceding word production in connected speech.

As for the comparison of trained and untrained items’ likelihood of retrieval in composite picture descriptions, contrary to our original hypothesis, speeded items were equally likely to be produced in descriptions as non speeded items. Given that speaking is a highly trained task, it is striking that participants showed no benefit of extensive practice in naming pictures over picture descriptions. The causality underlying this absence of interaction between speed of naming and likelihood of retrieval in descriptions is unclear.
One could argue that single presentation’s contribution in increasing accuracy and reducing speed (as observed in the comparison of the two NNs) may suffice for using these items in connected speech. That is, neurotypical participants’ connected speech may have a limit of maximum benefit from picture naming (maximum increase in accuracy and reduction in speed they can benefit from), and exceeding this limit is only redundant in terms of carrying this benefit over to connected speech. This limit is not expected to be evidenced in people with complications in word retrieval (e.g. aphasic patients or bilinguals), but merely in neurotypical participants whose lexical access in connected speech is not exceedingly demanding and only a fundamental improvement on accuracy and speed is required. Further research is required to replicate these results with bilinguals or aphasic patients, whose word finding difficulties in connected speech are more severe than neurotypical participants’ and so speed of retrieval can be more critical for deciding whether to produce an item or not in connected speech (e.g. when describing a picture).

Alternatively, an over generalisation from speeded to non speeded items may have occurred. Given that RISP items were significantly quicker and more accurately named compared to the SP items in the last NN, we can make the assumption that after the RISP manipulation there were more resources available to allocate to non speeded items when describing composite pictures. The intensity of the RISP method’s generalisation effect can be justified by RISP’s demanding composition of two standard methods (repetition priming & deadline naming). This interpretation is in line with the hypothesis made at the beginning of the study about the potential ability of the RISP method to induce to healthy neurotypical participants strong generalisation effects in untrained items.

It could also just have been the repetition of the picture description task from the baseline study (Chapter 3) to this study (Chapter 4) which contributed to the more efficient picture description in this study (i.e. potential picture description priming effect). Future research will need to better delineate the potential priming of picture descriptions by the same tasks even when descriptions are conducted with a long break in between (from minutes to months).

Finally, it could be supported that a meta-cognitive control mechanism may have been activated. Namely, participants could understand the link between picture naming and picture description and were consciously trying to prove that they can
produce eloquent picture descriptions without needing to resort to words they have been trained.

The implications of this finding for the mechanisms involved in repetition priming and ageing effects on word retrieval and memory should also be considered. The resolution of word finding difficulties in ageing population is aided by single repetition priming, while multiple presentations and speeded word production did not have an additional effect on accurate word retrieval in connected speech. Our finding extend to connected speech the previous results that young adults’ (Kelley & Lindsay, 1993) and older adults’ (Rastle & Burke, 1996) single prior production of a word increases its correct retrieval in response to a general knowledge question. Wheeldon and Monsell (1992) also found that prior single production of a concrete noun in response to a definition reduced this word’s picture naming latencies. Our findings are compatible with those of Wheeldon and Monsell (1992): not only can a priming effect be exerted on different contexts (picture naming and picture description, comparatively to naming-to-definition and picture naming), but this effect can be exerted by a single presentation/production only.

This result can also be informative with respect to the cause of repetition priming effects in word production more generally. Wheeldon and Monsell (1992) found evidence that strengthened lexical connections/nodes between the prime and the target accounted for repetition priming effects, while strengthening phonological connections (e.g. by prior presentation of homophones) did not speed naming of the target (e.g. son – SUN). Given that the repeated presentation of the RISP words contributed to the strength of phonological connections and inasmuch as no additional facilitatory priming was observed for RISP stimuli compared to SP stimuli, we can verify the Wheeldon and Monsell hypothesis that strengthened lexical connections are responsible for priming effects even in different contexts. That is, single production of a word can strengthen the lexical connections/nodes among the word’s semantic representations, facilitating word retrieval even in a subsequent different context, like in a picture description (i.e. enhanced semantic processing than surface level / phonological processing).
4.4.5 Correlation of picture naming speed with time of production in connected speech

Our data did not support the original hypothesis about earlier production in descriptions of all items, and especially of those that were trained. Instead, it has been found that all target words (SP and RISP) were produced later in post-manipulation descriptions compared to baseline descriptions (Chapter 3). This counterintuitive finding combined with the previous one about likelihood of retrieval in picture descriptions point to a possible meta-cognitive mechanism employed by participants, resulting in consciously avoiding producing target words in descriptions within the first minutes and using them as a last resort later in the descriptions. This could be considered as a means of producing more eloquent descriptions, without having to use the already taught vocabulary (i.e. trained words either with one or with several repetitions). This interpretation can be supported by the nature of the tasks: while lexical access and retrieval are the main prerequisites to a simple picture naming task, connected speech tasks, like the picture description employed in this experiment, encompass perceptual and attentional components rendering word production a process that requires cognitive processing.

Furthermore, RISP items were not more likely to be produced earlier in descriptions compared to SP items from baseline (Chapter 3) to post-manipulation (Chapter 4). This means that the above mentioned general increased likelihood of target items’ retrieval later in baseline descriptions was not due to the speed manipulation but it pertained all items (speeded and non speeded). An explanation for this result could be the different time demands of word retrieval between the two contexts: picture naming requires rapid word retrieval in milliseconds while in picture description there is a larger time window to select and retrieve words that can be efficiently (i.e. quickly and accurately) named. This finding is not contrary to previous findings and theoretical approaches on word retrieval differences depending on the elicitation context. For example, for longer phrases containing more than one noun (e.g. “the baby is next to the dog”), other studies have reported faster latencies when the noun was phonologically primed (Wheeldon & Lahiri, 1997; Costa & Caramazza, 2002), while in other studies this effect was not observed (Schriefers, 1993; Schriefers & Teruel, 1999). Furthermore, according to Dell’s model, the time-course of the per-step activation depends on the context of the word to be named: if the word is going to be part of a sentence (like in
connected speech tasks), the word is highly activated when it reaches the specific free slot of the syntactic frame, but when the word has to be named in isolation, it is activated immediately on its selection (Dell et al., 1997). In this way, the syntactic slot to which the selected word is linked is responsible for the jolt of activation (e.g., MacKay, 1982; Stemberger, 1985; Dell & O'Seaghdha, 1991), indicating that priming effects are attenuated in connected speech and so providing an explanation for the current effect.

Another possibility is that this effect is simply a result of the longer time taken in post-training composite picture descriptions in this study, at which the use of more words (SP and RISP) resulted in shifting the baseline study (Chapter 3) mean time of word retrieval in descriptions to a later time point.

Finally, these results can account for the cause of (the observed facilitation effect in) repetition priming, which has been very controversial in the literature and has been attributed to three different mechanisms (Wheeldon & Monsell, 1992).

[1] The “task-specific response” associative learning. The effects are observed only under certain conditions: first on the condition that the prime and the target are identical or at least very similar (Lachman & Lachman, 1980; Mitchell & Brown, 1988); secondly, when there are no contextual differences between prime and probe encounter (Wheeldon & Monsell, 1992). In our case, only the first condition was fulfilled, i.e. both of them were almost identical objects depicted in (either simple or composite) pictures, while the latter was manipulated (confrontation naming vs. picture description), i.e. difference in contexts between the prime (objects included in isolated pictures as part of a confrontation naming task) and the target (objects included in composite pictures as part of a picture description task). If this theory is correct, one would expect picture naming priming to have some mild yet non significant effects in increasing likelihood of production in descriptions, because of the fulfillment of only one of the two conditions. This change would apply to both SP and RISP items.

[2] The changes in the accessibility of lexical knowledge. That is, the presentation of a word can change the state of its lexical representation and especially the strength of its connections, depending on the times of encounter with the word (McClelland & Rumelhart, 1981; Monsell, 1991; Vitkovitch & Humphreys, 1991). According to this approach, significant increase in the likelihood of retrieval in descriptions is expected only for the repeatedly primed RISP items, and not for the SP items.
[3] *The episodic memory trace*. This trace is created in the first encounter with a word and it is context-specific (Feustel, Shiffrin, & Salasoo, 1983), i.e. it helps “the retrieval of context specific information about the priming episode instead of changing the accessibility of lexical knowledge” (Wheeldon & Monsell, 1992, p. 727). If contextual congruence between prime and target exert such a strong influence in lexical retrieval, one would expect that repetition priming (single or RISP) would not increase the likelihood of target items’ retrieval in descriptions, because of their previous encounter in a different context (i.e. confrontation naming).

The facilitation of production of all target items in picture descriptions through picture naming presentation/s oppose to theories [theory 2] connecting the ease of lexical access to the number of repetitions/prime presentations (not significantly different likelihood of retrieval of SP and RISP items), but also to theories [theory 3] that consider context to be the only factor responsible for the attainment of priming effects (existence of priming effects in picture description through picture naming). Theory [1] seems to be the most prevalent, since the shared type of stimuli (primes and targets were both objects on pictures) must have contributed to the significant change of likelihood of production in connected speech, while the change of context had its price, as mirrored in the change of latencies in connected speech from baseline (Chapter 3) to post-training (Chapter 4) (i.e. later production of target stimuli in Chapter 4 picture descriptions).

### 4.5 Conclusions

This study aimed to investigate the intriguing issue of lexical retrieval processes in different contexts by neurologically intact older adults. The contribution of this study lies in the comparison between the two methods, the standard single presentation (SP) and the new, invented one (RISP), while also in the specification of the picture naming variables (speed and accuracy) that affect the efficacy of participants performance in connected speech (picture descriptions). What can be concluded is that the very quick and accurate production of a subset of the stimuli can have very strong generalisation effects, supporting more efficient (quick and accurate) production of untrained items in both picture naming and connected speech (i.e. picture description). Furthermore, the
reduction of latencies (RISP effect) can persist, although somewhat diminished, a long time after the priming encounter and it is observed even when the two encounters with the target items are separated by another task. However, a major reduction of naming speed is not so critical for retrieving the same words in connected speech, and especially within the first minutes. Also single-word primes can be central to the selection of words for production in connected speech, with the accuracy of single-word retrieval being equally important to the speed of retrieval in predicting the likelihood of word production in connected speech. Last but not least, picture description has half the repetition priming effect that confrontation naming has on reducing picture naming latencies. That is, picture description can significantly reduce picture naming latencies only when it is combined with at least one confrontation naming exposure of the target items.
CHAPTER 5

Effects of standard (SP) versus speed-focused therapy (RISP) on lexical access in picture naming and composite picture descriptions in post-stroke aphasia
Abstract

Word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms affecting everyday communication. While picture naming tasks have typically been used for assessing and treating word finding problems in clinical practice, there is a dearth of studies investigating the relationship between confrontation naming and connected speech tasks. This study investigated whether a newly-developed treatment targeting both speed and accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming would be more effective for improving the use of the treated names in connected speech, than the standard therapy (‘standard presentation’ - SP) which targeted accuracy alone. Five participants with aphasia of varying degrees of severity and subtype took part in twelve therapy sessions over 6 weeks. In the baseline and post-treatment assessments, participants were asked to complete a composite picture description task and a picture naming task, the items of which were part of the composite pictures and constituted therapy targets. For the dependent variables of speed and accuracy in picture naming, speed-focused therapy was as effective as the standard therapy. The ‘carry over’ of the therapy items to connected speech was increased for all items relative to the baseline. Speed therapy, however, in comparison to the standard one, led to significantly higher generalisation of targeted items to connected speech. These findings suggest that a more demanding single-word therapy can promote strong generalisation effects to more linguistically and cognitively demanding connected speech production.
5.1 Introduction

The ability to use words with ease and precision is pivotal in our everyday communication (Nippold, 1992). Unfortunately, word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms because even simple, everyday words cannot be produced easily or quickly (also known as ‘anomia’, Laine & Martin, 2006). Both the assessment and treatment of aphasia typically involves confrontation naming tasks (for pros and cons of picture naming tests, see Herbert et al., 2008), which make the assumption that performance in picture naming tasks will reflect, at least in broad terms, the ease and reliability of word retrieval in connected speech tasks and lexical retrieval within everyday communication. Ferguson and Armstrong (1996, p. 195) described this trend as a tendency “perpetuating in aphasiology the rather outdated view that investigation of the word as an isolated entity will reveal significant insights into the aphasic speaker’s overall language competence or functional performance”. This pilot study aimed to collate preliminary data of both picture naming and connected speech tasks.

5.1.1 Word retrieval in different contexts in aphasia

Regarding the impaired population, confrontation naming and spontaneous speech are particularly different in terms of word retrieval. Compared to naming of single words, access to lexical information in the context of connected discourse may prove to be either facilitated, if some words are primed, or handicapped, because of the more complex task requirements (Feyereisen et al., 1991).

Word retrieval patterns vary depending on the elicitation context. Error patterns of individuals suffering from different subtypes of fluent aphasia (e.g. conduction aphasic participants and anomic aphasic participants) are not the same in picture naming and spontaneous speech. More specifically, in confrontation naming tasks lexical and sublexical paraphasias (e.g. van → bus and ghost → /goʊ/ respectively) are produced by all aphasic patients independently of the specific aphasia impairment (Mitchum et al., 1990). In spontaneous speech, however, different errors types are produced depending on the aphasia subtype: conduction aphasic patients produce primarily sublexical errors
(mainly phonemic paraphasias), while anomic patients produce occasionally lexical errors (mainly semantic ones) and circumlocutions.

These results are quite revealing in several ways. First, they indicate that naming and spontaneous speech makes different linguistic and cognitive demands. Moreover, it becomes apparent that connected speech data (from both spontaneous speech samples and connected speech elicitation tasks) in comparison to naming provides much more opportunities to the speakers for avoidance of the difficult vocabulary, by using more familiar similar-synonym words, by making use of circumlocutions or even by choosing to convey a different message (Dell et al., 1997).

There has been a lot of work about the different patterns of word class retrieval (verbs vs. nouns retrieval) depending on the different elicitation context (confrontation naming/single word naming vs. sentences and/or connected speech). As for nouns, that are the most pertinent to this study because nominal stimuli are used (see the Methods sections), controversial results have been produced. Some studies have suggested that the two different contexts have a direct (“one-to-one”) relationship (Herbert et al., 2008). However, other studies have reported better object naming rather noun retrieval in connected speech tasks (Manning & Warrington, 1996), while others have reported the reverse results, i.e. worse noun retrieval in confrontation naming rather in connected speech tasks (Berndt et al., 1997; Zingeser & Berndt, 1988). Irrespective of word class, some authors have reported better word retrieval for both nouns and verbs in confrontation naming rather in conversation (Manning & Warrington, 1996), and others have argued that both nouns and verbs are better retrieved in connected speech tasks and worse in confrontation naming (Mayer & Murray, 2003; Pashek & Tompkins, 2002; Williams & Canter, 1987). Interestingly, in Maendl’s study (1998), at which the same design and stimuli were used across all six participants with aphasia, half of the participants experienced reduced word finding difficulties when carrying out the picture naming task rather when describing composite pictures, while the rest three participants performed equally well in the different types of tasks.

Other studies were more specific by associating noun retrieval in different contexts with different types of impairment. Some studies have reported that particularly fluent aphasic participants are subject to different patterns of nouns’ retrieval depending on the retrieval context (Berndt & Haendiges, 2000; Pashek & Tompkins, 2002; Mayer & Murray, 2003). According to Williams & Canter, relative to
other aphasic patients (Broca’s, Wernicke’s, and conduction aphasic patients), anomic patients show the lowest association between noun confrontation naming and noun retrieval in connected speech (Williams & Canter, 1982). Because of these results, the researchers proposed that aphasia type can be considered as a clinical marker denoting the association of word retrieval in different contexts.

With regard to post-therapy generalisation, the literature is equivocal regarding the effectiveness of the established accuracy based treatments in promoting treated items’ carry-over to connected speech. Whilst several cases indicating dissociations in naming skills across different naming contexts (picture naming vs. naming in spontaneous speech) have been recorded in the literature (Zingeser & Berndt, 1988; Marshall & Cairns, 2005), it has been argued that picture naming accuracy significantly predicted naming in connected speech contexts, either in more constrained speech elicitation contexts (composite picture description, Maendl, 1998; narratives, Conroy et al., 2009d) or in conversations (Herbert et al., 2008; for a review about generalisation to conversation, see Carragher et al., 2012). The same non conclusive results have been reported regarding the generalisation from treated to untreated items (for different generalisation results produced by different types of treatments, see Best et al., 2013). Generally, there is a strong belief in the clinical literature that there is a lack of generalisation for standard therapies (Howard, 2000; Nickels, 2002a; Wisenburn & Mahoney, 2009), yet it is an underpowered field with not many participants involved in the studies and an empirical basis missing.

Finally, regarding the variable of speed, there is theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b) yet naming speed has been a neglected area in the aphasiology literature (Crerar, 2004). From a clinical point of view, the items which are named more quickly at a post-therapy point are more expected to be named in connected speech contexts (Conroy et al., 2009d). As for therapies which aim at improvement only of accuracy and not of speed as well, Conroy et al. (2009d) illustrated that the speed of picture naming after a cueing-only type of therapy (i.e. decreasing cue therapy) could not predict the extent to which items are named in more spontaneous connected speech tasks. Given that fluent connected speech requires not only accurate (production of no more than one or two errors per 1000 words, Levelt, 1989) but also quick lexical access (fluent speakers produce around 100 words per minute, equating to around half a second per word or 2 words every second e.g. on the
Cookie Theft description, Levelt, 1989; Bird et al., 2000), therapy effects may be more likely to generalise to spontaneous speech if both accuracy and speed are improved. This is the basic hypothesis of our study, and the basic incentive for developing a new method that will emphasise both accuracy and speed of word retrieval.

5.1.2 Speed of naming as a potentially critical factor in generalisation to untreated items and connected speech

One variable which may be critical in determining whether words retrieved in isolation can also be retrieved within the time demands of fluent speech is naming latency, or speed of naming in confrontation naming (Conroy et al., 2009b, 2009d; Crerar, 2004). Speed of word retrieval during picture naming is considered to be the time needed for the initiation of a naming response after the presentation of the target picture and is distinct from the naming duration (see also Kello & Plaut, 2000). Along with accuracy, speed of naming is a critical variable for the response generation in naming, which is important for interpreting naming data and evolving theories about the underlying cognitive processes (e.g. Balota et al., 1989; Lupker et al., 1997). A novel yet potentially key finding in the literature (Fillingham et al., 2003, 2005a, 2005b, 2006; Conroy et al., 2009a, b, c, d) is that speed of naming is an important variable, not only within assessment tasks (McCall et al, 1997), but also within therapy tasks, warranting further investigation. This could be because an improvement in speech ratio in connected speech tasks is particularly difficult for aphasic patients. This derives from the fact that people with aphasia may be competent in ‘exploiting’ metalinguistic skills to enhance their accuracy performance even many years post-CVA, but not sufficiently competent to achieve neurotypical speed scores too (Crerar, 2004). This is also indicated by the recovery patterns of aphasic individuals who show an identical performance to neurotypical participants at the linguistic tasks (Kertesz & McCabe, 1977), but the time they need for the accomplishment of the tasks is double relative to the respective speed of neurotypical participants (Neto & Santos, 2012). Thus, the reduced response speed is a typical symptom of aphasia, even after standard therapies or rehabilitation. Moreover, there is theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b).
These findings highlight the importance for treatments to address the factor of speed, yet naming speed has been a neglected area in the aphasiology literature (Crerar, 2004). The vast majority of clinical studies have attempted to shed light on the pre- or post-treatment variables affecting picture naming speed in aphasia, either related to the treated items (e.g. word class, Bird et al., 2003b; Conroy et al., 2006, 2009a; imageability, Alario et al., 2004; Conroy et al., 2009b; metaphorical meaning, Papagno et al., 2004), or to participants with aphasia (e.g. linguistic, cognitive and neuropsychological profile, Fillingham et al., 2003; Conroy et al., 2009b; degree of baseline naming impairment, Conroy et al. 2009a, 2009d; aphasia subtype, Prather et al., 1997). As for the naming therapy studies (i.e. therapies targeting single word retrieval), they have focused solely on improving accuracy (for a review of studies aiming to treat anomia, see Nickels & Best, 1996; Nickels, 2002a). A therapy which has some evidence with respect to being effective in improving speed of word retrieval in aphasic participants is errorless learning (Conroy et al., 2009b). Pure errorless techniques in aphasia therapy are inclined to use word repetition as a phonological cue, the target picture as a visual cue, and the written target as orthographic cue (Fillingham et al., 2003; Abel et al., 2005; Conroy et al., 2006). Especially for verbs, using errorless learning techniques can minimise the requirement for executive control and the cognitive demands required for verb processing (Fillingham et al., 2003, 2005a, 2005b, 2005c). This is extremely important for this type of therapy, if we consider the verbs’ critical role in sentence production and thus in connected speech (lexical hypothesis of agrammatic speech, Saffran, Schwartz, & Marin, 1980) (Marshall et al., 1998; Bastiaanse, Edwards, Maas, & Rispens, 2003). However, a question yet to be answered is whether consistently faster naming responses on the part of participants during errorless therapy is a corollary to the type of the therapy being administered or not (Conroy et al., 2009b). Moreover, it should be stressed that errorful therapy technique is equally effective with errorless learning in terms of speed for verb and noun naming (Conroy et al., 2009c). However, errorless therapy has generally been found to be preferable by patients given that it is easier to engage with than trial and error naming and many find it more satisfying (Conroy et al., 2009b, 2009c).

The available information on the relation between picture naming speed and post-treatment word retrieval in connected speech is extremely scanty. To the best of our knowledge, only one study investigated this relation, but without making use of sufficient data, as admitted by the authors (Conroy et al., 2009d, p. 1060). Therefore,
this study focused on presenting preliminary data about the comparison between a newly developed treatment that attempted to reduce speed and increase accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming (i.e. no speed-accuracy trade-off) and a standard treatment (‘standard presentation’ - SP) that targeted accuracy alone. More specifically, we firstly aimed to investigate which treatment would produce more marked improvements in confrontation naming on both speed and accuracy, and subsequently determine the extent to which participants with aphasia can be trained to reduce picture naming latencies without compromising accuracy in responses, i.e. avoid a speed-accuracy trade-off. Secondly we sought to examine which therapy would lead to increased word access in connected speech samples and specifically identify which therapy would significantly increase the likelihood of production of treated and untreated words in composite picture descriptions. Our hypothesis was that, comparatively to the SP, RISP would have a cumulative effect of accuracy increase and speed decrease in picture naming (i.e. more successful post-therapy naming), and it would lead to increased generalisation of its targeted items in connected speech. Furthermore, taking into account the theoretical and clinical evidence that speed of naming may constitute a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b), we predicted that a focus on accuracy and speed would promote general changes in participants’ production strategy and it would lead to a significant increase in the use of untreated items in connected speech: improved efficiency for a subset of vocabulary in both the variables of speed and accuracy could have the positive side-effect of improved performance on the remaining words because effort for core vocabulary would be reduced and it could be diverted to other aspects of speech production. Lastly, we hypothesised that the new therapy would have long term effects regarding ease of word retrieval in both confrontation naming and composite picture descriptions.

5.2 Method

A within-subject case series design was employed to compare the effects of an accuracy-focused versus speed+accuracy-focused naming therapy on improving confrontation naming and the production of connected speech. The results of the case series study may be informative in confirming whether a speed+accuracy focused
naming therapy is feasible, will be tolerated by patients, and may give us some pilot data as to the effects of increasing accuracy and reducing speed in word retrieval.

5.2.1 Participants

Five participants (2 males, 3 females; mean age 64.8 years, SD = 11.56) with a clinical diagnosis of chronic aphasia following cerebrovascular accident (CVA) took part in the study. They had been involved in previous studies at the University of Manchester and were referred to the lead researcher by other researchers of these studies after participants expressing their interest in being contacted for future research studies. Participants were originally recruited from aphasia support groups and similar services in Greater Manchester and other North West counties, England. Due to the study using a case series design, participants had aphasia of varying degrees of severity and subtype. All were pre-morbidly right handed, native English speakers, and they had sustained one left hemisphere stroke (ischaemic or haemorrhagic) at least one year prior to the testing (chronic condition). Prerequisites for participating in the study were to have normal or corrected to normal hearing and vision and reliable repetition skills (judged as above 40% on Word Repetition Immediate test; PALPA 9, Kay, Lesser, & Coltheart, 1992). This would ensure that participants could meet the therapy requirements and could in theory benefit from the therapy. Potential participants with co-existing neurological impairments (e.g. dementia or multiple sclerosis), global aphasia, severe perceptual problems, or with very severe naming difficulties (below 8.33% or 5 out of 60 on the Boston Naming Test) (BNT, Kaplan, Goodglass, & Weintraub, 1983), were excluded from the study. However potential participants with very severely impaired speech or with very mild word finding difficulties (i.e. even when scoring over 45 out of 60 at the BNT and being in the normal range) were not excluded because we wanted to obtain a small but broad sample so that the newly developed therapy could be trialed in a range of patients (severe – moderate – mild anomic). For example, milder participants’ performance in picture naming was expected to be reasonably accurate but slower compared to neurotypical participants. By recruiting this type of participants, we would be able to determine how much quicker they could get in picture naming post-treatment and identify the number of target items that they would use in descriptions pre- and post-treatment.
Demographic details (i.e. participant profiles) of the participants are given in Table 5.1. In addition, Table 5.1 includes each participant’s baseline accuracy in picture naming. Scores representing each participant’s accuracy in retrieving the same items (as had been presented in picture naming) in composite picture descriptions are also reported in Table 5.1. Given that content words convey the main meaning in speech, these scores do not constitute a measure of fluency e.g. someone could have a low score in descriptions but be fluent (‘empty speech’), but they indicated the degree of difficulty in producing content words in connected speech.

All participants agreeing to take part in the study had signed a consent form, which was in line with the study’s ethical approval.

Table 5.1 Participant Demographic Details including baseline scores and aphasia subtypes

<table>
<thead>
<tr>
<th>Participant</th>
<th>KS</th>
<th>AD</th>
<th>EB</th>
<th>DM</th>
<th>JM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>63</td>
<td>77</td>
<td>53</td>
<td>52</td>
<td>74</td>
</tr>
<tr>
<td>Gender</td>
<td>male</td>
<td>female</td>
<td>female</td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td>Handedness</td>
<td>right</td>
<td>right</td>
<td>right</td>
<td>right</td>
<td>right</td>
</tr>
<tr>
<td>Education (years)</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>Time post-stroke (years)</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Stroke Aetiology</td>
<td>H</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Baseline Naming Score (max=80)</td>
<td>12</td>
<td>15</td>
<td>43</td>
<td>55</td>
<td>58</td>
</tr>
<tr>
<td>Baseline Description Score (max=80)</td>
<td>6</td>
<td>4</td>
<td>9</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>BDAE Classification</td>
<td>TSA</td>
<td>Broca</td>
<td>Anomia</td>
<td>Broca</td>
<td>Anomia</td>
</tr>
</tbody>
</table>

I = ischaemic, H = haemorrhagic, TSA= transcortical sensory aphasia

5.2.2 Background assessments

Before being involved in this study, participants had undergone extensive linguistic and cognitive assessments, as part of related projects conducted by researchers affiliated with the same research unit (Naru, University of Manchester) (e.g. Butler, Lambon Ralph, & Woollams, 2014). The results of these assessments are reported as percentages of correct responses and are contained in Table 5.2. Comprehensive examination of these scores can provide us with participants’ aphasiological and neuropsychological profiles and subsequently facilitate the interpretation of an individual’s therapy findings.
The scores of the Boston Naming Test (BNT) (Kaplan et al., 1983) were of major importance for the selection of participants: a wide range of word finding difficulties had to be covered, because the extent of each patient’s anomic problem could be later linked to differences in the degree of post-treatment improvement between participants. Patients were also tested on the following four phonological tasks (Psycholinguistic Assessments of Language Processing in Aphasia, PALPA 9) (Kay et al., 1992): (a) Auditory word repetition immediate, (b) Auditory word repetition delayed, (c) Auditory non-word repetition immediate, (d) Auditory non-word repetition delayed. The other two linguistic tasks involved the discrimination of two words if they were different or not: word minimal pairs and non-word minimal pairs (PALPA 2 & PALPA 1 respectively) (Kay et al., 1992). Furthermore, patients were asked to complete six tests on comprehension and semantic memory: (a) Spoken Sentence Comprehension from the Comprehensive Aphasia Test (CAT, Swinburn, Porter, & Howard, 2005) (b) 64 items’ picture naming (Bozeat, Lambon Ralph, Patterson, Garrard, & Hodges, 2000) (c) Spoken Word to Picture Matching (Bozeat et al., 2000), (d) Written Word to Picture Matching (Bozeat et al., 2000), (e) Synonym Judgement Test (Jefferies, Patterson, Jones, & Lambon Ralph, 2009), (f) Camel and Cactus Test (CCT, picture version, i.e. semantic association for pictures) (Bozeat et al., 2000). To test short memory skills, the forward memory span and the backward memory span were administered (Wechsler, 1945). The results of two more cognitive tests are reported: (a) Brixton Spatial Rule Anticipation Test (Burgess & Shallice, 1997) and Raven’s Coloured Progressive Matrices (Raven, 1962). Both are visuospatial tests measuring attentional/executive skills. These scores were important to ensure that it would be feasible for all participants to provide elaborate descriptions of composite pictures in the baseline and post-treatment assessment tasks.

5.2.3 Stimuli

To compare chronic stroke patients’ performance between treatment/picture naming tasks and connected speech, two types of stimuli were used: pictures depicting isolated objects (nouns) and composite multi-event pictures respectively. All items included in the therapy/picture naming assessments were part of the composite pictures.
More details regarding the number and the selection of these stimuli are provided below.

### Table 5.2 Participants’ performance on language, semantic and cognitive assessments

<table>
<thead>
<tr>
<th>Task</th>
<th>KS</th>
<th>AD</th>
<th>EB</th>
<th>DM</th>
<th>JM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston Naming Test</td>
<td>11.67</td>
<td>18.33</td>
<td>38.33</td>
<td>70.00</td>
<td>81.67</td>
</tr>
<tr>
<td>Word Repetition: Immediate</td>
<td>91.25</td>
<td>57.50</td>
<td>81.25</td>
<td>73.75</td>
<td>96.25</td>
</tr>
<tr>
<td>Word Repetition: Delayed</td>
<td>93.75</td>
<td>55.00</td>
<td>78.75</td>
<td>68.75</td>
<td>96.25</td>
</tr>
<tr>
<td>Non-word Repetition: Immediate</td>
<td>73.33</td>
<td>23.33</td>
<td>66.67</td>
<td>53.33</td>
<td>93.33</td>
</tr>
<tr>
<td>Non-word Repetition: Delayed</td>
<td>80.00</td>
<td>13.33</td>
<td>36.67</td>
<td>10.00</td>
<td>63.33</td>
</tr>
<tr>
<td>Word Minimal Pairs</td>
<td>95.83</td>
<td>93.06</td>
<td>95.83</td>
<td>93.06</td>
<td>95.83</td>
</tr>
<tr>
<td>Non-word Minimal Pairs</td>
<td>94.44</td>
<td>95.83</td>
<td>93.06</td>
<td>80.56</td>
<td>90.28</td>
</tr>
<tr>
<td>CAT Spoken Sentence Comprehension</td>
<td>84.38</td>
<td>68.75</td>
<td>75.00</td>
<td>56.25</td>
<td>71.88</td>
</tr>
<tr>
<td>CBU 64 Item Naming</td>
<td>26.56</td>
<td>37.50</td>
<td>76.56</td>
<td>73.44</td>
<td>96.88</td>
</tr>
<tr>
<td>Spoken Word to Picture Matching</td>
<td>71.88</td>
<td>96.88</td>
<td>100.00</td>
<td>98.44</td>
<td>100.00</td>
</tr>
<tr>
<td>Written Word to Picture Matching</td>
<td>67.19</td>
<td>98.44</td>
<td>98.44</td>
<td>98.44</td>
<td>100.00</td>
</tr>
<tr>
<td>96 Synonym Judgement</td>
<td>84.38</td>
<td>83.33</td>
<td>83.33</td>
<td>95.83</td>
<td>91.67</td>
</tr>
<tr>
<td>Camel &amp; Cactus Test: Pictures</td>
<td>68.75</td>
<td>85.94</td>
<td>90.63</td>
<td>98.44</td>
<td>93.75</td>
</tr>
<tr>
<td>Forward Digit Span</td>
<td>100.00</td>
<td>75.00</td>
<td>50.00</td>
<td>37.50</td>
<td>62.50</td>
</tr>
<tr>
<td>Backward Digit Span</td>
<td>50.00</td>
<td>37.50</td>
<td>25.00</td>
<td>0.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Brixton Spatial Rule Anticipation Test</td>
<td>52.73</td>
<td>30.91</td>
<td>47.27</td>
<td>50.91</td>
<td>50.91</td>
</tr>
<tr>
<td>Raven's Coloured Progressive Matrices</td>
<td>86.11</td>
<td>63.89</td>
<td>66.67</td>
<td>91.67</td>
<td>83.33</td>
</tr>
</tbody>
</table>

Cases are ordered according to BNT severity. Scores are given in percentages. Scores marked in bold fall below the cut-off for normal performance. The cut-off was calculated as 2 SD below the mean performance of healthy control participants (Butler et al., 2014). *Cut-off based on published norms. **No cut-off available. Authors’ details for published assessments are provided in the text.
**Stimuli - Pilot experiment**

Before conducting this study with chronic stroke participants, a pilot study was carried out with healthy adult volunteers (n=10). This allowed us to establish reliability of stimuli across both picture naming and composite picture description tasks (for more details, see Chapter 3).

The specific aims of this pilot study were:
1) to establish the likelihood of retrieval for words that could be produced when describing six composite pictures i.e. busy social scenes with multiple characters engaged in a range of activities. This helped us to select among these six pictures the four most suitable pictures to be included in the picture description task.
2) to establish picture name agreement for a large corpus of words used in the description of the 3 selected composite pictures to be included in study 1 and 2 (pictures A, B, and F). Because some extra stimuli were chosen to be included in the picture description and hence the picture naming task/ treatment of this study, an additional name agreement task was conducted for items not included in the initial name agreement task of the pilot study. All participants (n=10) were again native English speakers, aged between 24 and 38 years old.

**Stimuli - Main Experiment**

**Composite Picture Description Task**

To elicit a language sample, the stimuli for this task were four composite multi-event pictures that contained various common objects and activities (i.e. ‘Where’s Wally’ type pictures). Based on data from the first part of the pilot study, we selected four composite pictures (A, B, C and F, see Appendix 1) which were likely to elicit key content words (i.e. produced by more than 3/10 neurotypical participants in the pilot study). All these composite pictures were depicting both treated and untreated items, included in the picture naming task: these pictures were selected to provide us with the stimuli used in therapies (treated items) and in the picture naming assessments (treated & untreated items in baseline, between-cycles & post-treatment assessment).
**Picture Naming Task**

120 words were inserted into the Match program (Van Casteren & Davis, 2007). All stimuli were nouns and met the following criteria:

(a) While in the two previous studies with healthy older adults our aim was to include stimuli covering all the range of likelihood of retrieval in picture descriptions i.e. items produced by 1/10-10/10 participants in the pilot study, this study aimed for selecting items that reliably appeared in picture descriptions i.e. produced by more than 3/10 participants in the pilot study.

(b) items had to be of high imageability. For example, concrete nouns were preferred instead of abstract words e.g. *bench* and not *water* respectively.

(c) items had no synonyms or no equally frequent synonyms, which were used alternatively in the picture description task e.g. *dodgems* and *bumper cars*.

Among these 120 nouns, the aim was to select 80 stimuli across 4 matched sets of 20 items: 2 therapy sets and their control items undergoing no treatment. The two therapy sets were allocated to the two treatment conditions, i.e. 20 items for standard therapy (SP), 20 items for speeded therapy (RISP). This method was designed to allow us to investigate whether a) items would be named more quickly following speeded therapy and b) if items named more quickly would, as a result, be more likely to be produced in connected speech. This was based on the hypothesis that speed of word retrieval would have a positive effect on likelihood of retrieval in connected speech.

The word sets were matched for likelihood of retrieval in descriptions as represented by the number of neurotypical participants producing each word in the picture description task of the pilot study. The four sets were also matched for frequency and length (see Appendix 4). Frequency values were extracted from the British National Corpus (BNC) (Davies, 2004). Because of the first two variables’ values high importance (likelihood of retrieval in descriptions and word frequency), their matching weight across the 2 sets was set to be higher (i.e. 2) compared to length, which had the default weight (i.e. 1). Also, mutation rate (i.e. the probability of a mutation, that doesn’t affect the speed of the Match program, but has an effect on the quality of the solution) was set at 0.3 (default value).

As for the allocation of these selected items in the four different composite pictures utilised for descriptions, the accuracy-focused word sets were contained within two of the four composite pictures, and the speed-focused word sets were contained in
the remaining two composite pictures. This was because we wanted to avoid any interference between items from different therapy conditions being elicited in the same composite picture description task (see Table 5.3).

Table 5.3 Stimuli used in assessments (composite picture descriptions & picture naming) & treatments

<table>
<thead>
<tr>
<th>Composite Picture(s)</th>
<th>Treated Items</th>
<th>Untreated Items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(also included in picture naming assessments)</td>
<td>(but included in picture naming assessments)</td>
</tr>
<tr>
<td>A, C</td>
<td>20 (treated on accuracy)</td>
<td>20 (accuracy treatment controls)</td>
</tr>
<tr>
<td>B, F</td>
<td>20 (treated on speed)</td>
<td>20 (speed treatment controls)</td>
</tr>
</tbody>
</table>

5.2.4 Design

A comparison of a standard therapy (SP) focused on accuracy for 20 items versus repeated increasingly speeded presentation (RISP) therapy for the matched 20 items was implemented in order to evaluate therapies’ effects on retrieval latency in confrontation naming and likelihood of retrieval in connected speech.

Measurement of baseline performance on picture naming and picture description (twice for each task), treatment with the standard therapy, between-cycles assessment, treatment with the RISP therapy, and finally post-treatment assessments (1 week and 1 month post-treatment) were carried out within 18 sessions over about 2 months a half with each participant (Figure 5.1).

Figure 5.1 Schematic representation of sessions’ sequence
Baseline Assessments

Prior to the treatment, a fine-grained analysis of participants’ word finding difficulties in both confrontation naming and connected speech was made.

Chronic stroke participants had to carry out 2 tasks (picture naming and composite picture description) twice across 4 weeks, according to the following plan:

1st week: 1st session: Picture description of all 4 composite pictures
2nd week: 2nd session: Picture naming of all 80 items (treated + untreated)
3rd week: 3rd session: Picture description of all 4 composite pictures
4th week: 4th session: Picture naming of all 80 items (treated + untreated)

These detailed assessments helped us to identify each participant’s baseline scores in confrontation naming and composite picture descriptions (accuracy and RTs for the former and only accuracy for the latter), and thus determine if there was a change in participants’ scores from baseline to the end of the treatment. Also, the multiple implementation (2 times) of each task allowed us to determine if there were inconsistencies in patients’ performance on the picture naming and the picture description task and provided us with a sufficient overview of the patients’ ability to name pictures or produce connected speech.

Picture Naming Assessment

Participants were presented with items of all four sets (treated & untreated for both therapies). The total 80 stimuli were split in two blocks of 40 items with a resting pause between them. Each block comprised an equal number of pictures belonging to the 4 different sets (Table 5.4). All 40 pictures in each block were randomly presented to participants, with their presentation order being counterbalanced in each of the two baseline sessions.

Participants were asked to name each picture when coming up on screen and were informed that pictures would be presented for a maximum of 10 seconds.

Pictures were presented to patients using E-Prime software (Schneider et al., 2002). Audacity software was used to measure naming latencies: a subtle beep sound was produced simultaneously with the picture presentation and RTs were estimated by measuring the time between the beep sound and the patient’s response. Despite being very time-consuming, this method was considered better compared to E-prime’s voice
key trigger because it allowed us to measure RTs for trials which included false starts, hesitations (e.g., “uhmm”), articles, or any other extraneous material (e.g. “a lion” or “That’s a lion”).

Table 5.4 Composition of blocks in the picture naming task

<table>
<thead>
<tr>
<th>Blocks</th>
<th>Items treated on accuracy (SP)</th>
<th>Items treated on speed (RISP)</th>
<th>Items untreated on accuracy (UnSP)</th>
<th>Items untreated on speed (UnRISP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Block 2</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

SP = Standard Presentation items, RISP = Repeated Increasingly Speeded Presentation items, UnSP = Untreated SP items, UnRISP = Untreated RISP items

Composite Picture Description Assessment

To elicit connected speech samples, a picture description task (picture-supported narratives) of 4 multi-event pictures was employed.

The main purpose of the study was to answer the main research question regarding the contribution of speed in the carry over into connected speech and more specifically to investigate the degree of generalisation into connected speech of items with different treatment (standard vs. speed-focused treatment). Hence, the picture description task would allow us to compare likelihood of word retrieval in connected speech between baseline (pre-treatment production) and post-treatment production.

To complete the task, participants sat in front of a computer desktop screen. They were informed that they were going to see four busy pictures and that the instructions for all the pictures were the same. So beginning with the first picture, they were asked to describe what they saw in the picture in as much detail as they could for about 5-10 minutes. It was explained to them that this time limit was indicative and that they could exceed it if needed because the most important thing was to be as much accurate and thorough as they could in their descriptions. No guidance was provided as to where to start in picture description, as indicating to participants any direction for
their description would be quite artificial and could have altered participants’ focus in terms of direction.

Participants’ responses were tape-recorded with a voice recorder (Sony digital IC Recorder) and they had consented to being recorded before commencing the experiment. Finally, the order of presentation of each picture was randomised across participants, thus counterbalancing any effect of higher picture description difficulty in the pictures described first. Participants were also presented with a different picture presentation order when performing the task for a second time compared to the order they were presented the first time they carried out the task (Table 5.5).

**Therapies**

Having completed all four baseline assessment tasks, participants received the two types of speech therapy: a standard picture naming therapy (‘standard presentation’, SP) focusing on accuracy, and a new therapy (‘repeated increasingly speeded presentation’, RISP) focusing on both accuracy and speed. This study aimed to extend the findings of the two neurotypical studies to participants with aphasia, by adapting the naming speed manipulation (RISP) to the clinical population’s confinements. Regarding the method employed for investigating same or similar questions in different populations, the intervention for neurotypical participants was very similar to the treatment for patients with aphasia, yet the latter introduced equal numbers of repetitions in SP and RISP, so that accuracy could be established across all items, before proceeding to the speed manipulation. The two therapies (SP and RISP) were delivered in 2 cycles twice a week over 6 weeks.

In the first cycle (i.e. first 3 weeks) only standard therapy was administered for items of both treated sets (n=40), which aimed to improve participants’ picture naming accuracy for the SP set and establish accuracy before targeting speed for the RISP items.

A between-cycles assessment was administered at the end of the first cycle, i.e. in session 6, first the therapy was delivered and after a 10-20 minute break the patient was asked to carry out a picture naming task, but this time without the help of the feedback. This task was identical to the baseline picture naming task and it helped us to re-assess participants’ RTs for all treated & untreated items (n=80).
In the second cycle (i.e. following three weeks), both standard therapy (n=20, 1 set) and speed therapy (n=20, 1 set) were conducted. In each of the cycle 2 therapy sessions, therapies were implemented concurrently (‘parallel administration’) (Figure 5.2).

The only drawback of this design was the potential interference of the SP with the RISP treated items in the composite picture description, which was addressed by selecting different composite pictures to depict items of each treatment (see stimuli for picture description task).

In both cycles, stimuli in each block were randomised between sessions and the order of blocks presentation was counterbalanced in each session. The reason for counterbalancing the order of the therapies administration in cycle 2 (that the two treated sets received different therapies) was that the effectiveness of the therapy delivered second could be affected by the tiredness of participants towards the end of the session, while in cycle 1 this rendered the design more consistent/homogenous and familiarised participants with the process that would be followed in cycle 2.

Figure 5.2 Sequence of therapies’ administration

1) Standard therapy (6 sessions)
1st week: session 1 (Block A, Block B), session 2 (Block B, Block A)
2nd week: session 3 (Block A, Block B), session 4 (Block B, Block A)
3rd week: session 5 (Block A, Block B), session 6 (Block B, Block A + between-cycles picture naming assessment).

2) Standard (a) & Speed (b) therapy (6 sessions)
4th week: session 7 (therapies, SP-RISP), session 8 (therapies, RISP-SP)
5th week: session 9 (therapies, SP-RISP), session 10 (therapies, RISP-SP)
6th week: session 11 (therapies, SP-RISP), session 12 (therapies, RISP-SP)

Standard Therapy – Standard Presentation (SP)

This was a standard error reducing therapy, which aimed to improve participants’ picture naming accuracy for the SP set and establish accuracy before targeting speed for the RISP items. Participants were presented with pictures of both
treated sets (n=40) and they were asked to name each picture in 10 seconds without support, i.e. with no cues. After each naming attempt, feedback was provided both verbally by the experimenter and written on screen.

The software used for the picture presentation and the method for measuring participants latencies in therapy were identical to these used in the baseline picture naming task. Pictures were presented to patients using E-Prime software (Schneider et al., 2002). Audacity software was used to measure naming latencies: a subtle beep sound was produced simultaneously with the picture presentation and RTs were estimated by measuring the time between the beep sound and the patient’s response.

**Speed Therapy – Repeated Increasingly Speeded Presentation (RISP)**

Having completed the accuracy treatment for all treated items in cycle 1, participants received the RISP treatment for only one of the two treated sets (n=20). This therapy was a hybrid intervention that combined the error reducing method of the standard therapy with the deadline naming technique of experimental psycholinguistics. The RISP treatment made use of the deadline naming to verbally encourage quicker picture naming responses and employed repeated presentations (multiple repetition priming) to increase accuracy and avoid a speed-accuracy trade-off. Deadline naming was selected over tempo naming, because of the latter’s tendency to produce many mistakes in accuracy (robust speed-accuracy trade-off). Participants were repeatedly exposed, i.e. 3 times in a session, to the items of the RISP treated set, while simultaneously they were carrying out a deadline picture naming task.

In order to compare the two therapies’ effect on participants’ performance in naming and descriptions and exclude potential confounds stemming from inherent differences in the two therapies’ design, SP and RISP were identical except from the focus on speed. In the newly developed RISP therapy, the same process with the standard therapy has been followed, with only one difference: between sessions the deadline was reduced in a controlled way. At the end of the allotted time window, the picture disappeared as a beep sound was produced by the computer. Participants heard the beep sound and they were simultaneously presented with a blank screen for 1000msec. At the end of each trial participants were presented with a written feedback on screen and they were simultaneously hearing the computer verbally producing the
correct name of the picture. In case of an incorrect response, the patient was asked to repeat the correct name after the computer/experimenter three times. The reason for including a beep before the production of the correct name was that it was expected to attract patients’ attention to the forthcoming correct name of the picture, while also it would define more clearly the boundary of the deadline.

Presentation time was shortened in a controlled fashion across the 6 RISP sessions. To set the initial presentation time, the data from the between-cycles assessment were used. The initial picture exposure time was adapted to the mean of each participant’s picture naming speed in the between-cycles assessment, so that participants’ first naming attempt would feel fairly natural even for low frequency items. The target deadline (i.e. the deadline of the 6th RISP session) was 1 second, which was the mean naming speed of elderly neurotypical participants in picture naming in a previous study (1st natural naming, see Chapter 4), at which they named the same stimuli with patients without a speed manipulation (mean time: 1002msec, i.e. approximately 1 second). Regarding the sessions between the 1st and the last one (2nd, 3rd, 4th & 5th), each patient’s mean naming speed was divided in 5 steps until we reached the target of 1 second, and so each session was allotted the respective deadline. The method employed for speeding-up participants was both standardised because of the pre-determined speed reduction pattern (i.e. common target of 1 second for all participants), but simultaneously it was subject-specific because the initial presentation time and the subsequent specific deadlines were tailored to each participant’s naming skills (as provided by the between-cycles assessment).

The number of naming attempts (3 for each picture in every session) was held constant across the two therapies so that the two treated sets would be matched for exposure. The presentation time/deadline was changing between sessions, yet it remained the same (i.e. no speed reduction) across all three naming attempts within each session, in accordance with the error reducing method.

Participants were informed that they would be presented with half the pictures they were practicing in the 1st cycle, and that they had to try to name each as quickly and accurately as they could. It was specified that “speed is very important” and that it was investigated if they could gradually get “quicker and quicker” and not just accurate. Participants were told that “A picture will come up and after some time a beep will be produced as a deadline”, so they should “try to say the name before the beep sound, and try to beat the beep”. Participants were also informed that “immediately after the beep
sound the correct word will appear written on screen while simultaneously it will be produced by the computer” and so that they will have to “beat the beep, and in this way beat the computer”.

Pictures were presented and picture naming latencies were manipulated using E-Prime software (Schneider et al., 2002). The sound used to indicate the onset of the picture presentation was the same plain beep sound used in the standard therapy, while the sound for indicating the deadline was a non-standard low pitch beep sound (‘error beep sound’). The difference between the two different beep sounds was easily discernible in order to avoid confusion within a trial. To estimate picture naming latencies, the time between the first standard beep sound and the patient’s response was measured (Audacity software). Finally, a native English speaker from the same area with participants was recorded pronouncing clearly the therapy target items and the recorded named items were used as the computerised feedback.

Post-treatment assessments

Following therapy, participants performance in picture description and picture naming was evaluated both at an immediate time point, i.e. 1 week post-treatment, and in the long term, i.e. 1 month post-treatment. In both post-treatment assessments, participants were asked to first complete the picture description task and describe all four composite pictures included in baseline assessments. They then took a 10-20 minute comfort break, following which they were asked to name all 4 sets of items (n=80). Both the stimuli and the process of the picture description and the picture naming task were identical to those used in the baseline assessments, so that participants’ performance would be comparable across all time points. The only difference from what was adopted in the baseline design was the order of the composite pictures’ presentation which was randomised across participants in both post-treatment assessments (Table 5.5). The same applied to picture naming, with the presentation order of the two blocks being the same between the 1st baseline and the 1 week post-treatment assessment (Block 1 - Block 2), but with reversed order in the 2nd baseline and the 1 month post-treatment assessment (Block 2 - Block 1). However, contrary to the picture description, the counterbalanced order in picture naming was the same across all participants (Table 5.6).
Table 5.5 Composite pictures’ order of presentation in the picture description task of all assessments

<table>
<thead>
<tr>
<th>Time Point</th>
<th>KS</th>
<th>AD</th>
<th>EB</th>
<th>DM</th>
<th>JM</th>
</tr>
</thead>
</table>

Table 5.6 Blocks’ (A, B) order of presentation in the picture naming task of all assessments

<table>
<thead>
<tr>
<th>Time Point</th>
<th>KS</th>
<th>AD</th>
<th>EB</th>
<th>DM</th>
<th>JM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; baseline assessment</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; baseline assessment</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A</td>
</tr>
<tr>
<td>Between-cycles assessment</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
</tr>
<tr>
<td>1 week post-treatment assessment</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
<td>A, B</td>
</tr>
<tr>
<td>1 month post-treatment assessment</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A</td>
</tr>
</tbody>
</table>
5.3 Results

All 5 participants who took part in the main experiment produced reliable data that was entered for statistical analyses.

The study employed a within-subject or repeated measures design. The apparent advantage of the repeated measures design was that the effect of the experiment was more likely to be attributed to the manipulation and not to unknown/random factors or characteristics of people allocated to different comparable groups. Speed manipulation (speeded RISP vs. non speeded SP items) and presentation number (‘Time Point’ of the assessment/task in the study) were within-subjects factors. The comparison pertained the two treated or the two untreated sets (treated SP items vs. treated RISP items or untreated SP vs. untreated RISP items) between different assessment time points: participants’ performance at the 1st baseline session (1b) was compared to their performance at 2 post-treatment time points, i.e. 1 week post-treatment assessment (1w), and 1 month post-treatment assessment (1m). The 1st baseline assessment was considered optimal for comparing pre-treatment scores to post-treatment scores, rather the 2nd baseline assessment (2b), because at the 1st baseline no priming of the items had occurred due to repeated presentation, as in the 2nd baseline session. Paired-samples t-tests were conducted to compare participants’ performance in the two baseline assessments (1b and 2b). There was not a significant difference in the picture naming scores for 1b accuracy (M=2.29, SD=1.35) and 2b accuracy (M=2.29, SD=1.36) conditions; t=1.99, p=1, and for 1b speed (M=2.517, SD=1.18) and 2b speed (M=2.210, SD=0.93) conditions; t=1.99, p=.05. However, there was a significant difference in the picture description scores for 1b accuracy (M=0.84, SD=1.14) and 2b accuracy (M=1.06, SD=1.11) conditions; t=1.99, p=.01. That is, a single occurrence of the picture naming task did not exert an immediate repetition priming effect on picture naming accuracy and speed, while the picture description task was more sensitive to baseline priming effects.

The dependent variables in picture naming were accuracy and speed/reaction time (RT). Yet, speed/time of retrieval was not computed for the composite picture description task, as only accuracy was directly related to the main research question about improving words’ accuracy of retrieval in connected speech. This resulted in three measures, two for the picture naming and one for the picture description task:
a) accuracy in picture naming: this related to accuracy in confrontation naming for each item (i.e., either 1 for accurate or 0 for inaccurate) as measured by the proportion of participants who named the word correctly e.g. 3/5 participants. Participants’ performance was scored based on their first response for all picture naming assessments. Minor dysfluencies in responses were not accepted (e.g. barerina instead of ballerina), given that they were subject to therapy. Self corrections were considered correct if the correct item was produced immediately (i.e. in less than two seconds) after the first response. However, an additional scoring and statistical analysis was conducted, at which all self-corrections were accepted (i.e independently of the time elapsing between the first naming attempt and the correct response). This analysis did not produce significantly different results from the first one.

b) speed of picture naming (in seconds): for each correctly named item we collated reaction times by measuring the time elapsing from the start of the beep produced simultaneously with picture presentation to the correct word production (Audacity software). RTs for some items were excluded from further analysis if the target picture name was not accurately produced or produced disfluently. Very late responses were also excluded if they were not produced within the allotted time window of 10 seconds.

c) accuracy in picture description: this related to accurate production of a word (i.e., either 1 for accurate or 0 for inaccurate) within a composite picture description task. Items retrieved with minor dysfluencies were excluded as incorrect. While self-corrections were not considered as accurate productions in the picture naming task, they were accepted in the picture description task once the self-correction did lead to accurate retrieval. Contrary to the picture naming task that the two outcome measures (accuracy and speed) were computed only for treated items, the single outcome measure for picture descriptions (accuracy of retrieval) was computed for both treated and untreated items as this would address the main research question about increasing the use of treated and untreated items in connected speech.

The results are presented in four sections:

1. Results for treated items’ picture naming accuracy
2. Results for treated items’ picture naming speed
3. Results for treated items’ picture description accuracy
4. Results for untreated items’ picture description accuracy
In each of these sections, first group results and then individual participant results are presented to compare the two therapies’ effectiveness in improving participant performance on each of the two outcome measures (accuracy or speed). Group results are reported by conducting a within-subjects ANOVA. In the by items 3*2 ANOVA, each of the two factors had 3 and 2 levels respectively. The first was Time Point, i.e. 1st baseline assessment, 1 week post-treatment, and 1 month post-treatment (in all four sections), and the second was the Speed Manipulation, i.e. treated SP vs. treated RISP items (first three sections) or untreated SP vs. untreated RISP items (last fourth section). Additional group level 2*2 ANOVAs were carried out in order to better clarify the results of the comparison between the two sets (treated SP vs. treated RISP or untreated SP vs. untreated RISP), either in the short term (1b vs. 1w - immediate assessment results) or in the long term (1b vs. 1m - follow-up assessment results). Finally, individual participant’s results of both treatments are described, based on the figure presented at the end of each section. Results for each participant are included in a single box. The time point of each assessment is presented on the x axis: 1st baseline assessment (1b), 1 week post-treatment assessment (1w), and 1 month post-treatment assessment. The y-axis indicates the accuracy of responses in percentages (sections 1, 3 and 4) or the speed of naming in seconds (section two). The four sets are indicated in different colors: blue for the SP treated items, red for the RISP treated items, green for the untreated SP items, and purple for the untreated RISP items. The presentation order of the figures was based on participant baseline naming accuracy: KS with the most severe naming impairments, following AD, EB, and DM with progressively milder naming difficulties and finally JM with the mildest anomia out of all five participants.

When completing the presentation of the measurable results regarding the two therapies, a complementary description of participants’ views on therapy is provided.

5.3.1 Therapies’ effectiveness in improving picture naming accuracy

The first question we wanted to address was about the effectiveness of the two therapies in improving participants’ accuracy in picture naming. To answer this question, a group level 3*2 within-subjects ANOVA was conducted. The ANOVA
indicated that there was a significant effect of the ‘Time Point’ factor (both therapies increased accuracy from baseline to post-therapy): F(2,38) = 27.557, p < .0005. However, the main effect of therapy was not significant: F(1,19) = 1.460, p = .242, and the interaction did not reach significance either (F(2,38) = 1.000, p = .377) (Figure 5.3).

Additional group level 2*2 ANOVAs were carried out in order to better delineate standard treatment versus speed treatment-induced improvements in picture naming accuracy, either in the short term (1w) or in the long term (1m). These tests revealed that participants were more accurate in naming all treated items (SP and RISP) at the end of the treatment (1w), compared to their baseline performance (F(1,19) = 30.163, p < .0005). However, neither the main effect of ‘Treatment’ factor was significant: F(1,19) = 1.668, p = .212, nor the interaction between ‘Time Point’ and ‘Treatment’: F(1,19) = 1.027, p = .324, indicating that the two therapies equally improved participants’ accuracy on picture naming.

As for the two therapies’ long term effects (1 month assessment), accuracy remained significantly increased compared to the baseline for both therapies (F(1,19) = 38.668, p < .0005), but this increase was not significantly different for SP vs. RISP items (F(1,19) = 1.710, p = .207).

Individual participant’s results of both treatments are shown in Figure 5.4. As can be noticed, there was an improvement on accuracy in all treated items at the immediate assessment (1w) for all participants. To assess the long-term effect of each therapy, the 1 month post-treatment accuracy (1m) was compared against baseline findings (1b). All participants’ accuracy improved from baseline to the follow-up assessment, with some of them demonstrating a greater retention of accuracy than others: participants with the most severe (KS) or the mildest naming impairments (DM and JM) showed a long-term benefit from both therapies, while participants having moderate anomia (AD and EB) preserved the accuracy on the one treated set but their accuracy on the other set (SP and RISP respectively) slightly decreased.
Figure 5.3 Distribution of accuracy in picture naming by Time Point and Treatment (group data)
Figure 5.4 Distribution of accuracy (percentages of correct responses - y axis) in picture naming by Time Point (3 time points - x axis) and Manipulation (4 sets - Legend) for each participant.

Cases are ordered according to baseline picture naming accuracy severity (KS-AD-EB-DM-JM). 1b = 1st baseline assessment, 1w = 1 week post-treatment assessment, 1m = 1 month post-treatment assessment, SP = Standard Presentation items, RISP = Repeated Increasingly Speeded Presentation items, UnSP = Untreated SP items, UnRISP = Untreated RISP items.
5.3.2 Therapies’ effectiveness in speeding up picture naming

The second question we wanted to address was about the effectiveness of the two therapies in reducing participants’ latencies in picture naming. The 3*2 ANOVA indicated that there was a significant effect of the ‘Time Point’ factor (both therapies induced quicker RTs from baseline to post-therapy): F(2,36) = 31.393, p < .0005. However, the main effect of therapy was not significant: F(1,18) = .686, p = .418 and the interaction did not reach significance either (F(2,36) = .032, p = .968) (Figure 5.5). These results are similar to the respective 3x2 results for accuracy in picture naming, indicating that both treatments produced the same pattern of improvement in the picture naming task.

Additional group level 2*2 ANOVAs were carried out in order to better delineate standard treatment versus speed treatment-induced improvements in picture naming speed, either in the short term (1w) or in the long term (1m). These tests revealed that participants were much quicker in naming all treated items (SP and RISP) at the end of the treatment (1w), compared to their baseline performance (F(1,18) = 33.437, p < .0005). However, neither the main effect of ‘Treatment’ factor was significant: F(1,18) = .441, p = .515 nor the interaction between ‘Time Point’ and ‘Treatment’: F(1,18) = .053, p = .820, indicating that participants were not faster to name RISP rather than SP items in post-treatment picture naming (speed as a behavioral pattern spreads in patients’ and neurotypical participants’ naming). As for the two therapies’ long term effects (1 month assessment), latencies remained significantly reduced compared to the baseline for both therapies F(1,18) = 39.584, p < .0005, but this increase was not significantly different for SP vs. RISP items (F(1,18) = .237, p = .633).

Individual participant’s results of both treatments are shown in Figure 5.6. As for the immediate assessment (1baseline vs. 1week), three different patterns of improvement emerged. The two participants with the mildest naming impairment (JM and DM) significantly improved confrontation naming speed on all treated items, with latencies of both SP and RISP items being reduced at least by half. Similarly to these participants, the same sharp reduction of latencies was observed for the speeded RISP items in participants with moderate and moderate to severe naming impairment (latencies were reduced by half for EB and almost by half for AD respectively), but SP items were named only moderately quicker (EB) or even moderately slower (AD),
compared to the baseline. Finally, contrary to the other findings, the most severely naming impaired participant (KS) demonstrated an improved confrontation naming speed on SP treated items, but not on RISP items, which were named slightly slower compared to the baseline. To assess the long-term effect of each therapy, the 1 month post-treatment accuracy (1m) was compared against baseline findings (1b). Our findings replicated the three patterns of improvement noticed when comparing the 1 week vs. baseline assessment. JM and DM preserved the therapy benefit as measured on the 1w assessment, with only a small increase on both treated sets’ latencies. However, compared to the baseline, both SP and RISP items’ latencies were reduced at least by half (as in the 1 week assessment). As for EB and AD, the sharp naming speed reduction of RISP items observed in the immediate assessment was retained in the follow up assessment, yet latencies for the SP treated set remained only slightly quicker compared to 1b (EB) or were even more increased (AD). Finally, in the case of KS, SP items latencies were significantly reduced, but there was no significant improvement on RISP items.

Figure 5.5 Distribution of speed in picture naming by Time Point and Treatment (group data)
Figure 5.6 Distribution of latencies (in milliseconds - y axis) in picture naming by Time Point (3 time points - x axis) and Manipulation (4 sets - Legend) for each participant.

Cases are ordered according to baseline picture naming accuracy severity (KS-AD-EB-DM-JM). 1b = 1st baseline assessment, 1w = 1 week post-treatment assessment, 1m = 1 month post-treatment assessment, SP = Standard Presentation items, RISP = Repeated Increasingly Speeded Presentation items, UnSP = Untreated SP items, UnRISP = Untreated RISP items.
5.3.3 Therapies’ effectiveness in promoting treated items’ generalisation to connected speech

In order to address this issue, a comparison of accuracy for speeded and non-speeded items between the baseline and the two post-treatment time points was made. The 3*2 ANOVA indicated that there was a significant effect of the ‘Time Point’ factor (both therapies improved target vocabulary use in the descriptions): F(2,38) = 46.323, p < .0005. More importantly, the main effect of therapy was also significant: F(1,19) = 29.830, p < .0005 as well as the interaction (F(2,38) = 5.940, p = .006) (Figure 5.7), indicating that the speed therapy, in comparison to the standard one, led to significantly higher generalisation of its targeted items to connected speech.

Additional group level 2*2 ANOVAs were carried out in order to specify therapies’ short term (1w) vs. long term (1m) effects on treated items’ use in connected speech. These tests revealed that participants were more efficient in using SP and RISP treated items in descriptions at the end of the treatment (1w), compared to their baseline performance (F(1,19) = 83.755, p < .0005). More strikingly, the main effect of ‘Treatment’ factor was also significant: F(1,19) = 23.515, p < .0005, as well as the interaction between ‘Time Point’ and ‘Treatment’: F(1,19) = 9.416, p = .006, indicating that the ‘carry over’ to connected speech significantly more increased for RISP treated relative to the SP treated items. As for the two therapies’ long term effects (1 month assessment), accurate use of treated items in descriptions remained significantly increased compared to the baseline for both therapies (F(1,19) = 38.668, p < .0005). This increase was also significantly different for SP vs. RISP items, as the significantly higher generalisation of the RISP items attained in the 1w assessment was preserved even 1 month post-treatment (long lasting RISP generalisation effect) (significant main effect of ‘Treatment’: F(1,19) = 13.455, p = 0.002 and ‘Interaction’: F(1,19) = 7.006, p = .016). RISP therapy’s immediate effectiveness was verified by the comparison of SP to RISP items between the second baseline and the 1 week assessment (2x2 ANOVA, F(1,19) = 6.782, p=.017). However, the long lasting RISP generalisation effect was not observed when comparing the second baseline to the 1 month assessment (2x2 ANOVA, F(1,19) = 3.701, p=.069).

Individual participant’s results of both treatments are shown in Figure 5.8. The four participants with milder WFDs (AD, EB, DM and JM) demonstrated a significant improvement on the accurate use of all treated items in descriptions at the immediate
assessment (1w), but they were much more likely to produce the RISP treated items than the SP treated items in connected speech compared to the baseline. KS who had the most severe naming difficulties improved only on the production of the RISP items in connected speech, while there was no generalisation of the SP items in descriptions from baseline to the 1w assessment. To assess the long-term effect of each therapy, the 1 month post-treatment accuracy (1m) was compared against baseline findings (1b). Besides that picture description accuracy was reduced between the 1 week and the 1 month assessment, all participants’ accuracy improved from baseline to the follow-up assessment for the RISP items, especially in AD, EB and DM (but not so significant improvement for KS and JM, who had the most severe or the mildest naming impairments respectively). As for the SP items, only two participants (AD and JM) had a long-term benefit from the standard therapy, while only a small increase on accuracy from baseline to the 1 month assessment was found for the rest three participants (KS, EB and DM).

Figure 5.7 Distribution of accuracy in picture description by Time Point and Treatment (group data for treated items)
Figure 5.8 Distribution of accuracy (percentages of correct responses - y axis) in picture description by Time Point (3 time points - x axis) and Manipulation (4 sets - Legend) for each participant.

Cases are ordered according to baseline picture naming accuracy severity (KS-AD-EB-DM-JM). 1b = 1st baseline assessment, 1w = 1 week post-treatment assessment, 1m = 1 month post-treatment assessment, SP = Standard Presentation items, RISP = Repeated Increasingly Speeded Presentation items, UnSP = Untreated SP items, UnRISP = Untreated RISP items.
5.3.4 Therapies’ effectiveness in promoting untreated items’ generalisation to connected speech

Another research question was the extent to which the likelihood of producing untreated words in picture description is improved by manipulating the speed of naming of those items (RISP treatment). In order to answer this question, a comparison of accuracy for untreated RISP and untreated SP items between the baseline and the two post-treatment time points was made. The 3*2 ANOVA indicated that there was a significant effect of the ‘Time Point’ factor (both therapies improved the use of untreated items in the descriptions): F(2,38) = 10.209, p < .0005. However, the main effect of therapy was not significant: F(1,19) = 1.198, p = .287 and the interaction did not reach significance either (F(2,38) = .093, p = .912) (Figure 5.9).

Additional group level 2*2 ANOVAs were carried out in order to specify therapies’ short term (1w) vs. long term (1m) effects on untreated items’ use in connected speech. These tests revealed that participants were more efficient in using all the untreated items (SP and RISP) in descriptions at the end of the treatment (1w), compared to their baseline performance (F(1,19) = 6.181, p = .022). However, neither the main effect of ‘Treatment’ factor nor the interaction were significant: F(1,19) = .976, p = .336, and F(1,19) = .091, p = .766 respectively, indicating that the two therapies equally improved the ‘carry over’ to connected speech of untreated items (untreated SP and untreated RISP).

As for the two therapies’ long term effects (1 month assessment), accurate use of untreated items in descriptions remained significantly increased compared to the baseline for both therapies (F(1,19) = 17.242, p = .001), but this increase was not significantly different for SP vs. RISP items i.e. not significant main effect of treatment or interaction: F(1,19) = 1.412, p = .249 and F(1,19) = .013, p = .910 respectively. What is mostly striking, is that picture description accuracy continued to increase even between post-treatment assessments (1 week and 1 month) (significant main effect of ‘Time Point’ in the 1w vs. 1m comparison: F(1,19) = 4.932, p = .039), resulting in higher accuracy in the 1 month than in the 1 week assessments for both untreated sets (no difference between untreated RISP and untreated SP: F(1,19) = 1.015, p = .326).

Figure 5.8 demonstrates individual participant’s results for the use of untreated items in connected speech, along with the respective results for the two therapies’ treated items. At the immediate assessment (1 baseline vs. 1 week), three participants
(KS, AD and EB) increased the use of untreated RISP items in descriptions, while the use of these items by the rest two participants with milder WFDs (DM and JM) did not change from baseline to the 1w assessment. As for the untreated SP items, AD, EB and JM had also retrieved more accurately these items in descriptions in the 1w compared to the baseline, while KS and DM used approximately the same number of items in the two assessment points. As for the two therapies’ long term generalisation effects to untreated items (1 month assessment), both therapies promoted stronger generalisation effects even between the two post-treatment assessment points (1w vs. 1m): as for the RISP therapy, it mostly led to either a significant (AD and DM) or a moderate/slight increase (JM) of untreated items in description, while two participants’ use of untreated RISP items (KS and EB) slightly decreased. On the other side, the use of untreated SP items were significantly increased only in JM, and moderately increased in KS and DM’s descriptions, while two participants’ use of untreated SP items (AD and EB) slightly decreased. When comparing the 1b vs. 1m assessment points, three patterns emerge: (1) AD and DM demonstrated a striking/ significant improvement on untreated RISP items and a slight improvement on untreated SP items, (2) KS and EB demonstrated only a slight improvement on untreated items of both therapies, (3) JM demonstrated an opposite to the previous participants effect, with a significant improvement on untreated SP items and a null effect on RISP items (neither increase nor decrease).

5.3.5 Subjective measures for the RISP therapy

Statistically analysing the two therapies’ quantitative data and comparing their respective results provides an interesting insight into the underlying word retrieval mechanisms in both confrontation naming and connected speech production. Compared to the standard therapy, the newly developed therapy that was trialed to chronic stroke participants produced promising measurable results in terms of improving participants naming skills and, especially, in promoting strong generalisation effect to connected speech. However, these valuable measurable results are inconclusive if they are not combined with more subjective results regarding participants’ and experimenter’s response to the new therapy (therapy context).
Contrary to our concerns that participants may find the speed-focused RISP therapy stressful, they not only tolerated the new therapy (as proved by the zero dropouts in the two months and a half long therapy study), but they also found that it was positively challenging. Participants particularly found the therapy engaging and satisfying because they were prompted to beat the beep and preserve a certain level of challenge throughout the therapy. What can account for participants not being discouraged by the speeded task is that the speed reduction was carefully manipulated (i.e. data driven and tailored to each participant’s naming skills/RTs) and hence not many mistakes were produced. Also the more demanding nature of the task, compared to the standard therapy, was frequently acknowledged by both the experimenter and the participants and provided a plausible excuse when mistakes were produced. A questionnaire should be administered to participants in relevant future studies (see Chapter 6), so that participants’ views on therapy can be more objectively measured.

*Figure 5.9 Distribution of accuracy in picture description by Time Point and Treatment (group data for untreated items)*
5.4 Discussion

We have presented a therapy study in which we examined if naming speed could be manipulated in chronic stroke participants over and above standard priming effects (i.e. attainment of maximum RTs’ reduction without a speed-accuracy trade-off), and whether manipulating picture naming latencies in picture naming (RISP treatment) would lead to more accurate production of both treated and untreated words in connected speech.

5.4.1 Picture naming accuracy & speed

As expected, participants were more accurate and much quicker in naming all treated items (SP and RISP) at the end of the treatment (1w), compared to their baseline performance (1b). This is especially important for the RISP method; not only did it not have a speed-accuracy trade off effect, but it also encouraged patients to be more accurate. Participants have also retained this improvement on both accuracy and speed after 1 month, i.e. both therapies produced marked improvements in picture naming accuracy and induced quicker RTs with long lasting effects.

However, the two treated sets showed a similar degree of change, suggesting that the RISP treatment did not benefit picture naming on speed and accuracy more than the SP therapy, i.e. the speed therapy was as effective as the standard therapy. While this was expected for accuracy (i.e. same number of presentations in both treatments), it was not expected for speed and so the hypothesis that RISP therapy would provide a significantly higher effect for picture naming speed was not confirmed. The equivalent decrease in latencies across both therapy types can be attributed to two reasons: (1) The behavioural style of going fast for the RISP items carried over to the SP items (fast naming as a behavioral pattern spreads in patients’ naming), (2) Pure repetition priming effect due to the standard treatment’s repeated presentations.

The validity of the first interpretation was tested by examining potential speed carry over effects of untreated items in picture naming. If latencies of completely untreated were faster in post-treatment assessments (1w or 1m) than the respective latencies in baseline (1b), we would then be able to attribute this effect to a behavioural
style of speeding up when naming pictures. A 2*2 ANOVA was carried out to test this hypothesis. The test revealed that participants were not quicker in naming the untreated items (both untreated SP and untreated RISP) at the end of the treatment (1w and 1m), compared to their baseline performance: F(1,17) = .130, p = .724, and F(1,17) = 1.321, p = .266 respectively). This implies that the post-treatment fast latencies for the SP items cannot be attributed to a behavioral style of speeding up, since there was not the same effect on RTs of untreated items.

The second interpretation’s validity was tested by making a purely post-hoc analysis, which investigated the accumulating effect of repeated presentations on reducing RTs of standard SP items. When analyzing at which point of the therapy this gain on speed occurred, we found that the extra repetitions of the 2nd cycle significantly reduced picture naming speed for all items in the 1week assessment, compared to the between-cycles assessment (significant results in the bc vs. 1w comparison: F(1,19) = 9.798, p = .006) i.e. irrespectively of the delivered therapy, picture naming speed could benefit from extra repetitions after a certain threshold/number of presentations (i.e. after the 6 sessions of the 1st cycle).

5.4.2 Picture Description Accuracy – Treated & Untreated

The most positive outcome in both post-treatment assessments (1w and 1m) was that the ‘carry over’ to connected speech was increased for all treated items (SP and RISP) relative to the baseline. Contrary to the most common assumption in the literature about standard therapies’ absence of carry-over effects to connected speech, this finding suggests that single word therapy effects can generalise to connected speech and hence that there is a direct relationship between word finding in single word contexts and connected speech contexts across different participants with aphasia. The study thereby supported the conclusion of Conroy et al. (2009d) who suggested that gains in picture-naming achieved in therapy can generalise to naming of the same items in connected speech tasks. The study also extended the findings of Maendl’s single case therapy study (1998) who found evidence of generalisation from a semantic picture naming therapy to composite picture descriptions.
However, what was most striking, was that the speed therapy, in comparison to the standard one, led to significantly higher generalisation of its targeted items to connected speech, and this effect was long lasting, even 1 month post-treatment.

However, RISP therapy’s increased generalisation effect in connected speech was not due to speed. That is, RISP treated and untreated items were more likely to be produced in composite picture descriptions, but picture naming latencies of the respective items were not quicker, compared to matched SP items. The causality underlying RISP therapy’s effectiveness in promoting generalisation to connected speech is unclear. The RISP increased generalisation effect of both treated and untreated items across elicitation contexts may reflect a number of different factors.

First, it was hypothesised that RISP can exert this strong generalisation effect because the nature of the employed RISP method was congruent with the linguistically and cognitively demanding nature of the target-connected speech task: while lexical access and retrieval are the main prerequisites to a simple picture naming task, like the one used in the SP treatment, connected speech tasks, like the picture description employed in this experiment, encompass perceptual and attentional components rendering word production a process that requires cognitive processing. Contrary to a simple picture naming task, the speeded naming employed in the RISP treatment required both accurate and quick word production, and hence it promoted greater sustained attention and vigilance that was required for efficient descriptions.

From a linguistic and cognitive perspective, the increased ‘carry over’ of the RISP items to connected speech could also be attributed to the effectiveness of the RISP method in improving participants’ executive control mechanism of suppression. Linguistically, lexical retrieval in a picture naming attempt entails selection-activation-(production) and suppression, so that another word can be produced in the following trial. That is, suppression serves as a syntactic control process that facilitates the activation and selection of the appropriate lemma representation (Schwartz & Hodgson, 2002). In the case studies reported by McCarthy and Kartsounis (2000) and Schwartz and Hodgson (2002), aphasic participants experienced increased difficulty with picture naming when the time elapsing from the patient’s response to the presentation of the following picture was fast (1sec and 2 sec respectively), rather when the presentation rate was slow (10sec and 5 sec respectively). In the RISP therapy, participants were asked to name pictures quickly alternating because of the deadline and hence they had to quickly suppress the name (correct or erroneous, verbally produced or not) of the
previous picture in order to name the following one. In the context of composite picture descriptions, participants could more effectively suppress responses of irrelevant/not known untreated items (‘interference suppression’, Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002), monitor their attention to the relevant/trained RISP items and avoid producing an incorrect (e.g. very generic or habitual) response over the correct RISP response (e.g. correctly producing *poodle* instead of *dog*, or *rabbit* instead of *bunny* respectively) (‘response inhibition’, Bunge et al., 2002; Abel, Dressel, Weiller, & Huber, 2012). This interpretation can be tested on chronic stroke patients that produce many perseveration errors (i.e. errors that constitute erroneous repetition of a certain word), and will be verified if RISP therapy is more effective in helping these patients to suppress and reduce these errors, compared to the SP.

From a neurobiological perspective, performing better than expected in the process of learning, and the subsequent increased motivation and reward seeking behavior have all been associated with dopamine (Fiorillo, 2013; Morita, Morishima, Sakai, & Kawaguchi, 2013; Foerde, Braun, Higgins, & Shohamy, 2015). When participants were undergoing the more demanding RISP treatment, successfully beating the beep was challenging and simultaneously rewarding, and hence it potentially triggered psychological chemicals of excitement and satisfaction like dopamine. The production of this chemical may have contributed to the facilitation of the lexical retrieval process for RISP items in descriptions, by inexplicitly associating RISP items with reward values.

Another potential explanation for the effectiveness of RISP method comes from studies underlining the importance of explicit memory in forming new connections required for conscious recall (MacKay & Burke, 1990; Howard, Fry, & Brune, 1991). That is, SP may not have had strong carry over effects in speech because of simply strengthening target words’ existent connections in memory through repetition, while RISP was more effective by activating the explicit memory and hence due to an additional formation of new connections, which were crucial for coping with the more demanding RISP words’ recall (increase of participants memory resources). The validity of this interpretation could not be tested because of the absence of a verbal learning task (e.g. an adapted version of the California Verbal Learning Test) (CVLT, Delis, Kramer, Kaplan, & Ober, 2000), which could have been administered at the end of the 1 week assessment to measure the number of SP and RISP items participants could recall without having the visual aid of the respective picture.
Finally, this result could be due to a threshold effect, i.e. there could be a threshold in the outcome measures of the picture naming task (either in percentage for accuracy or in seconds for latencies) that when exceeded, it triggered the production of the respective item in description. In order to test the validity of this interpretation, we compared items produced (IP) vs. items not produced (INP) in composite picture descriptions (PD) across three time points (1b, 1w, 1m) to find out if they were also differentiated on the two outcome measures in picture naming (i.e. accuracy and speed). Table 5.7 demonstrates that over 55% accuracy in picture naming predicts accurate retrieval in connected speech, while there is a 2.500 seconds threshold for baseline picture naming and 2 seconds threshold for post-treatment naming assessments, that when exceeded, items are rarely produced in descriptions.

Table 5.7 Comparison of items produced (IP) versus items not produced (INP) in composite picture descriptions (PD) on accuracy (ACC) and speed (RTs) across three time points (1st baseline -1b, 1 week post-treatment -1w, 1 month post-treatment -1m)

<table>
<thead>
<tr>
<th></th>
<th>1b PD ACC (%)</th>
<th>1b PN ACC (%)</th>
<th>1b PN RTs (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>36</td>
<td>58</td>
<td>2.423</td>
</tr>
<tr>
<td>INP</td>
<td>0</td>
<td>35</td>
<td>2.742</td>
</tr>
<tr>
<td></td>
<td>1w PD ACC (%)</td>
<td>1w PN ACC (%)</td>
<td>1w PN RTs (sec)</td>
</tr>
<tr>
<td>IP</td>
<td>51</td>
<td>66</td>
<td>1.750</td>
</tr>
<tr>
<td>INP</td>
<td>0</td>
<td>44</td>
<td>2.194</td>
</tr>
<tr>
<td></td>
<td>1m PD ACC (%)</td>
<td>1m PN ACC (%)</td>
<td>1m PN RTs (sec)</td>
</tr>
<tr>
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<td>47</td>
<td>62</td>
<td>1.892</td>
</tr>
<tr>
<td>INP</td>
<td>0</td>
<td>55</td>
<td>2.379</td>
</tr>
</tbody>
</table>

1b: 1st baseline, 1w: 1 week post-treatment, 1m: 1 month post-treatment, ACC: Accuracy, RTs: Reaction Times, PD: Picture Description, PN: Picture Naming
5.4.3 Picture Description Accuracy – Untreated

As for control items, we found that both therapies’ untreated items were sufficient to carry over into connected speech samples but this effect (therapies’ generalisation effect in untreated items) did not reach significance, and it was reduced compared to the treated items. Contrary to our expectation, no difference was observed between therapies, with SP and RISP having the same generalisation results in the use of untreated items in picture descriptions. That is, RISP therapy promoted the generalisation of both treated and untreated items in connected speech, but its carry over effects in connected speech were greater for treated compared to untreated items.

What was also striking, is that untreated items’ picture description accuracy continued to increase even between post-treatment assessments (i.e. between 1 week and 1 month), resulting in higher accuracy in the 1 month than in the 1 week assessments for both untreated sets. At least two possible explanations of the untreated items’ increased use in the 1m assessment are tenable.

First, this result could be attributed to a robust facilitatory effect of repetition priming on accuracy of untreated items. According to this view, the repetition of the composite picture description task from 1-week to 1-month post-treatment assessment could have contributed to the more efficient retrieval of untreated items. The study thereby extended the findings of Howard, Patterson, Franklin, Orchard-Lisle and Morton (1985) and Nickels (2002b) who found evidence of such repetition priming effect in picture naming (i.e. repeated naming attempts), yet in this case priming did not occur through direct presentation of the target item. According to Nickels (2002a), correctly naming a picture entails the activation of both the semantic and the phonological representation of the item, which “strengthens the mapping” of that stimulus. Future research will need to better delineate the potential priming of picture descriptions by the same task (i.e. picture description repetition priming even when conducted with a long break in between (i.e. over 3 weeks).

Another possible interpretation of this finding is ‘proactive interference’ (PI) (Bialystok & Feng, 2009), induced by the repeatedly practiced treated items during therapy to the untreated items when the latter had to be produced at the immediate post-treatment assessment (1w). However, at the follow-up assessment (1m), the conflict (PI) between treated and untreated items was largely resolved due to the long period that had
elapsed after the end of the treatment and therefore untreated items received less interference from primed/treated items (attenuation of the PI effect).

These two interpretations are not mutually exclusive: the attenuation of the PI effect at the 1m was possibly combined with the long-lasting repetition priming effect for untreated items from 1w to 1m, and resulted in the facilitation of untreated items’ retrieval at the follow-up assessment.

5.5 Conclusions

This study aimed to investigate the intriguing issue of lexical retrieval processes in different contexts by neurologically impaired participants with post-stroke aphasia. Standard picture naming therapies focusing only on accuracy are considered to have very limited carry-over effects to connected speech, and thus rendering a therapy functionally beneficial is critical for patients’ quality of everyday communication. The contribution of this study lies in the comparison between two speech therapies, a therapy involving a standard presentation (SP) and a new, invented one (RISP), while also in assessing the impact of picture naming variables (speed and accuracy) on the efficacy of participants’ performance in connected speech (picture descriptions). RISP therapy items were named equally accurately and quickly as SP items but RISP items’ carry-over to connected speech was much higher, relative to SP items, with long term effects. Furthermore, both therapies increased the use of untreated items in descriptions, with RISP being equally effective as SP. The evidence reported here suggests that a more demanding single-word therapy focusing on both speed and accuracy can promote strong carry-over effects to connected speech production, yet even a less demanding therapy can have generalisation effects to untreated items in connected speech. Although the data are more suggestive than conclusive, this pilot study extends our understanding of how a focus on speed of confrontation naming (RISP) affects cognitive and linguistic abilities in post-stroke aphasia and therefore it warrants further evaluation in a larger more definitive and empirically solid study.
CHAPTER 6

The impact of accuracy-focused and speed-focused therapy on word retrieval in picture naming and composite picture descriptions in post-stroke aphasia
Abstract

Word finding problems constitute one of the most common but also most pervasive symptoms in aphasia. While picture naming tasks have typically been employed for the assessment and treatment of word-retrieval difficulties, very few studies have investigated the relationship between confrontation naming and connected speech tasks in the aphasiological literature. This study investigated whether a newly-developed treatment targeting both speed and accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming would be more effective for improving the use of the treated names in connected speech, than the standard therapy (‘standard presentation’ - SP) which targeted accuracy alone. Twenty participants with aphasia of varying degrees of severity and subtype took part in twelve therapy sessions over 6 weeks. In the baseline and post-treatment assessments, participants were asked to complete a composite picture description task and a picture naming task, the items of which were part of the composite pictures and constituted therapy targets. For the dependent variables of speed and accuracy in picture naming, we found that, compared to the standard therapy, the speed-focused therapy was significantly more effective in improving picture naming accuracy and in maintaining the reduced RTs in the long term. The ‘carry over’ of the therapy items to connected speech was increased for all items relative to the baseline. RISP, however, in comparison to the SP, led to significantly higher generalisation of targeted items to connected speech. These findings suggest that a speed and accuracy focused naming therapy has advantages over a standard therapy and can promote strong generalisation effects to more linguistically and cognitively demanding connected speech production.
6.1 Introduction

The ability to use words with ease and precision is pivotal in our everyday communication (Nippold, 1992). Unfortunately, word-retrieval difficulties commonly occur in aphasia and are considered one of the most pervasive symptoms because even simple, everyday words cannot be produced easily or quickly (also known as ‘anomia’, Laine & Martin, 2006).

6.1.1 Word retrieval differences depending on the elicitation context in aphasia

Both the assessment and treatment of aphasia typically involves confrontation naming tasks (for pros and cons of picture naming tests, see Herbert et al., 2008), which make the assumption that performance in picture naming tasks will reflect, at least in broad terms, the ease and reliability of word retrieval in connected speech tasks and lexical retrieval within everyday communication. Confrontation naming and spontaneous speech are different contexts for word retrieval. Compared to naming of single words, access to lexical information in the context of connected discourse may prove to be either facilitated, if some words are primed, or handicapped, because of the more complex task requirements (Feyereisen et al., 1991). Word retrieval patterns vary depending on the elicitation context. Error patterns of patients suffering from different subtypes of fluent aphasia (e.g. conduction aphasic participants and anomic aphasic participants) are not the same in picture naming and spontaneous speech. More specifically, in confrontation naming tasks lexical and sublexical paraphasias (e.g. van → bus and ghost → /goʊ/ respectively) are produced by all aphasic patients independently of the specific aphasia impairment (Mitchum et al., 1990). In spontaneous speech, however, different errors types are produced depending on the aphasia subtype: conduction aphasic patients produce primarily sublexical errors (mainly phonemic paraphasias), while anomic patients produce occasionally lexical errors (mainly semantic ones) and circumlocutions.

These results are quite revealing in several ways. First, they indicate that naming and spontaneous speech makes different linguistic and cognitive demands. Moreover, it becomes apparent that connected speech data (from both spontaneous speech samples
and connected speech elicitation tasks) in comparison to naming provides much more opportunities to the speakers for avoidance of the difficult vocabulary, by using more familiar similar-synonym words, by making use of circumlocutions or even by choosing to convey a different message (Dell et al., 1997).

With regard to post-therapy generalisation, the literature is equivocal regarding the effectiveness of the established accuracy based treatments in promoting treated items’ carry-over to connected speech. Whilst several cases indicating dissociations in naming skills across different naming contexts (picture naming vs. naming in spontaneous speech) have been recorded in the literature (Zingeser & Berndt, 1988; Marshall & Cairns, 2005), it has been argued that picture naming accuracy significantly predicted naming in connected speech contexts, either in more constrained speech elicitation contexts (composite picture description, Maendl, 1998; narratives, Conroy et al., 2009d) or in conversations (Herbert et al., 2008; for a review about generalisation to conversation, see Carragher et al., 2012). The same non conclusive results have been reported regarding the generalisation from treated to untreated items (for different generalisation results produced by different types of treatments, see Best et al., 2013). Generally, there is a strong belief in the clinical literature that there is a lack of generalisation for standard therapies (Howard, 2000; Nickels, 2002a; Wisenburn & Mahoney, 2009), yet it is an underpowered field with not many participants involved in the studies and an empirical basis missing.

Finally, regarding the variable of speed, there is theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b) yet naming speed has been a neglected area in the aphasiology literature (Crerar, 2004). From a clinical point of view, the items which are named more quickly at a post-therapy point are more expected to be named in connected speech contexts (Conroy et al., 2009d). As for therapies which aim at improvement only of accuracy and not of speed as well, Conroy et al. (2009d) illustrated that the speed of picture naming after a cueing-only type of therapy (i.e. decreasing cue therapy) could not predict the extent to which items are named in more spontaneous connected speech tasks. Given that fluent connected speech requires not only accurate (production of no more than one or two errors per 1000 words, Levelt, 1989) but also quick lexical access (fluent speakers produce around 100 words per minute, equating to around half a second per word or 2 words every second e.g. on the Cookie Theft description, Levelt, 1989; Bird et al., 2000), therapy effects may be more
likely to generalise to spontaneous speech if both accuracy and speed are improved. This is the basic hypothesis of our study, and the basic incentive for developing a new method that will emphasise both accuracy and speed of word retrieval.

6.1.2 Speed of naming as a potentially critical factor in generalisation to untreated items and connected speech

One variable which may be critical in determining whether words retrieved in isolation can also be retrieved within the time demands of fluent speech is naming latency, or speed of naming in confrontation naming (Conroy et al., 2009b, 2009d; Crerar, 2004). Speed of word retrieval during picture naming is considered to be the time needed for the initiation of a naming response after the presentation of the target picture and is distinct from the naming duration (see also Kello & Plaut, 2000). Along with accuracy, speed of naming is a critical variable for the response generation in naming, which is important for interpreting naming data and developing theories about the underlying cognitive processes (e.g. Balota et al., 1989; Lupker et al., 1997). A novel yet potentially key finding in the literature (Fillingham et al., 2003, 2005a, 2005b, 2006; Conroy et al., 2009a, b, c, d) is that speed of naming is an important variable, not only within assessment tasks (McCall et al, 1997), but also within therapy tasks, warranting further investigation. This could be because an improvement in speech ratio in connected speech tasks is particularly difficult for aphasic patients. This derive from the fact that people with aphasia may be competent in ‘exploiting’ metalinguistic skills to enhance their accuracy performance even many years post-CVA, but not sufficiently competent to achieve neurotypical speed scores too (Crerar, 2004). This is also indicated by the recovery patterns of aphasic individuals who show an identical performance to neurotypical participants at the linguistic tasks (Kertesz & McCabe, 1977), but the time they need for the accomplishment of the tasks is double relative to the respective speed of neurotypical participants (Neto & Santos, 2012). Thus, the reduced response speed is a typical symptom of aphasia, even after standard therapies or rehabilitation. Moreover, there is theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b).
These findings highlight the importance for treatments to address the factor of speed, yet naming speed has been a neglected area in the aphasiology literature (Crerar, 2004). The vast majority of clinical studies have attempted to shed light on the pre- or post-treatment variables affecting picture naming speed in aphasia, either related to the treated items (e.g. word class, Bird et al., 2003b; Conroy et al., 2006, 2009a; imageability, Alario et al., 2004; Conroy et al., 2009b; metaphorical meaning, Papagno et al., 2004), or to participants with aphasia (e.g. linguistic, cognitive and neuropsychological profile, Fillingham et al., 2003; Conroy et al., 2009b; degree of baseline naming impairment, Conroy et al. 2009a, 2009d; aphasia subtype, Prather et al., 1997). As for the naming therapy studies (i.e. therapies targeting single word retrieval), they have focused solely on improving accuracy (for a review of studies aiming to treat anomia, see Nickels & Best, 1996; Nickels, 2002a). A therapy which has some evidence with respect to being effective in improving speed of word retrieval in aphasic participants is errorless learning (Conroy et al., 2009b). Pure errorless techniques in aphasia therapy are inclined to use word repetition as a phonological cue, the target picture as a visual cue, and the written target as orthographic cue (Fillingham et al., 2003; Abel et al., 2005; Conroy et al., 2006). Especially for verbs, using errorless learning techniques can minimise the requirement for executive control and the cognitive demands required for verb processing (Fillingham et al., 2003, 2005a, 2005b, 2005c). This is extremely important for this type of therapy, if we consider the verbs’ critical role in sentence production and thus in connected speech (lexical hypothesis of agrammatic speech, Saffran, Schwartz, & Marin, 1980) (Marshall et al., 1998; Bastiaanse, Edwards, Maas, & Rispens, 2003). However, a question yet to be answered is whether consistently faster naming responses on the part of participants during errorless therapy is a corollary to the type of the therapy being administered or not (Conroy et al., 2009b).

The available information on the relation between picture naming speed and post-treatment word retrieval in connected speech is extremely limited: to the best of our knowledge, only Conroy et al. (2009d) investigated this relation, but without making use of sufficient data, as noted by the authors (Conroy et al., 2009d, p. 1060). In a previous pilot study with five chronic stroke participants (see Chapter 5), we trialed a newly developed treatment that attempted to reduce speed and increase accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming (i.e. no speed-accuracy trade-off) and compared it to a standard treatment (‘standard presentation’ -
SP) that targeted accuracy alone. The results of that study suggested that, even though SP therapy and RISP therapy were equally effective in improving stroke patients’ picture naming accuracy and speed, RISP led to significantly higher generalisation of targeted items to connected speech. Given the importance of these findings for the theoretical literature and the clinical practice and given the positive outcome of testing participants’ tolerance to the new therapy, the current study sought to substantiate the very promising preliminary results of the previously conducted pilot study (Chapter 5), extrapolate them for a wider range of participants and therefore obtain more conclusive results that would allow us to draw stronger conclusions.

More specifically, we firstly aimed to investigate which treatment would produce more marked improvements in confrontation naming on both speed and accuracy, and subsequently determine the extent to which these therapies can have an increased therapy effect or a generalisation effect compared to untreated items. Secondly we sought to examine which therapy would lead to increased word access in connected speech samples and specifically identify which therapy would significantly increase the likelihood of production of treated and untreated words in composite picture descriptions. Finally, we aimed to obtain qualitative measures on the two therapies’ effectiveness in improving chronic stroke patients’ naming and speech, i.e. establish the extent to which one of the two therapies is perceived as more preferable and effective compared to the other by the patients themselves.

Our hypothesis was that, comparatively to the SP, RISP would have a cumulative effect of accuracy increase and speed decrease in picture naming i.e. more successful post-therapy naming. As for the two therapies’ generalisation effects to untreated items in the picture naming task, RISP and SP were expected to be equally effective. In the picture description task, we predicted that RISP would lead to increased carry-over of its targeted items to connected speech and it would promote general changes in participants’ production strategy i.e. significant increase in the use of its untreated items in connected speech.
6.2 Method

A within-subject design was employed to compare the effects of an accuracy-focused versus speed+accuracy-focused naming therapy on improving confrontation naming and the production of connected speech. Contrary to the pilot study that employed a case series design with few participants (n=5) (see Chapter 5), this study employed a group design that would help to investigate the same questions in a larger number and range of participants. The same experimental process as in the pilot study was followed so that we could combine the results of the current study (n=15) with those of the pilot study (n=5) and report the findings across the whole cohort (n=20).

6.2.1 Participants

Twenty participants (11 males, 9 females; mean age 65.8 years, SD = 12.34) with a clinical diagnosis of chronic aphasia following cerebrovascular accident (CVA) took part in the study. Five of these participants were involved in the project as part of a pilot study (see Chapter 5), and the rest fifteen participants were involved in the project as part of this main study, in two different cycles (1st cycle of recruitment and testing: 10 participants, 2nd cycle: 5 participants). All participants had been involved in previous studies at the University of Manchester and were referred to the lead researcher by other researchers of these studies after participants expressing their interest in being contacted for future research studies. They were originally recruited from aphasia support groups and similar services in Greater Manchester and other North West counties, England. Participants had aphasia of varying degrees of severity and subtype. All were premorbidly right handed, native English speakers, and they had sustained one left hemisphere stroke (ischaemic or haemorrhagic) at least one year prior to the testing (chronic condition). Prerequisites for participating in the study were to have normal or corrected to normal hearing and vision and reliable repetition skills (judged as above 40% on Word Repetition Immediate test; PALPA 9, Kay et al., 1992). This would ensure that participants could meet the therapy requirements and could in theory benefit from the therapy. Potential participants with co-existing neurological impairments (e.g. dementia or multiple sclerosis), global aphasia, severe perceptual problems, or with very
severe naming difficulties (below 8% or 5 out of 60 on the Boston Naming Test, Kaplan et al., 1983), were excluded from the study. However, potential participants with very severely impaired speech or with very mild word finding difficulties (i.e. even when scoring over 45 out of 60 at the BNT and thus scoring in the neurotypical subject range, 2/20 participants: JBr and JM, see Table 6.2) were in the normal range (i.e. over 45 out of 60) were not excluded because we wanted to obtain a broad sample so that the newly developed therapy could be trialed in a range of patients (severe – moderate – mild anomic). For example, milder participants’ performance in picture naming was expected to be reasonably accurate but slower compared to neurotypical participants. By recruiting this type of participants, we would be able to determine how much quicker they could get in picture naming post-treatment and identify the number of target items that they would use in descriptions pre- and post-treatment.

Demographic details (i.e. participant profiles) of the participants are given in Table 6.1. In addition, Table 6.1 includes each participant’s baseline accuracy and baseline speed (RTs in msec.) in picture naming. Scores representing each participant’s accuracy in retrieving the same items (as had been presented in picture naming) in composite picture descriptions are also reported in Table 6.1. Given that content words convey the main meaning in speech, these scores do not constitute a measure of fluency e.g. someone could have a low score in descriptions but be fluent (‘empty speech’), but they indicated the degree of difficulty in producing content words in connected speech. The order of participants’ details presentation was based on their baseline naming accuracy, with data of the most severely impaired participants being presented first, followed by data of progressively less impaired participants. All participants agreeing to take part in the study had signed a consent form, which was in line with the study’s ethical approval.
Table 6.1 Participant Demographic Details including baseline scores and aphasia subtypes

<table>
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<tr>
<th>Participant</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Handedness</th>
<th>Education (years)</th>
<th>Time post-stroke (years)</th>
<th>Baseline Naming Accuracy (max=80)</th>
<th>Baseline Naming Speed (in msec.)</th>
<th>Baseline Description Accuracy (max=80)</th>
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TSA = transcortical sensory aphasia, MN = mixed non-fluent, TMA = transcortical motor aphasia
6.2.2 Background assessments

Before being involved in this study, participants had undergone extensive linguistic and cognitive assessments, as part of related projects conducted by researchers affiliated with the same research unit (Naru, University of Manchester) (e.g. Butler et al., 2014). The results of these assessments are reported as percentages of correct responses and are contained in Table 6.2. The order of participants’ presentation was based on their naming scores (BNT), with data of the most severely impaired participants being presented first, followed by data of progressively less impaired participants. Missing data for one participant (JSo) are indicated with ‘x’. Comprehensive examination of these scores provides us with participants’ aphasiological and neuropsychological profiles and subsequently facilitates the interpretation of an individual’s therapy findings.

The scores of the Boston Naming Test (BNT) (Kaplan et al., 1983) were of major importance for the selection of participants; a wide range of word finding difficulties were found which would be an important consideration in examining the degree of post-treatment improvement between participants. Patients were also tested on the following four phonological tasks (Psycholinguistic Assessments of Language Processing in Aphasia, PALPA 9) (Kay et al., 1992): (a) Auditory word repetition immediate, (b) Auditory word repetition delayed, (c) Auditory non-word repetition immediate, (d) Auditory non-word repetition delayed. The other two linguistic tasks involved the discrimination of two words if they were different or not: word minimal pairs and non-word minimal pairs (PALPA 2 & PALPA 1 respectively) (Kay et al., 1992). Furthermore, patients were asked to complete six tests on comprehension and semantic memory: (a) Spoken Sentence Comprehension from the Comprehensive Aphasia Test (CAT, Swinburn et al., 2005) (b) 64 items’ picture naming (Bozeat et al., 2000) (c) Spoken Word to Picture Matching (Bozeat et al., 2000), (d) Written Word to Picture Matching (Bozeat et al., 2000), (e) Synonym Judgement Test (Jefferies et al., 2009), (f) Camel and Cactus Test (CCT, picture version, i.e. semantic association for pictures) (Bozeat et al., 2000). To test short memory skills, the forward memory span and the backward memory span were administered (Wechsler, 1945). The results of two more cognitive tests are reported: (a) Brixton Spatial Rule Anticipation Test (Burgess & Shallice, 1997) and Raven’s Coloured Progressive Matrices (Raven, 1962). Both are
visuospatial tests measuring attentional/executive skills. These scores were important to ensure that it would be feasible for all participants to provide elaborate descriptions of composite pictures in the baseline and post-treatment assessment tasks.
Table 6.2 Participants’ performance on language, semantic and cognitive assessments

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Cases are ordered according to BNT severity. Scores are given in percentages. Missing data for one participant (JSo) are indicated with ‘x’. Scores marked in bold fall below the cut-off for normal performance. The cut-off was calculated as 2 SD below the mean performance of healthy control participants (Butler et al., 2014). "Cut-off based on published norms. ¹No cut-off available. Authors’ details for published assessments are provided in the text."
6.2.3 Stimuli

To compare chronic stroke patients’ performance between picture naming tasks and connected speech tasks, two types of stimuli were used: pictures depicting isolated objects (nouns) and composite multi-event pictures respectively. All items included in the therapy and the picture naming assessments were part of the composite pictures. More details regarding the number and the selection of these stimuli are provided below.

Pilot experiment

Before conducting this study with chronic stroke participants, a pilot study was carried out with healthy adult volunteers (n=10). This allowed us to establish reliability of stimuli across both picture naming and composite picture description tasks (for more details, see Chapter 3).

The specific aims of this pilot study were:
1) to establish the likelihood of retrieval for words that could be produced when describing six composite pictures i.e. busy social scenes with multiple characters engaged in a range of activities. This helped us to select among these six pictures the four most suitable pictures to be included in the picture description task.
2) to establish picture name agreement for a large corpus of words used in the description of the composite pictures that were included in previous studies (pictures A, B, and F, see Chapters 3, 4 and 5). Because some extra stimuli were chosen to be included in the picture description and therefore the picture naming task and treatment of this study, an additional name agreement task was conducted for items not included in the initial name agreement task of the pilot study. All participants (n=10) were again native English speakers, aged between 24 and 38 years old.
Main Experiment

Composite Picture Description Task

To elicit a language sample, the stimuli for this task were four composite multi-event pictures that contained various common objects and activities (i.e. ‘Where’s Wally’ type pictures). Based on data from the first part of the pilot study, we selected four composite pictures (A, B, C and F, see Appendix 1) which were likely to elicit key content words (i.e. produced by more than 3/10 neurotypical participants in the pilot study). All these composite pictures were depicting both treated and untreated items, included in the picture naming task: these pictures were selected to provide us with the stimuli used in therapies (treated items) and in the picture naming assessments (treated & untreated items in baseline, between-cycles & post-treatment assessment).

Picture Naming Task & Therapy

120 words were inserted into the Match program (Van Casteren & Davis, 2007). All stimuli were nouns and met the following criteria:
(a) items had reliably appeared in picture descriptions i.e. produced by more than 3/10 participants in the pilot study.
(b) items had to be of high imageability. For example, concrete nouns were preferred instead of abstract words e.g. bench and not water respectively.
(c) items had no synonyms or no equally frequent synonyms, which were used alternatively in the picture description task e.g. dodgems and bumper cars.

Among these 120 nouns, the aim was to select 80 stimuli across 4 matched sets of 20 items: 2 therapy sets and their control items undergoing no treatment. The two therapy sets were allocated to the two treatment conditions, i.e. 20 items for standard therapy (SP) and 20 items for speed-focused therapy (RISP). This method was designed to allow us to investigate whether a) items would be named more quickly following speed-focused therapy and b) if items named more quickly would, as a result, be more likely to be produced in connected speech. This was based on the hypothesis that speed
of word retrieval would have a positive effect on likelihood of retrieval in connected speech.

The word sets were matched for likelihood of retrieval in descriptions as represented by the number of neurotypical participants producing each word in the picture description task of the pilot study. The four sets were also matched for frequency and length (see Appendix 4). Frequency values were extracted from the British National Corpus (BNC) (Davies, 2004). Because of the first two variables’ values high importance (likelihood of retrieval in descriptions and word frequency), their matching weight across the 2 sets was set to be higher (i.e. 2) compared to length, which had the default weight (i.e. 1). Also, mutation rate (i.e. the probability of a mutation, that doesn’t affect the speed of the Match program, but has an effect on the quality of the solution) was set at 0.3 (default value).

As for the allocation of these selected items in the four different composite pictures utilised for descriptions, the word sets of one treatment were contained within two of the four composite pictures, and the word sets of the other treatment were contained in the remaining two composite pictures. This was because we wanted to avoid any interference between items from different therapy conditions being elicited in the same composite picture description task (see Table 6.3).

Finally, the sets allocated to each treatment and the respective control sets and composite pictures were counterbalanced for the type of therapy they received (SP or RISP) and therefore half the participants (n=10) received SP treatment on treated set A and RISP treatment on treated set B, and the other half of participants (n=10) received SP treatment on treated set B and RISP treatment on treated set A. As for the composite pictures, this design implied that half the participants were treated on accuracy on pictures A, C and on RISP on pictures B,F, and vice versa for the other half of participants (see Table 6.3).
Table 6.3 Stimuli used in assessments (composite picture descriptions & picture naming) & treatments

<table>
<thead>
<tr>
<th>Composite Pictures</th>
<th>Treated Items</th>
<th>Untreated Items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(also included in picture naming assessments)</td>
<td>(but included in picture naming assessments)</td>
</tr>
<tr>
<td>A, C</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(10 participants treated on SP &amp; 10 participants treated on RISP)</td>
<td>(SP treatment controls for 10 participants &amp; RISP treatment controls for 10 participants)</td>
</tr>
<tr>
<td>B, F</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(10 participants treated on SP &amp; 10 participants treated on RISP)</td>
<td>(SP treatment controls for 10 participants &amp; RISP treatment controls for 10 participants)</td>
</tr>
</tbody>
</table>

6.2.4 Design

A comparison of a standard therapy (SP) focused on accuracy for 20 items versus repeated increasingly speeded presentation (RISP) therapy for the matched 20 items was implemented in order to evaluate therapies’ effects on retrieval latency in confrontation naming and likelihood of retrieval in connected speech. Measurement of baseline performance on picture naming and picture description (twice for each task), treatment with the standard therapy, between-cycles assessment, treatment with the RISP therapy, and finally post-treatment assessments (1 week and 1 month post-treatment) were carried out within 18 sessions over about 2 months a half with each participant (Figure 6.1). The design of this study replicated the design of the pilot study (see Chapter 5) with the only difference being the increased number of participants involved in the study.
Baseline Assessments

Prior to the treatment, a fine-grained analysis of participants’ word finding difficulties in both confrontation naming and connected speech was made. Chronic stroke participants had to carry out 2 tasks (picture naming and composite picture description) twice, according to the following plan:

1st session: Picture description of all 4 composite pictures
2nd session: Picture naming of all 80 items (treated + untreated)
3rd session: Picture description of all 4 composite pictures
4th session: Picture naming of all 80 items (treated + untreated)

These detailed assessments helped us to identify each participant’s baseline scores in confrontation naming and composite picture descriptions (accuracy and RTs for the former and only accuracy for the latter), and thus determine if there was a change in participants’ scores from baseline to the end of the treatment. Also, the multiple implementation (2 times) of each task allowed us to determine if there were inconsistencies in patients’ performance on the picture naming and the picture description task and provided us with a sufficient overview of the patients’ ability to name pictures or produce connected speech (see Table 6.1 for participants’ scores on the first baseline assessment).

Picture Naming Assessment

Participants were presented with items of all four sets (treated & untreated for both therapies). The total 80 stimuli were split in two blocks of 40 items with a resting pause between them. Each block comprised an equal number of pictures belonging to the 4 different sets (Table 6.4). All 40 pictures in each block were randomly presented to participants, with their presentation order being counterbalanced in each of the two baseline sessions.
Participants were asked to name each picture when coming up on screen and were informed that pictures would be presented for a maximum of 10 seconds. Pictures were presented to patients using E-Prime software (Schneider et al., 2002). Audacity software was used to measure naming latencies: a subtle beep sound was produced simultaneously with the picture presentation and RTs were estimated by measuring the time between the beep sound and the patient’s response. Despite being very time-consuming, this method was considered better compared to E-prime’s voice key trigger because it allowed us to measure RTs for trials which included false starts, hesitations (e.g., “uhmm”), articles, or any other extraneous material (e.g. “a lion” or “That’s a lion”).

Table 6.4 Composition of blocks in picture naming

<table>
<thead>
<tr>
<th>Blocks</th>
<th>Items treated on accuracy</th>
<th>Items treated on speed</th>
<th>Items untreated on accuracy</th>
<th>Items untreated on speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Block 2</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Composite Picture Description Assessment

To elicit connected speech samples, a picture description task (picture-supported narratives) of 4 multi-event pictures was employed. The main purpose of the study was to answer the main research question regarding the contribution of speed in the carry over into connected speech and more specifically to investigate the degree of generalisation into connected speech of items with different treatment (standard vs. speed-focused treatment). Hence, the picture description task would allow us to compare likelihood of word retrieval in connected speech between baseline (pre-treatment production) and post-treatment production.

To complete the task, participants sat in front of a computer desktop screen. They were informed that they were going to see four busy pictures and that the instructions for all the pictures were the same. So beginning with the first picture, they
were asked to describe what they saw in the picture in as much detail as they could for about 5-10 minutes. It was explained to them that this time limit was indicative and that they could exceed it if needed because the most important thing was to be as much accurate and thorough as they could in their descriptions. No guidance was provided as to where to start in picture description, as indicating to participants any direction for their description would be quite artificial and could have altered participants’ focus in terms of direction.

Participants’ responses were tape-recorded with a voice recorder (Sony digital IC Recorder) and they had consented to being recorded before commencing the experiment. Finally, the order of presentation of each picture was randomised across participants, thus counterbalancing any effect of higher picture description difficulty in the pictures described first. Participants were also presented with a different picture presentation order when performing the task for a second time compared to the order they were presented the first time they carried out the task.

**Therapies**

Having completed all four baseline assessment tasks, participants received the two types of speech therapy: a standard picture naming therapy (standard presentation, SP) focusing on accuracy, and a new therapy (repeated increasingly speeded presentation, RISP) focusing on both accuracy and speed. This study aimed to extend the findings of the two neurotypical studies to participants with aphasia, by adapting the naming speed manipulation (RISP) to the clinical population’s confinements. Regarding the method employed for investigating same or similar questions in different populations, the intervention for neurotypical participants was very similar to the treatment for patients with aphasia, yet the latter introduced equal numbers of repetitions in SP and RISP, so that accuracy could be established across all items, before proceeding to the speed manipulation. The two therapies (SP and RISP) were delivered in 2 cycles twice a week over 6 weeks.

In the first cycle (i.e. first 3 weeks) only standard therapy was administered for items of both treated sets (n=40), which aimed to improve participants’ picture naming accuracy for the SP set and establish accuracy before targeting speed for the RISP items. A between-cycles assessment was administered at the end of the first cycle, i.e. in
session 6, first the therapy was delivered and after a 10-20 minute break the patient was asked to carry out a picture naming task, but this time without the help of the feedback. This task was identical to the baseline picture naming task and it helped us to re-assess participants’ RTs for all treated & untreated items (n=80).

In the second cycle (i.e. following three weeks), both standard therapy (n=20, 1 set) and speed therapy (n=20, 1 set) were conducted. In each of the cycle 2 therapy sessions, therapies were implemented concurrently (‘parallel administration’) (Figure 6.2).

The only drawback of this design was the potential interference of the SP with the RISP treated items in the composite picture description, which was addressed by selecting different composite pictures to depict items of each treatment (see stimuli for picture description task).

In both cycles, stimuli in each block were randomised between sessions and the order of blocks presentation was counterbalanced in each session. The reason for counterbalancing the order of the therapies administration in cycle 2 (that the two treated sets received different therapies) was that the effectiveness of the therapy delivered second could be affected by the tiredness of participants towards the end of the session, while in cycle 1 this rendered the design more consistent/homogenous and familiarised participants with the process that would be followed in cycle 2.

Figure 6.2 Sequence of therapies’ administration

1) Standard therapy (6 sessions)
1st week: session 1 (Block A, Block B), session 2 (Block B, Block A)
2nd week: session 3 (Block A, Block B), session 4 (Block B, Block A)
3rd week: session 5 (Block A, Block B), session 6 (Block B, Block A + between-cycles picture naming assessment).

2) Standard (a) & Speed (b) therapy (6 sessions)
4th week: session 7 (therapies, SP-RISP), session 8 (therapies, RISP-SP)
5th week: session 9 (therapies, SP-RISP), session 10 (therapies, RISP-SP)
6th week: session 11 (therapies, SP-RISP), session 12 (therapies, RISP-SP)
**Standard Therapy – Standard Presentation (SP)**

This was a standard error reducing therapy, which aimed to improve participants’ picture naming accuracy for the SP set and establish accuracy before targeting speed for the RISP items. Participants were presented with pictures of both treated sets (n=40) and they were asked to name each picture in 10 seconds without support, i.e. with no cues. After each naming attempt, feedback was provided both verbally by the experimenter and written on screen.

The software used for the picture presentation and the method for measuring participants latencies in therapy were identical to these used in the baseline picture naming task. Pictures were presented to patients using E-Prime software (Schneider et al., 2002). Audacity software was used to measure naming latencies: a subtle beep sound was produced simultaneously with the picture presentation and RTs were estimated by measuring the time between the beep sound and the patient’s response.

**Speed Therapy – Repeated Increasingly Speeded Presentation (RISP)**

Having completed the accuracy treatment for all treated items in cycle 1, participants received the RISP treatment for only one of the two treated sets (n=20). This therapy was a hybrid intervention that combined the error reducing method of the standard therapy with the deadline naming technique of experimental psycholinguistics. The RISP treatment made use of the deadline naming to verbally encourage quicker picture naming responses and employed repeated presentations (multiple repetition priming) to increase accuracy and avoid a speed-accuracy trade-off. Deadline naming was selected over tempo naming, because of the latter’s tendency to produce many mistakes in accuracy (robust speed-accuracy trade-off). Participants were repeatedly exposed, i.e. 3 times in a session, to the items of the RISP treated set, while simultaneously they were carrying out a deadline picture naming task.

In order to compare the two therapies’ effect on participants’ performance in naming and descriptions and exclude potential confounds stemming from inherent differences in the two therapies’ design, SP and RISP were identical except from the focus on speed. In the newly developed RISP therapy, the same process with the standard therapy has been followed, with only one difference: between sessions the
deadline was reduced in a controlled way. At the end of the allotted time window, the picture disappeared as a beep sound was produced by the computer. Participants heard the beep sound and they were simultaneously presented with a blank screen for 1000msec. At the end of each trial participants were presented with a written feedback on screen and they were simultaneously hearing the computer verbally producing the correct name of the picture. In case of an incorrect response, the patient was asked to repeat the correct name after the computer/experimenter three times. The reason for including a beep before the production of the correct name was that it was expected to attract patients’ attention to the forthcoming correct name of the picture, while also it would define more clearly the boundary of the deadline.

Presentation time was shortened in a controlled fashion across the 6 RISP sessions. To set the initial presentation time, the data from the between-cycles assessment were used. The initial picture exposure time was adapted to the mean of each participant’s picture naming speed in the between-cycles assessment, so that participants’ first naming attempt would feel fairly natural even for low frequency items. The target deadline (i.e. the deadline of the 6th RISP session) was 1 second, which was the mean naming speed of elderly neurotypical participants in an earlier study’s picture naming (1st natural/simple naming, see Chapter 4), at which they named the same stimuli with aphasic participants without a speed manipulation (mean time: 1002msec, i.e. approximately 1 second). Regarding the sessions between the 1st and the last one (2nd, 3rd, 4th & 5th), each patient’s mean naming speed was divided in 5 steps until we reached the target of 1 second, and so each session was allotted the respective deadline. The method employed for speeding-up participants was both standardised because of the pre-determined speed reduction pattern (i.e. common target of 1 second for all participants), but simultaneously it was subject-specific because the initial presentation time and the subsequent specific deadlines were tailored to each participant’s naming skills (as provided by the between-cycles assessment).

The number of naming attempts (3 for each picture in every session) was held constant across the two therapies so that the two treated sets would be matched for exposure. The presentation time/deadline was changing between sessions, yet it remained the same (i.e. no speed reduction) across all three naming attempts within each session, in accordance with the error reducing method.

Participants were informed that they would be presented with half the pictures they were practicing in the 1st cycle, and that they had to try to name each as quickly
and accurately as they could. It was specified that “speed is very important” and that it was investigated if they could gradually get “quicker and quicker” and not just accurate. Participants were told that “A picture will come up and after some time a beep will be produced as a deadline”, so they should “try to say the name before the beep sound, and try to beat the beep”. Participants were also informed that “immediately after the beep sound the correct word will appear written on screen while simultaneously it will be produced by the computer” and so that they will have to “beat the beep, and in this way beat the computer”.

Pictures were presented and picture naming latencies were manipulated using E-Prime software (Schneider et al., 2002). The sound used to indicate the onset of the picture presentation was the same plain beep sound used in the standard therapy, while the sound for indicating the deadline was a non-standard low pitch beep sound (‘error beep sound’). The difference between the two different beep sounds was easily discernible in order to avoid confusion within a trial. To estimate picture naming latencies, the time between the first standard beep sound and the patient’s response was measured (Audacity software). Finally, a native English speaker from the same area with participants was recorded pronouncing clearly the therapy target items and the recorded named items were used as the computerised feedback.

**Post-treatment assessments & Questionnaire**

Following therapy, participants performance in picture description and picture naming was evaluated both at an immediate time point, i.e. 1 week post-treatment, and in the long term, i.e. 1 month post-treatment. In both post-treatment assessments, participants were asked to first complete the picture description task and describe all four composite pictures included in baseline assessments. They then took a 10-20 minute comfort break, following which they were asked to name all 4 sets of items (n=80). Both the stimuli and the process of the picture description and the picture naming task were identical to those used in the baseline assessments, so that participants’ performance would be comparable across all time points. The only difference from what was adopted in the baseline design was the order of the composite pictures’ presentation which was randomised across participants in both post-treatment assessments. The same applied to picture naming, with the presentation order of the two
blocks being the same between the 1st baseline and the 1 week post-treatment assessment (Block 1 - Block 2), but with reversed order in the 2nd baseline and the 1 month post-treatment assessment (Block 2 - Block 1).

Before commencing the 1 week post-treatment assessment, participants (n=15) were asked to answer some questions regarding their views on the two different types of therapy they had received as part of their involvement in the project. The questionnaire comprised 6 closed (yes/no) quantitative questions (see Appendix 5) and was administered to participants as a guided interview, so that they could simply evaluate the two therapies and optionally elaborate on their original answer. The questions were addressed in the simplest possible way i.e. synonyms were provided for more difficult words (e.g. interesting for engaging etc.). Participants’ responses were tape-recorded with a voice recorder (Sony digital IC Recorder).

6.3 Results

Data from the 5 participants reported in Chapter 5 were integrated with data from 15 new participants and the results for these 20 participants are reported here. The dependent variables in picture naming were accuracy and speed/reaction time (RT). Speed/time of retrieval was not computed for the composite picture description task, as only accuracy was directly related to the main research question about improving words’ accuracy of retrieval in connected speech. This resulted in three outcome measures, two for the picture naming (accuracy and speed) and one for the picture description task (accuracy). The results are presented in three sections, one for each outcome measure:

1. Results for picture naming accuracy
2. Results for picture naming speed
3. Results for picture description accuracy

In each of these sections, first scoring criteria are presented and then group results are reported. Initially the results of a global 3x4 by subjects ANOVA are provided. While each section’s global ANOVA can effectively illustrate a potential different response for all four sets across time, it cannot inform us where the effects are coming from. For this reason, each global ANOVA will be followed by 2x3 ANOVAs, i.e. comparisons of 2 sets (e.g. SP vs. RISP, SP vs. UnSP, RISP vs. UnRISP, UnSP vs.
UnRISP) across the 3 time points (1b, 1w and 1m) and by relevant paired t-tests, either for same set comparison between two different time points (baseline and a post-treatment time point, either 1w or 1m) or for two sets’ comparison at a certain time point (1b, 1w, or 1m) (horizontal and vertical comparisons respectively, see the two Tables at each of the three sections). The variation across the mean performance for each research question will also be presented in graphs depicting individual participant performance.

The 1st baseline assessment was considered optimal for comparing pre-treatment scores to post-treatment scores, rather the 2nd baseline assessment (2b), because at the 1st baseline no priming of the items had occurred due to repeated presentation, as in the 2nd baseline session. Paired-samples t-tests were conducted to compare participants’ performance in the two baseline assessments (1b and 2b). There was not a significant difference in the picture naming scores for 1b accuracy (M=37, SD=14.21) and 2b accuracy (M=39, SD=14.22) conditions; t=2.11, p =.16. However, there was a significant difference in the picture description scores for 1b accuracy (M=12, SD=7.2) and 2b accuracy (M=14, SD=8.2) conditions; t=2.11, p = .02, and in the picture naming scores for 1b speed (M=2.786, SD=0.669) and 2b speed (M=2.571, SD=0.688) conditions; t=2.11, p = .04. That is, a single occurrence of the picture naming task did not exert an immediate repetition priming effect on picture naming accuracy, while picture description accuracy and picture naming speed were more sensitive to baseline priming effects.

6.3.1 Results for picture naming accuracy

Participant performance was scored based on their first response for all picture naming assessments. Minor dysfluencies in responses were not accepted (e.g. *barerina* instead of *ballerina*). Self corrections were considered correct if the correct item was produced immediately (i.e. in less than two seconds) after the first response.

There were some missing values in the picture naming task because of problems with the recording for one participant (JW) in the 1st baseline assessment. JW’s missing data (5% of the dataset) were replaced by the 2nd baseline scores for statistic purposes and therefore a series of ANOVA tests were carried out for both 20 and 19 participants (with and without JW’s data respectively). There were no differences of statistical
significance between the two different types of analyses, so the results of all 20 participants are presented below.

To answer the more general research question regarding post-treatment improvement on picture naming accuracy for all 4 sets of items, a 3x4 ANOVA was conducted. The ANOVA indicated that there was a significant effect of the ‘Time Point’ factor: F(2,38) = 55.630, p < .0005, partial η² = .74. The main effect of ‘Treatment’ factor was also significant: F(3,57) = 35.682, p < .0005, partial η² = .65. Finally, there was a significant interaction between ‘Time Point’ and ‘Treatment’: F(6,114) = 17.981, p < .0005, partial η² = .47 (Figure 6.3).

Figure 6.3 Distribution of accuracy in picture naming by Time Point and Treatment (group data)

One of the main questions was about the comparison of the two therapies’ effectiveness (SP vs. RISP) in improving participant performance on picture naming accuracy. A 2x3 ANOVA indicated that there was a trend towards a borderline interaction between time and treatment: F(2,38) = 2.272, p = .117, partial η² = .11. Both therapies significantly increased picture naming accuracy between the baseline and both post-treatment assessments (Table 6.5a). However, additional pairwise analyses showed that the RISP effect was significantly more increased compared to the SP set not only at
the 1week post-treatment assessment (p < .0005), but also at the follow-up (1m) assessment (p = .001) (Table 6.5b).

To find out whether RISP had a therapy effect on picture naming accuracy, a 2x3 ANOVA was carried out for the comparison of the RISP set and its control set (UnRISP) across the three time points (1b, 1w and 1m) and a significant interaction between ‘Time Point’ and ‘Treatment’ was found (F(2,38) = 34.643, p < .0005, partial η² = .65). More specifically, while RISP significantly increased picture naming accuracy between the baseline and both post-treatment assessments, there was no significant effect of the UnRISP set at any post-treatment time point (Table 6.5a). Likewise, RISP set’s picture naming accuracy was significantly increased compared to UnRISP at both post-treatment assessments (p < .0005 at both 1w and 1m) (Table 6.5b).

Table 6.5a Horizontal comparisons for picture naming accuracy (paired t-tests, all 1-tailed)

<table>
<thead>
<tr>
<th></th>
<th>1b vs. 1w</th>
<th>1b vs. 1m</th>
<th>1w vs. 1m</th>
</tr>
</thead>
<tbody>
<tr>
<td>For SP</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.020</td>
</tr>
<tr>
<td>For RISP</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.021</td>
</tr>
<tr>
<td>For UnSP</td>
<td>.407</td>
<td>.003</td>
<td>.004</td>
</tr>
<tr>
<td>For UnRISP</td>
<td>.346</td>
<td>.219</td>
<td>.411</td>
</tr>
</tbody>
</table>

Table 6.5b Vertical comparisons for picture naming accuracy (paired t-tests, 2-tailed the 1b comparisons, 1-tailed the 1w and 1m comparisons)

<table>
<thead>
<tr>
<th></th>
<th>SP vs. RISP</th>
<th>SP vs. UnSp</th>
<th>SP vs. UnRISP</th>
<th>RISP vs. UnRISP</th>
<th>UnSP vs. UnRISP</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1b</td>
<td>.428</td>
<td>.725</td>
<td>.309</td>
<td>.929</td>
<td>.232</td>
</tr>
<tr>
<td>At 1w</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.091</td>
</tr>
<tr>
<td>At 1m</td>
<td>.001</td>
<td>.0005</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.321</td>
</tr>
</tbody>
</table>
Another question that had to be addressed was about SP therapy’s effectiveness in increasing picture naming accuracy compared to its control word set (UnSP). A 2x3 ANOVA showed that the SP effect was significantly different to the control set (significant interaction: F(2,38) = 14.935, p < .0005, partial η² = .44). This effect was corroborated by additional paired t-tests, indicating that SP’s picture naming accuracy was significantly increased compared to UnSP at both post-treatment assessments (p < .0005 at both 1w and 1m) (Table 6.5b). While UnSP items did not demonstrate a significant improvement on picture naming accuracy between the baseline and the 1w assessment (p = .407), an unexpected upward drift on these items was observed between the baseline and the 1m assessment, that reached significance (p = .003) (Table 6.5a).

Finally, UnRISP and UnSP were compared, in order to ascertain if the two control sets were matched. Only the main effect of the ‘Time Point’ factor was significant (F(2,38) = 3.723, p = .033, partial η² = .16). However, the main effect of ‘Set’ factor was not significant (F(1,19) = 6.33, p = .436, partial η² = .03), neither the interaction between ‘Time Point’ and ‘Set’ (F(2,38) = 2.033, p = .145, partial η² = .10).

Individual participant’s results of all four sets are shown in Figure 6.4. Most participants’ picture naming accuracy slightly improved from 1w to 1m (small priming effect) (AB, JSc, KAd, GP, PR, DCS, JM), while some participants were equally efficient in picture naming at 1w and 1m (KS, MD, EB, JBr). Four mid-range participants (JS, DF, RL, Jso) had a strong tendency to get less accurate from 1w to 1m (no priming) and two participants (one very severe-JBo, and one much less impaired-CH) demonstrated a strong priming effect.
6.3.2 Results for picture naming speed

This related to speed of picture naming (in seconds) for correctly named items, as measured by estimating the time elapsing from the start of the beep produced simultaneously with picture presentation to the correct word production (Audacity software). Very late responses were excluded from further analysis if they were not produced within the allotted time window of 10 seconds.

There were some missing values in the picture naming task because of problems with the recording for one participant (JW) in the 1st baseline assessment. As we did for picture naming accuracy statistical analysis, JW’s missing data were replaced by the 2nd baseline scores. Also another participant (JBo) had two zero values (‘0’) on accuracy at 2nd baseline and one zero value at 1 week post-treatment assessment. These zero values did not affect statistical analyses for picture naming accuracy but they did affect...
statistical analyses for picture naming speed because of the respective missing RT values. Unlike JW’s missing 1st baseline data, there was no equivalent data to reliably replace the 2nd baseline and especially the 1 week post-treatment assessment missing data. Furthermore, JBo had the most severely impaired picture naming accuracy and therefore the respective RTs for each set were stemming from limited data and were not considered reliable for statistical analyses. For these reasons, the results reported below are for 19 and not 20 participants (i.e. excluding JBo’s data and therefore 5% of the dataset).

To answer the more general research question regarding post-treatment improvement on picture naming speed for all 4 sets of items, a 3x4 ANOVA was conducted. The ANOVA indicated that the main effect of the ‘Time Point’ factor was significant: F(2,36) = 21.055, p < .0005, partial $\eta^2 = .54$. The main effect of ‘Treatment’ factor was not significant: F(3,54) = 1.719, p = .174, partial $\eta^2 = .09$. Finally, there was a significant interaction between ‘Time Point’ and ‘Treatment’: F(6,108) = 5.709, p < .0005, partial $\eta^2 = .24$.

Figure 6.5 Distribution of speed in picture naming by Time Point and Treatment (group data)
We then compared therapy effectiveness (SP vs. RISP) in speeding up participants in picture naming. A 2x3 ANOVA indicated that there was a borderline significant interaction between time and treatment: $F(2,36) = 3.218$, $p = .052$, partial $\eta^2 = .002$. Both therapies significantly reduced picture naming latencies between the baseline and both post-treatment assessments (1w and 1m, see Table 6.6a). Additional pairwise analyses showed that there was a trend of the RISP therapy to reduce RTs more than the SP therapy from baseline to the immediate assessment (1w, $p = .101$), but most importantly RISP was significantly more effective in maintaining its therapy effect in the long term (1m, $p = .001$) (Table 6.6b).

To establish whether RISP had a therapy effect on picture naming speed, a 2x3 ANOVA was carried out for the comparison of the RISP set and its control set (UnRISP) across the three time points (1b, 1w and 1m) and a significant interaction between ‘Time Point’ and ‘Treatment’ was found ($F(2,36) = 8.561$, $p = .001$, partial $\eta^2 = .32$). More specifically, while RISP significantly reduced picture naming speed between the baseline and 1w assessment ($p < .0005$), there was no significant effect of the UnRISP set at the 1w assessment ($p = .096$, Table 6.6a). However, both RISP and UnRISP had a significant effect in reducing RTs from baseline to the long term (1m) assessment ($p < .0005$ and $p = .0005$ respectively, see Table 6.6a). Finally, RISP set’s picture naming speed was significantly reduced compared to UnRISP at both post-treatment assessments (Table 6.6b).

*Table 6.6a Horizontal comparisons for picture naming speed (paired t-tests, all 1-tailed)*

<table>
<thead>
<tr>
<th></th>
<th>1b vs. 1w</th>
<th>1b vs. 1m</th>
<th>1w vs. 1m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For SP</strong></td>
<td>$&lt; .0005$</td>
<td>.044</td>
<td>.011</td>
</tr>
<tr>
<td><strong>For RISP</strong></td>
<td>$&lt; .0005$</td>
<td>$&lt; .0005$</td>
<td>.386</td>
</tr>
<tr>
<td><strong>For UnSP</strong></td>
<td>.438</td>
<td>.086</td>
<td>.136</td>
</tr>
<tr>
<td><strong>For UnRISP</strong></td>
<td>.096</td>
<td>.0005</td>
<td>.083</td>
</tr>
</tbody>
</table>
Another question that had to be addressed was about SP therapy’s effectiveness in speeding up participants compared to its control word set (UnSP). A 2x3 ANOVA showed that the SP effect was significantly different to the control set (significant interaction: F(2,36) = 3.905, p = .029, partial $\eta^2 = .18$). This effect was corroborated by additional paired t-tests, indicating that SP set’s picture naming speed was significantly reduced compared to UnSP at 1w (p = .003), yet not at the 1m (p = .381) (Table 6.6b), because there was a speeding in the UnSP at the 1m, that almost reached significance compared to the baseline (p = .086, see Table 6.6a). On the contrary, SP significantly reduced picture naming speed between the baseline and both post-treatment assessments (Table 6.6a).

Finally, UnRISP and UnSP were compared, in order to ascertain if the two control sets were matched. Only the main effect of ‘Time Point’ factor was (marginally) significant (F(2,36) = 3.213, p = .052, partial $\eta^2 = .64$). However, the main effect of ‘Set’ factor was not significant (F(1,18) = .750, p = .398, partial $\eta^2 = .04$), neither the interaction between ‘Time Point’ and ‘Set’ (F(2,36) = 1.333, p = .276, partial $\eta^2 = .002$).

Individual participant’s results of all four sets are shown in Figure 6.6. A pattern emerged when comparing the 1b to 1w: most severely impaired participants dramatically speed up at the immediate post-treatment assessment (therapy effect), while most less severely impaired participants do not benefit from therapy on getting quicker. As for the comparison between the two post-treatment assessments, most participants’ picture naming speed slightly decreased from 1w to 1m (no priming effect) (DF, Jso, GP, DM, JBr, JW, Kad, JM), while some participants were equally quick in picture naming at 1w and 1m (PR, EB, AD, DCS). The two slower at baseline participants (AB, JBo) had a strong tendency to lose the therapy benefit and get slower
from 1w to 1m (no priming), while a relatively strong priming effect (shorter RTs at 1m compared to 1w) was demonstrated by three mid-range participants (KS, JS, MD).

*Figure 6.6 Distribution of speed (in milliseconds for all treated and untreated items - y axis) in picture naming by Time Point (3 time points - Legend) for each participant (x axis)*

1b = 1st baseline assessment, 1w = 1 week post-treatment assessment, 1m = 1 month post-treatment assessment

### 6.3.3 Results for picture description accuracy

This related to accurate production of a word (i.e., either 1 for accurate or 0 for inaccurate) within a composite picture description task. Items retrieved with minor dysfluencies were excluded as incorrect. While self-corrections were not considered as accurate productions in the picture naming task, they were accepted in the picture description task once the self-correction did lead to accurate retrieval.

There were some missing values in the picture description task because of problems with the recording for one participant (DCS) in the 1st baseline assessment. DCS’s missing data (5% of the dataset) could be replaced by the 2nd baseline scores and therefore two different statistical analyses were carried out depending on the replacement or not of DCS’s missing values (with 20 and 19 participants respectively).
There were no differences of statistical significance between the two different types of analyses, so the results of all 20 participants are presented below.

To answer the more general research question regarding post-treatment improvement on picture description accuracy for all 4 sets of items, a 3x4 ANOVA was conducted. The ANOVA indicated that there was a significant effect of the ‘Time Point’ factor: $F(2,38) = 87.769$, $p < .0005$, partial $\eta^2 = .82$. The main effect of ‘Treatment’ factor was also significant: $F(3,57) = 43.684$, $p < .0005$, partial $\eta^2 = .70$. Finally, there was a highly significant interaction between ‘Time Point’ and ‘Treatment’: $F(6,114) = 19.874$, $p < .0005$, partial $\eta^2 = .51$ (Figure 6.7).

Figure 6.7 Distribution of accuracy in picture description by Time Point and Treatment (group data)

We then compared the therapies (SP vs. RISP) with regard to the likelihood of increasing treated items’ retrieval in connected speech. A 2x3 ANOVA indicated that there was a highly significant interaction between ‘Time Point’ and ‘Treatment’: $F(2,38) = 19.624$, $p < .0005$, partial $\eta^2 = .51$. Both therapies significantly increased picture description accuracy between the baseline and both post-treatment assessments (Table 6.7a). However, additional pairwise analyses showed that RISP effect was
significantly stronger compared to the SP set not only at the 1 week post-treatment assessment, but also at the follow-up (1m) assessment (p < .0005 at both 1w and 1m) (Table 6.7b). RISP therapy’s effectiveness was verified by the comparison of SP to RISP items between the second baseline and the 1 week assessment (2x2 ANOVA, F(1,19) = 35.599, p<.0005), and between the second baseline and the 1 month assessment (2x2 ANOVA, F(1,19) = 27.272, p<.0005).

To ascertain if RISP had a carry-over to its control sets, a 2x3 ANOVA was conducted for the comparison of the RISP set and its control set (UnRISP) across the three time points (1b, 1w and 1m) and a significant interaction between ‘Time Point’ and ‘Treatment’ was found (F(2,38) = 56.582, p<.0005, partial η² = .75). More specifically, both RISP and UnRISP significantly improved on picture description accuracy between the baseline and both post-treatment assessments (Table 6.7a), yet RISP set’s picture description accuracy was significantly increased compared to UnRISP at both post-treatment assessments (p < .0005 at both 1w and 1m) (Table 6.7b).

Table 6.7a Horizontal comparisons for picture description accuracy (paired t-tests, all 1-tailed)

<table>
<thead>
<tr>
<th></th>
<th>1b vs. 1w</th>
<th>1b vs. 1m</th>
<th>1w vs. 1m</th>
</tr>
</thead>
<tbody>
<tr>
<td>For SP</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.192</td>
</tr>
<tr>
<td>For RISP</td>
<td>&lt; .0005</td>
<td>&lt; .0005</td>
<td>.014</td>
</tr>
<tr>
<td>For UnSP</td>
<td>.002</td>
<td>.0005</td>
<td>.230</td>
</tr>
<tr>
<td>For UnRISP</td>
<td>.0005</td>
<td>&lt; .0005</td>
<td>.014</td>
</tr>
</tbody>
</table>

Table 6.7b Vertical comparisons for picture description accuracy (paired t-tests, 2-tailed the 1b comparisons, 1-tailed the 1w and 1m comparisons)

<table>
<thead>
<tr>
<th></th>
<th>SP vs. RISP</th>
<th>SP vs. UnSp</th>
<th>SP vs. UnRISP</th>
<th>RISP vs. UnRISP</th>
<th>UnSP vs. UnRISP</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1b</td>
<td>.302</td>
<td>.767</td>
<td>.566</td>
<td>.399</td>
<td>.379</td>
</tr>
<tr>
<td>At 1w</td>
<td>&lt; .0005</td>
<td>.002</td>
<td>.009</td>
<td>&lt; .0005</td>
<td>.124</td>
</tr>
<tr>
<td>At 1m</td>
<td>&lt; .0005</td>
<td>.005</td>
<td>.409</td>
<td>&lt; .0005</td>
<td>.004</td>
</tr>
</tbody>
</table>
Another question that had to be addressed was about SP therapy’s potential carry-over to its control set (UnSP). A 2x3 ANOVA showed that the SP effect was significantly different to the control set (significant interaction: $F(2,38) = 5.245, p = .010$, partial $\eta^2 = .22$). This effect was corroborated by additional paired t-tests: while both SP and UnSP sets significantly improved on picture description accuracy between the baseline and the two post-treatment assessments (Table 6.7a), SP set’s picture description accuracy was significantly increased compared to UnSP at both post-treatment assessments ($p = .002$ at 1w, $p = .005$ at 1m) (Table 6.7b).

Finally, UnRISP and UnSP were compared, in order to ascertain if the two therapies had a differential carry-over to control sets. Both the main effect of ‘Time Point’ factor ($F(2,36) = 3.213, p = .052$, partial $\eta^2 = .64$) and the main effect of ‘Set’ factor ($F(1,18) = .750, p = .398$, partial $\eta^2 = .04$) were significant. However, the interaction between ‘Time Point’ and ‘Treatment’ was not significant ($F(2,36) = 1.333, p = .276$, partial $\eta^2 = .002$).

Individual participant’s results of all four sets are shown in Figure 6.8. Among all participants, the most severely impaired participant (JW) did not have a benefit from therapy (1b vs. 1w). There was no pattern in terms of maintaining or not therapy effects in the long term (1w vs. 1m). Some participants’ picture description accuracy slightly improved from 1w to 1m (small priming effect) (JW, JSc, CH, DM), while three demonstrated a stronger priming effect (GP, DCS, JS). Other participants (JBo, KS, EB, AB) had a strong tendency to get less accurate from 1w to 1m (no priming), while four participants (PR, Jso, Kad, JBr) had the same tendency but it was less strong. Finally, four participants were equally efficient in picture description at 1w and 1m (AD, MD, DF, JM, RL).
The above statistical analysis of the two therapies’ quantitative data and comparison of their respective results provides an interesting insight into the underlying word retrieval mechanisms in both confrontation naming and connected speech production, yet it is inconclusive if not combined with qualitative measures on participant views on the two therapies. Both therapies (SP and RISP) were evaluated as very effective in tackling participants’ word finding difficulties but also in improving participants’ connected speech. Contrary to our concerns that participants may find the speed-focused RISP therapy overly challenging and possibly stressful, they not only tolerated the new therapy, but they also found that it was enjoyable and positively engaging and stimulating. The collected ratings from participants about their views on the overall therapy effect (Table 6.8a) and on the comparison between the two
therapies’ (SP and RISP) effect (Table 6.8b), as evidenced by the questionnaire administered to them (n=15), are provided below.

Table 6.8a Participant (n=15) evaluation on the overall therapy effect

<table>
<thead>
<tr>
<th>Were therapies…</th>
<th>Yes, both therapies</th>
<th>No, neither therapy</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>engaging?</td>
<td>13</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>challenging?</td>
<td>10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>stressful?</td>
<td>2</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>efficient in improving naming?</td>
<td>10</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>efficient in improving speech?</td>
<td>13</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>enjoyable?</td>
<td>15</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Table 6.8b Participant (n=15) evaluation on the comparison between the two therapies’ (RISP and SP) effect

<table>
<thead>
<tr>
<th>Which therapy was more…</th>
<th>RISP was more</th>
<th>SP was more</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>engaging?</td>
<td>5</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>challenging?</td>
<td>11</td>
<td>x</td>
<td>4</td>
</tr>
<tr>
<td>stressful?</td>
<td>3</td>
<td>x</td>
<td>12</td>
</tr>
<tr>
<td>enjoyable?</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

6.4 Discussion

We have presented a therapy study in which we examined if naming speed could be manipulated in chronic stroke participants over and above standard priming effects (i.e. attainment of maximum RTs’ reduction without a speed-accuracy trade-off), and whether manipulating picture naming latencies in picture naming (RISP treatment) would lead to more accurate production of both treated and untreated words in connected speech.
6.4.1 Picture Naming Accuracy

As expected, both therapies increased accuracy with long lasting effects, i.e. participants were more accurate in naming all treated items (SP and RISP) at the end of the treatment (1w), compared to their baseline performance (1b). This increase in picture naming accuracy was also largely retained in the follow-up (1m) assessment. Speed therapy (RISP), however, in comparison to the standard one (SP), was significantly more effective in promoting increased accuracy in both post-treatment picture naming assessments (1w and 1m). This was an important finding; not only did RISP not lead to a speed-accuracy trade off effect, but it also encouraged patients to be more accurate and retain this improvement in the long term (i.e. 1 month after the end of the treatment). What made this finding even more striking was that the increased accuracy for RISP items could not be attributed to repetition priming, since both therapies involved the same number of presentations. Two different hypotheses can be made about the causality underlying this effect. The first hypothesis is related to the design of RISP treatment that targeted both accuracy and speed. In optimally easy and efficient word retrieval, the language system processes well specified lexical representations (Lupker et al., 1997). RISP therapy may have ‘tuned up’ or ‘sharpened up’ these representations leading to improved picture naming accuracy with long term effects (representational re-tuning hypothesis). Another possible hypothesis accounting for the RISP effect is related to a domain-general mechanism that exerts a more general/cognitive effect. That is, RISP may have triggered executive and attentional skills (i.e. increased control over the system that boosted participants’ attention, enhanced ‘default mode network’ connectivity, Bonnelle et al., 2011) that improved the efficacy of the learning mechanism (learning efficacy hypothesis) but also the robustness of representations (i.e. a related but not a mutually exclusive hypotheses).

As for the generalisation from treated to untreated items from baseline to post-treatment, both SP and RISP promoted an equal increase in untreated sets’ picture naming accuracy from baseline to post-treatment assessments that did not reach significance (no significant interaction). Only the main effect of ‘Time Point’ was significant, an effect mostly driven by the increase for UnSP items at the 1month post-treatment assessment, suggesting that repeated presentations of untreated items (5th presentation at the 1m) even without the help of a therapy intervention, can significantly increase picture naming accuracy (repetition priming effect) (Howard et al., 1985;
Nickels, 2002b). Also both SP’s and RISP set’s effects were significantly different to their respective control sets, verifying that both therapies had a therapy effect in improving picture naming accuracy and that repetition priming of control sets do not suffice for attaining a therapy effect on increasing accuracy in picture naming. The absence of a generalisation effect to untreated items in picture naming accords with most of the naming therapy studies, the typical finding of which was that generalisation from treated to untreated items is weak or even non-existent (Howard, 2000; Nickels, 2002a; Wisenburn & Mahoney, 2009). This also militates against the generalisation to untreated items found in semantic treatments (Kiran & Thompson, 2003; Boyle & Coelho, 1995). However, untreated items’ increased naming success has to be carefully attributed to the generalisation of therapy effects (as happened with semantic treatments), as repeated attempts at naming can strengthen the mapping for untreated items and lead to enhanced naming efficiency (Nickels, 2002a).

6.4.2 Picture Naming Speed

As expected, participants were much quicker in naming all treated items (SP and RISP) at the immediate post-treatment assessment (1w) compared to the baseline (1b), with RISP items showing a tendency to be named quicker compared to SP that not reached significance (p= .101). As for long term effects (1b vs. 1m), participants retained the improvement on speed after 1 month. Long lasting effects, however, were not equally significant, with RISP therapy demonstrating a strong effect of maintaining quick RTs compared to the baseline (p < .0005) and SP demonstrating a much weaker-borderline significant effect (p = .044). This difference was mirrored when directly comparing SP and RISP items’ latencies at the 1m assessment, as RISP items were found to be named significantly quicker than SP items in the follow-up (1m), indicating that RISP can much more effectively maintain its effect on reducing RTs in the long term. This was a very interesting finding, given that the reduced response speed is the most typical symptom of aphasia, even after standard therapies or rehabilitation (Neto & Santos, 2012).

The similar degree of change across treated sets from 1b to 1w and the subsequent maintained latencies’ reduction for RISP but not SP items were not expected
but they can be attributed to two reasons. First, the behavioural style of naming more quickly for the RISP items could have carried over to the SP items (fast naming as a behavioral pattern spreads in patients’ naming). The validity of this interpretation was tested by examining potential speed carry-over effects of untreated items in picture naming. If latencies of completely untreated items were faster in 1w compared to the baseline, we would then be able to attribute this effect to a behavioural style of speeding up when naming pictures. The t-tests revealed that participants were not quicker in naming the untreated items (both untreated SP and untreated RISP) at the end of the treatment (1w), compared to their baseline performance (p = .438 and p = .096 respectively, see Table 6.6a). This implied that the post-treatment fast latencies for the SP items cannot be attributed to a behavioral style of speeding up, since there was not the same effect on RTs of untreated items. Another counterargument for this interpretation is that if it were only a behavioural speeding pattern, then SP set’s reduced latencies would have been maintained from 1w to 1m and we would not have the obtained sharp increase on SP items’ picture naming latencies. However, this was not the case (only RISP items continued to be named quickly compared to the baseline) and therefore this explanation seems to be less likely.

Another possible account for these effects is that SP items’ reduced latencies in the 1w assessment were due to the standard treatment’s multiple repeated presentations from baseline to the 1w assessment (i.e. accumulation of repetition priming) (Howard et al., 1985; Nickels, 2002b). This interpretation accords with the SP items’ performance found in the 1 month assessment: due to the complete absence of presentations between the two post-treatment assessments, SP items were named much slower compared to the 1w assessment (weakened repetition priming effect), while RISP items largely retained their fast 1w RTs.

Finally, regarding the generalisation from treated to untreated items, both SP and RISP did not promote a significant reduction in the naming speed of their untreated items (UnSP and UnRISP) from baseline to 1w (p = .438 and p = .096 respectively). However, latencies for both untreated sets further reduced from 1w to 1m, with UnRISP items being named significantly quicker in 1m, compared to the baseline (p = .0005) and UnSP items reaching borderline significance (p = .086). This repetition priming effect was not as robust as the one attained for the SP treated items in the 1 week assessment, as the number of preceding presentations for the untreated items were much fewer compared to the naming attempts of SP items. Also both SP’s and RISP set
effects were significantly different to their respective control sets in the 1w assessment, verifying that both therapies had a therapy effect in reducing picture naming latencies. However, in the 1m assessment, the significant difference of treated items from their control sets was preserved only for RISP, while UnSP items RTs almost matched those of the treated set’s (SP). This finding, combined with RISP therapy’s increased effectiveness in preserving reduced RTs of its treated items in the long term (1m), suggested that RISP had very reliable and strong long term effects on maintaining improvements on picture naming speed for both treated and untreated items.

6.4.3 Picture Description Accuracy

The most positive outcome in both post-treatment assessments (1w and 1m) was that the ‘carry over’ to connected speech was increased for all treated items (SP and RISP) relative to the baseline. Contrary to the most common assumption in the literature about standard therapies’ absence of carry-over effects to connected speech, this finding suggests that single word therapy effects can generalise to connected speech and hence that there is a direct relationship between word finding in single word contexts and connected speech contexts across different participants with aphasia. The study thereby supported the conclusion of Conroy et al. (2009d) who suggested that gains in picture-naming achieved in therapy can generalise to naming of the same items in connected speech tasks. The study also extended the findings of Maendl’s single case therapy study (1998) who found evidence of generalisation from a semantic picture naming therapy to composite picture descriptions.

However, what was most striking, was that the RISP therapy, in comparison to the standard therapy (SP), led to significantly higher ‘carry-over’ of its targeted items to connected speech. Also the RISP therapy was significantly more effective than SP in preserving the improved speech accuracy, even 1 month after the end of the treatment.

Compared to SP, RISP therapy’s increased carry-over effect in connected speech can be due to the increased benefit of RISP therapy on both picture naming accuracy (at 1w and 1m) and picture naming speed (at 1m), i.e. improved accuracy and quicker speed of word retrieval for RISP items may have a cumulative positive effect on likelihood of retrieval of the same items in connected speech. This interpretation can also be related to a threshold effect, i.e. there could be a threshold in the outcome
measures of the picture naming task (either in percentage for accuracy or in seconds for latencies or a combination of them) that when exceeded (as happened with RISP’s both accuracy and speed), it triggered the production of the respective item in description.

RISP increased generalisation effect for both treated and untreated items across elicitation contexts may also reflect a number of different factors, not directly related to the outcome measures of the tasks. First, it was hypothesised that RISP can exert this strong ‘carry-over’ effect because the nature of the employed RISP method was congruent with the linguistically and cognitively demanding nature of the target-connected speech task. While lexical access and retrieval are the main prerequisites to a simple picture naming task, like the one used in the SP treatment, connected speech tasks, like the picture description employed in this experiment, encompass perceptual and attentional components rendering word production a process that requires cognitive processing. Contrary to a simple picture naming task, the speeded naming employed in the RISP treatment required both accurate and quick word production, and hence it promoted greater sustained attention and vigilance that was required for efficient descriptions.

From a linguistic and cognitive perspective, the increased ‘carry-over’ of the RISP items to connected speech could also be attributed to the effectiveness of the RISP method in improving participants’ executive control mechanism of suppression. Linguistically, lexical retrieval in a picture naming attempt entails selection-activation-(production) and suppression, so that another word can be produced in the following trial. That is, suppression serves as a syntactic control process that facilitates the activation and selection of the appropriate lemma representation (Schwartz & Hodgson, 2002). In the case studies reported by McCarthy and Kartsounis (2000) and Schwartz and Hodgson (2002), aphasic participants experienced increased difficulty with picture naming when the time elapsing from the patient’s response to the presentation of the following picture was fast (1 sec and 2 sec respectively), rather when the presentation rate was slow (10 sec and 5 sec respectively). In the RISP therapy, participants were asked to name pictures quickly alternating because of the deadline and hence they had to quickly suppress the name (correct or erroneous, verbally produced or not) of the previous picture in order to name the following one. In the context of composite picture descriptions, participants could more effectively suppress responses of irrelevant/not known untreated items (‘interference suppression’, Bunge et al., 2002), monitor their attention to the relevant/trained RISP items and avoid producing an incorrect (e.g. very
generic or habitual) response over the correct RISP response (e.g. correctly producing *poodle* instead of *dog*, or *rabbit* instead of *bunny* respectively) (‘response inhibition’, Bunge et al., 2002; Abel et al., 2012). This interpretation can be tested on chronic stroke patients that produce many perseveration errors (i.e. errors that constitute erroneous repetition of a certain word), and will be verified if RISP therapy is more effective in helping these patients to suppress and reduce these errors, compared to the SP.

From a neurobiological perspective, performing better than expected in the process of learning, and the subsequent increased motivation and reward seeking behavior have all been associated with dopamine (Fiorillo, 2013; Morita et al., 2013; Foerde et al., 2015). When participants were undergoing the more demanding RISP treatment, successfully beating the beep was challenging and simultaneously rewarding, and hence it potentially triggered psychological chemicals of excitement and satisfaction like dopamine. The production of this chemical may have contributed to the facilitation of the lexical retrieval process for RISP items in descriptions, by implicitly associating RISP items with reward values.

Finally, another potential explanation for the effectiveness of RISP method comes from studies underlining the importance of explicit memory in forming new connections required for conscious recall (MacKay & Burke, 1990, Howard et al., 1991). That is, SP may not had strong carry over effects in speech because of simply strengthening target words’ existent connections in memory through repetition, while RISP was more effective by activating the explicit memory and hence due to an additional formation of new connections, which were crucial for coping with the more demanding RISP words’ recall (increase of participants memory resources). The validity of this interpretation could not be tested because of the absence of a verbal learning task (e.g. an adapted version of the California Verbal Learning Test) (CVLT, Delis et al., 2000), which could have been administered at the end of the 1 week assessment to measure the number of SP and RISP items participants could recall without having the visual aid of the respective picture.

As for control items, we found that both therapies’ untreated items were sufficient to carry over into connected speech samples but this effect of generalisation in untreated items did not reach significance, and it was reduced compared to the treated items (therapy effect for both SP and RISP). Contrary to our expectation, no difference was observed between therapies at 1w, with SP and RISP having the same generalisation results in the use of untreated items in picture descriptions. That is, RISP
therapy promoted the generalisation of both treated and untreated items in connected speech, but its carry over effects in connected speech were greater for treated compared to untreated items.

What was also striking was that untreated items’ picture description accuracy continued to increase even between post-treatment assessments (i.e. between 1 week and 1 month). This resulted in higher accuracy in the 1 month than in the 1 week assessments for both untreated sets, but especially for the RISP therapy’s control items: at the 1 month post-treatment assessment, UnRISP items’ accuracy matched the accuracy of the relapsed SP items and was also significantly different from the accuracy of UnSP items (p = .004) (Table 6.7b).

At least two possible explanations of the untreated items’ increased use in the 1m assessment are tenable. First, this result could be attributed to a robust facilitatory effect of repetition priming on accuracy of untreated items. According to this view, the repetition of the composite picture description task from 1-week to 1-month post-treatment assessment contributed to the more efficient retrieval of untreated items. The study thereby extended the findings of Howard et al. (1985) and Nickels (2002b) who found evidence of such repetition priming effect in picture naming (i.e. repeated naming attempts), yet in this case priming did not occur through direct presentation of the target item. According to Nickels (2002a), correctly naming a picture entails the activation of both the semantic and the phonological representation of the item, which “strengthens the mapping” of that stimulus. Future research will need to better delineate the potential priming of picture descriptions by the same task (i.e. picture description repetition priming even when conducted with a long break in between (i.e. over 3 weeks).

Another possible interpretation of this finding is ‘proactive interference’ (PI) (Bialystok & Feng, 2009), induced by the repeatedly practiced treated items during therapy to the untreated items when the latter had to be produced at the immediate post-treatment assessment (1w). However, at the follow-up assessment (1m), the conflict (PI) between treated and untreated items was largely resolved due to the long period that had elapsed after the end of the treatment and therefore untreated items received less interference from primed/treated items (attenuation of the PI effect).

These two interpretations are not mutually exclusive: the attenuation of the PI effect at the 1m was possibly combined with the long-lasting repetition priming effect for untreated items from 1w to 1m, and resulted in the facilitation of untreated items’ retrieval at the follow-up assessment.
As for the more efficient retrieval of UnRISP items compared to the UnSP at the 1m assessment, this cannot be merely due to repetition priming since UnSP items were not equally facilitated at the 1m assessment, neither merely due to an increased effectiveness of RISP therapy in improving controlled processing and attention (executive function) as part of the overall PI attenuation (Bialystok & Feng, 2009), since UnRISP items’ accuracy was not significantly different from UnSP items at the 1w assessment. However, a cumulative effect of repetition priming and increased effectiveness of the RISP therapy in improving executive function is tenable.

Qualitative measures were also obtained on the two therapies’ effectiveness in improving naming and speech and the extent to which one of the two therapies was perceived as more preferable compared to the other by the participants of the study. Both therapies (SP and RISP) were evaluated as effective in tackling participants’ word finding difficulties but also in improving participants’ connected speech. Contrary to our concerns that participants may find the speed-focused RISP therapy overly challenging and possibly stressful, they not only tolerated the new therapy (as proved by the zero dropouts in the two months and a half long therapy study), but they also found that it was enjoyable and positively engaging and stimulating. Participants appeared to find the therapy engaging because they were prompted to beat the beep and preserve a certain level of challenge throughout the therapy. What may account for participants not being overwhelmed by the speeded task is that first accuracy was established and then the speed reduction was carefully manipulated (i.e. data driven and tailored to each participant’s naming skills/RTs) and hence not many mistakes were produced. Also the more demanding nature of the task, compared to the standard therapy, was frequently acknowledged by both the experimenter and the participants and provided a plausible excuse when mistakes were produced.

6.5 Conclusions

This study aimed to investigate the issue of lexical retrieval processes in different contexts by neurologically impaired participants with post-stroke aphasia. The contribution of this study lies in extending the findings of a previously conducted pilot study: both studies aimed to compare two speech therapies, a therapy involving a standard presentation (SP) and a new, invented one (RISP), while also to assess the
impact of picture naming variables (speed and accuracy) on the efficacy of participants’ performance in connected speech (picture descriptions). Both therapies increased picture naming accuracy but the RISP treatment, not only did it not have a speed-accuracy trade-off, but it also benefited picture naming on accuracy significantly more than the SP therapy at both the immediate and the follow-up assessment (1 week and 1 month post-treatment respectively). Also both therapies reduced latencies, but RISP was significantly more effective in maintaining the improvement on picture naming speed in the long term (1m). As for the picture description task, RISP items’ carry-over to connected speech was much higher, relative to SP items, with long term effects. Furthermore, both SP and RISP increased the use of untreated items in descriptions but RISP facilitated its control items to be more effectively retrieved in the long term (1m). Finally, all patients were amenable and receptive to the challenging treatment that manipulated picture naming speed (RISP) and most of them preferred RISP to the standard treatment. The evidence reported here suggests that a more demanding single-word therapy focusing on both speed and accuracy can significantly increase picture naming efficiency and promote striking carry-over effects to connected speech production, with long term effects. Further research is required to better delineate the essence of the speed benefit.
CHAPTER 7

General Discussion
7 Overview

The overarching aim of this thesis was to investigate the under-researched variable of speed of word retrieval across both neurotypical participants and participants with aphasia. More specifically, the studies contained in the thesis examined the relationship between speed of retrieval and production in different elicitation contexts, namely confrontation picture naming and composite picture description using connected speech.

These issues were explored in a systematic manner across four studies, which initially established a basic correlation between picture naming latency and likelihood of retrieval in connected speech (Chapter 3). The finding that speed of retrieval could be manipulated with subsequent effects for retrieval in connected speech in neurologically healthy participants was then established (Chapter 4). A pilot therapy study with post-stroke participants with aphasia was then conducted to extend these findings to the clinical realm (Chapter 5). Following positive pilot data, a larger more definitive case-series clinical study with participants with aphasia appeared to confirm the robustness of the findings across aphasia as a whole (Chapter 6).

In the four empirical studies presented in the thesis (Chapters 3-6), various novel methodologies have been utilised and their effect on different variables and tasks was investigated: (i) the link between speed of word retrieval in confrontation naming tasks and vocabulary use in connected speech tasks was assessed using a timed naming and a set of composite picture description tasks; (ii) a novel training/therapy method for improving retrieval speed without a speed-accuracy trade-off was developed for neurotypical participants and chronic stroke participants respectively; (iii) this novel method was compared to standard accuracy-focused methods on confrontation naming gains; and (iv) the impact of these methods on connected speech for both treated and untreated items was assessed.

In this final chapter, an overview of findings from the literature review (Chapter 2) and the four empirical studies contained in the thesis (Chapter 3-6) will be reviewed. Secondly, a discussion of these findings in terms of how they addressed the main research questions originally set in the introductory chapter of the thesis will be provided and the broader theoretical and clinical implications of these results will be considered. Finally, the thesis limitations will be discussed and potential directions for future research will be described.
7.1 Summary of findings

7.1.1 Chapter 2

Chapter 2 consisted of a literature review which described the theoretical background to word retrieval in the psycholinguistic literature. Initially the mechanisms engaged in picture naming were reported, and an overview of Levelt’s and Dell’s contributions to the theory of lexical access was given. This theory provided a framework for understanding the underlying processes involved in spoken word production, not just in unconstrained word retrieval contexts of neurotypical participants but also when lexical access breaks down in aphasia. The review found that Dell’s model is more consistent with evidence stemming from patients’ errors and the time course of processing during lexicalisation, yet both Levelt’s and Dell’s models would be much more integrated if they had considered how the structure of the lexicon is linked to differences in response time among aphasic individuals and neurotypical speakers.

Moreover, the variables which can affect picture naming latencies were presented (i.e. visual complexity, image agreement, concept familiarity, imageability, concreteness, semantic category, prototypicality, [± living], name agreement, frequency, age of acquisition, word length, participant’s age and participant’s education) and the two main methods for the elicitation of quicker responses were described (i.e. deadline naming and tempo naming). It was underlined that these speeding-up methods can result in error production and the concept of speed-accuracy trade-off effect was discussed. Crucially, it was concluded that there is a paucity of information about the differences between different word retrieval contexts with respect to the variable of speed.

The review chapter also elaborated on the complications to lexical access and speed of word retrieval as caused by aphasia. Dell’s model accounting for error production in aphasia was first analysed and then both item-related (word class, imageability, literal vs. metaphorical meaning) and subject-related variables (participants’ linguistic, cognitive and neuropsychological profile, severity of baseline naming impairment, aphasia subtype) affecting picture naming speed in aphasia were presented. These variables were taken into account and were reported in Chapters 5 and 6 in which empirical studies examining speed of naming in aphasia were reported.
Different patterns of word retrieval efficiency in aphasia depending on the elicitation context were reviewed and it was concluded that speed of naming may be a critical variable in generalisation from picture naming to connected speech. Also a review of the different speech therapy methods in aphasia was made and the effectiveness of errorless learning therapy regarding the variable of speed of word retrieval was identified.

7.1.2 Chapter 3

Chapter 3 reported the pilot study which provided us with stimuli for subsequent experiments and it also described the first of the four empirical studies presented in the thesis. Before investigating the impact of a speed-focused method/manipulation on speech production (Chapters 4, 5 and 6), this empirical study sought to establish whether a statistically robust relationship could be found between picture naming latencies and word retrieval in connected speech. 27 neurologically intact, monolingual, English-speaking, elderly participants were asked to carry out a composite picture description task and a picture naming task. A statistically significant negative correlation was found between picture naming latencies and accuracy in picture descriptions indicating that words which are retrieved more quickly and therefore easily in picture naming tasks are also those which are more readily available and produced in connected speech tasks. This outcome was both theoretically and clinically important. Theoretically, it indicated that speed of word retrieval was an important factor which had some measureable influence on the availability of words in connected speech in neurotypical language processing. As for the clinical outcomes, this finding provided some evidence that speed of picture naming in itself could be a reasonable therapy target for vocabulary which is retrieved accurately but inefficiently in aphasia. In other words, a novel therapy designed to improve patients’ retrieval speed in picture naming could potentially support use of words in connected speech and could contribute to establish functionally beneficial gains in the quality of participants’ expressive language. This was also consistent with theoretical and clinical evidence that speed of naming may be a critical variable in generalisation from picture naming to spontaneous speech (Conroy et al., 2009b).
It was also found that the most rapidly retrieved words in picture naming tasks were produced earlier (i.e. within the first minutes) in connected speech tasks. Furthermore, if we make the assumption that words produced earlier in picture description and named faster in picture naming are more easily retrieved than those produced later or named slower, the above statistically significant correlation indicated that the impact of pragmatic factors (e.g. attention or attraction to specific stimuli) on word retrieval during composite picture description may be less important than the influence of the purely linguistic factor of ease of word retrieval (at least for neurotypical participants). Therefore, the results of our experiment suggested that even computational models that are solely focused on content selection for reference production need to pay more attention to linguistic variables affecting the lexical choice, as these two things appear to be more closely related than most existing models recognise (Viethen et al., 2012; Viethen & Dale, 2006).

There was a highly significant correlation between speed and accuracy within the tasks. This outcome demonstrated robustly that items which were more likely to be produced accurately in picture naming were also more quickly produced within the same task, and items which were more likely to be produced accurately in picture descriptions, were produced earlier in picture descriptions i.e. within the first minutes. This within-task correlation is in line with observations in the literature about the critical role of both accuracy and speed for the response generating in picture naming (Balota et al., 1989; Lupker et al., 1997). What was striking was that this correlation between accuracy and speed also occurred in connected speech.

A further analysis of the findings revealed that speed of word retrieval was no different when picture naming occurred either before or after composite picture description within a single testing session. That is, there was no priming effect of preceding composite picture descriptions on picture naming speed. This result implied that picture description did not exert a lexical priming effect on picture naming. Language/sentence comprehension studies have found that priming vanished in sentence contexts, when words of these sentences were presented first in isolation (Williams, 1988; Hess et al., 1995). Also our finding was in line with previous psycholinguistic experiments, which found that the priming effect was larger in the condition where the primes were of the same type with the targets (picture + picture priming condition), rather when the primes were of a different type (word + picture condition) (Wheeldon & Monsell, 1992).
Finally, the pilot study in Chapter 3 helped us to establish a suitable set of stimuli tapping picture naming and picture description skills for further studies to investigate the connection between these naming and description tasks and therefore understand the variables which influence word retrieval in speech production. Given that there are no standardised stimuli of isolated pictures for naming that are also included in composite pictures for description (e.g. the Cookie Theft picture contains only a limited number of such stimuli), this pilot study provided us with stimuli that enabled us not only to investigate the correlation between naming variables and connected speech, but also to extend the correlation findings of Chapter 3 to empirical studies employing a speed manipulation and investigating this manipulation’s generalisation effects to connected speech in both neurotypical participants (Chapter 4) and participants with aphasia (Chapters 5 and 6).

7.1.3 Chapter 4

Chapter 4 described a study which aimed to extend the findings of Chapter 3 by examining if naming speed could be manipulated in neurologically intact older adults (n=21 participants, also involved in the Chapter 3 study) over and above standard priming effects (i.e. attainment of maximum RTs’ reduction without a speed-accuracy trade-off). We also investigated whether reduced picture naming latencies would lead to more accurate and earlier production of trained words in connected speech. The study compared a standard priming method (‘standard presentation’- SP) against a method encouraging increasingly speeded production across repetitions (‘repeated increasingly speeded presentation’ - RISP). In light of the findings in Chapter 3, it was expected that RISP would produce greater effects in terms of both picture naming speed and picture description accuracy.

While both SP and RISP items were named quicker post-intervention and had lasting effects i.e. reduced RTs were retained after the conduction of another task (picture description), RISP was found to be significantly more effective in dramatically reducing picture naming latencies (i.e. RISP items’ RTs were reduced from approximately 1 second at the beginning of the study to ~ 630 msec, which was below the mean minimum RT at the beginning of the study) and in preserving this speed
reduction until the end of the session, even after conducting another task (i.e. picture description task). This highlighted that the combination of repetitions and time pressure, as exerted in the task through the reducing deadline, was very beneficial in terms of speed of lexical retrieval. This finding is even more striking because of the age of the recruited participants (mean = 70, SD = 5) (Hodgson & Ellis, 1998), but also because of the absence of a speed-accuracy trade-off, i.e. naming accuracy was significantly improved for all items but RISP items’ naming accuracy was significantly improved at the end of the training session, compared to the SP items. Other studies in the literature employing standard speeding up methods did not avoid a speed-accuracy trade-off (Kello, 2004) especially when the speed reduction was very large, as in our case.

Finally, a meta-analysis indicated that picture description has half the repetition priming effect that confrontation naming has on reducing picture naming latencies. That is, picture description can significantly reduce picture naming latencies only when it is combined with at least one confrontation naming exposure of the target items. This finding could potentially account for the significant speed reduction of the untrained SP items (i.e. accumulative priming effect of SP items’ single naming presentation at the beginning of the study and the composite picture presentation later on). Another possible explanation for this effect was the ‘carry-over’ of the behavioural style of responding increasingly quickly for the trained (RISP) items to the non-trained (SP) items. The validity of the latter account, however, could not be tested due to the absence of a completely untreated set.

As for the impact of speed training (RISP) on the lexical retrieval in connected speech, all target items (SP and RISP) were more likely to be produced post-training compared to the baseline (i.e. picture descriptions pre-training in Chapter 3 study). However, a reduction of naming speed was not critical for retrieving the words in connected speech, in that SP was as effective in promoting retrieval in connected speech as RISP. This finding, together with this of Bock and Griffin (2000a, 2000b) about lexical priming in sentence contexts, and specifically sentence production, strongly suggested that single-word primes are central to the selection of words for production in ageing population’s connected speech. Taken into account the correlation found in Chapter 3, speed reduction and accuracy increase may had a cumulative effect in encouraging the production of more target words (both produced once-SP and repeatedly-RISP) in descriptions. This finding was also compatible with other findings in the literature: not only can a priming effect be exerted on different contexts (picture
naming and picture description in our study, comparatively to naming-to-definition and picture naming in the study of Wheeldon & Monsell, 1992, but this effect can be exerted by a single presentation/production only (Kelley & Lindsay, 1993; Rastle & Burke, 1996). This result was also analysed with respect to the cause of repetition priming effects in word production more generally, i.e strengthened lexical and not phonological connections are responsible for priming effects even in different contexts (Wheeldon & Monsell, 1992).

Finally, our data did not support the original hypothesis based on Chapter 3 results about earlier production in descriptions of all items, and especially of those that were trained with RISP. Instead, it was found that all target words (SP and RISP) were produced later in descriptions compared to the baseline. This finding was interpreted in light of theoretical approaches on word retrieval differences depending on the elicitation context (different time demands of word retrieval between the two contexts of confrontation naming and description), methodological approaches (longer time taken to complete post-training composite picture descriptions), and the repetition priming theory (for which our findings suggested that the “task-specific response” associative learning is the prevalent cause of repetition priming).

7.1.4 Chapter 5

Chapter 5 described the first clinical study of the thesis, which aimed to adapt the Chapter 4 RISP method to an anomia treatment and trial this treatment to post-stroke participants with aphasia. We specifically investigated whether this newly-developed treatment targeting both speed and accuracy (‘repeated increasingly speeded presentation’ - RISP) in picture naming would be more effective for improving the use of the treated names in connected speech, than the standard therapy (‘standard presentation’ - SP) which targeted accuracy alone. All participants (n=5, with varying degrees of aphasia severity and subtype) showed significant therapy gains on both picture naming accuracy and speed, with the RISP therapy being as effective as the SP therapy.

Chapter 5 results showed that participants were more accurate and much quicker in naming all treated items (SP and RISP) at the end of the treatment (1 week post-
treatment assessment), compared to their baseline performance. This was especially important for the RISP method; not only did it not have a speed-accuracy trade off effect, but it also encouraged patients to be more accurate. Participants had also retained this improvement on both accuracy and speed after 1 month, i.e. both therapies produced marked improvements in picture naming accuracy and induced quicker RTs with long lasting effects. However, the two treated sets showed a similar degree of change, suggesting that the RISP treatment did not benefit picture naming on speed and accuracy more than the SP therapy, i.e. the speed therapy was as effective as the standard therapy. While this was expected for accuracy (i.e. same number of presentations in both treatments), it was not expected for speed and so two possible explanations were tested. Based on a meta-analysis, the first explanation (i.e. ‘carry-over of the behavioural style of going fast from RISP to the SP items) was rejected, while the second interpretation regarding the pure repetition priming effect due to the standard treatment’s repeated presentations was proved to be more valid.

The most positive outcome in both post-treatment assessments (1 week and 1 month post-treatment) was that the ‘carry over’ to connected speech was increased for all treated items relative to the baseline. However, what was most striking, was that the speed therapy (RISP), in comparison to the standard one, led to significantly higher generalisation of its targeted items to connected speech, and this effect was long lasting, even 1 month post-treatment.

However, RISP therapy’s increased generalisation effect in connected speech was not due to speed. That is, RISP treated and untreated items were more likely to be produced in composite picture descriptions, but picture naming latencies of the respective items were not quicker, compared to matched SP items. The source of RISP therapy’s effectiveness in promoting generalisation to connected speech was attributed to a neurobiological factor, i.e. RISP method promoted increased motivation and a reward seeking behavior, both of which were associated with dopamine and, in turn, with more efficient learning (Fiorillo, 2013; Morita et al., 2013; Foerde et al., 2015) but also to linguistic and cognitive factors. These were: the linguistic and cognitively demanding nature of the RISP therapy promoting greater sustained attention and vigilance; RISP’s effectiveness in improving participants’ control mechanism of suppression; and, RISP’s efficiency in strengthening target words’ existent connections in memory through repetition, threshold effect.
As for control items, we found that both therapies’ untreated items were sufficient to carry over into connected speech samples but this effect (generalisation effect in untreated items) did not reach significance, and it was reduced compared to the treated items. Contrary to our expectation, no difference was observed between therapies, with SP and RISP having the same generalisation results in the use of untreated items in picture descriptions.

What was also striking was that untreated items’ picture description accuracy continued to increase even between post-treatment assessments (i.e. between 1 week and 1 month), resulting in higher accuracy in the 1 month than in the 1 week assessments for both untreated sets. Repetition priming and proactive interference were suggested as possible causes accounting for the facilitatory effect observed in the 1 month post-treatment assessment.

Chapter 5 concluded that a more demanding single-word therapy can promote strong carry-over effects to more linguistically and cognitively demanding connected speech production, yet even a less demanding therapy can have carry-over effects to untreated items in connected speech. Although the data were more suggestive than conclusive, that pilot study extended our understanding of how a focus on speed of confrontation naming (RISP) affects cognitive and linguistic abilities in post-stroke aphasia and therefore it warranted further evaluation in a larger empirical study.

### 7.1.5 Chapter 6

Chapter 6 reported the final empirical study contained in the thesis. This sought to substantiate the very promising preliminary results of the previously conducted pilot study (Chapter 5), extrapolate them for a wider range of participants and therefore obtain more conclusive results that would allow us to draw stronger conclusions. Data from the 5 participants reported in Chapter 5 were integrated with data from 15 new participants and the results for these 20 participants were reported.

As expected, both therapies increased accuracy with long lasting effects, i.e. participants were more accurate in naming all treated items (SP and RISP) at the end of the treatment (1 week and 1 month post-treatment), compared to their baseline performance. Contrary to the pilot study findings (Chapter 5) but in line with our
original hypothesis, speed therapy (RISP), in comparison to the standard one (SP), was significantly more effective in promoting increased accuracy in both post-treatment picture naming assessments (immediate and follow-up). This was an important finding; not only did RISP not lead to a speed-accuracy trade off effect, but it also encouraged patients to be more accurate and retain this improvement in the long term (i.e. 1 month after the end of the treatment). What made this finding even more striking was that the increased accuracy for RISP items could not be attributed to repetition priming, since both therapies involved the same number of presentations. Two different hypotheses were made about the causality underlying this effect: one about RISP’s efficacy in retuning lexical representations and one about RISP exerting a more general/cognitive effect that improved the efficacy of the learning mechanism (learning efficacy hypothesis) but also the robustness of representations.

As for the generalisation from treated to untreated items from baseline to post-treatment, both SP and RISP promoted an equal increase in untreated sets’ picture naming accuracy from baseline to post-treatment assessments that did not reach significance (no significant interaction). Only the main effect of ‘Time Point’ was significant, an effect mostly driven by the increase for UnSP (untreated standard presentation) items at the 1month post-treatment assessment, suggesting that repeated presentations of untreated items (5th presentation at the 1m) even without the help of a therapy intervention, can significantly increase picture naming accuracy (repetition priming effect) (Howard et al., 1985; Nickels, 2002b). Also both SP’s and RISP’s effects were significantly different to their respective control sets, verifying that both therapies had a therapy effect in improving picture naming accuracy and that repetition priming of control sets do not suffice for attaining a therapy effect on increasing accuracy in picture naming.

As expected, participants were much quicker in naming all treated items (SP and RISP) at the immediate post-treatment assessment (1 week post-treatment assessment) compared to the baseline, with RISP items showing a tendency to be named quicker compared to SP items that had not reached significance. However, contrary to the pilot study findings (Chapter 5) but in line with our hypothesis, speed therapy (RISP), in comparison to the standard one (SP), was significantly more effective in maintaining the reduced RTs in the long term (1 month post-treatment assessment). Fast latencies for the SP items at the immediate post-treatment assessment (1 week) and significantly reduced latencies at the follow-up (1 month) were attributed to an accumulation of
repetition priming (Howard et al., 1985; Nickels, 2002b) and a weakened repetition priming effect respectively.

Regarding the generalisation from treated to untreated items, both SP and RISP did not promote a significant reduction in the naming speed of their untreated items (UnSP & UnRISP) from baseline to 1w. However, latencies for both untreated sets further reduced from 1w to 1m, with UnRISP items being named significantly quicker at 1m, compared to the baseline (p = .0005) and UnSP items reaching borderline significance (p = .086). Also both SP’s and RISP set effects were significantly different to their respective control sets in the 1w assessment, verifying that both therapies had a therapy effect in reducing picture naming latencies. However, in the 1m assessment, the significant difference of treated items from their control sets was preserved only for RISP, while UnSP items RTs almost matched those of the treated set’s (SP).

The most striking finding of Chapter 6 was about the ‘carry-over’ to connected speech. This was increased for all therapy items (RISP and SP) relative to the baseline, yet RISP, in comparison to the SP, led to significantly higher carry-over of targeted items to connected speech. Also the RISP therapy was significantly more effective than SP in preserving the improved speech accuracy, even 1 month after the end of the treatment. A number of different factors accounting for RISP’s increased generalisation effect for both treated and untreated items across elicitation contexts were considered, either directly related to the outcome measures of the tasks (i.e. cumulative effect of picture naming measures) or not (see neurobiological, linguistic and cognitive factors mentioned for the interpretation of the same finding at Chapter 5).

As for control items, it was found that there was no difference between therapies at 1w, with SP and RISP having the same generalisation results in the use of untreated items in picture descriptions. Untreated items’ picture description accuracy, however, continued to increase even between post-treatment assessments, resulting in higher accuracy in the 1 month than in the 1 week assessments for both untreated sets, but especially for the RISP therapy’s control items. Two not mutually exclusive interpretations were suggested for this accuracy increase from the immediate to the follow-up assessment. The first concerned a possible robust facilitatory effect (repetition priming) exerted from picture description on accuracy of untreated items in the follow-up confrontation naming, and the second one related to the attenuation of
the ‘proactive interference’ effect (PI) at the 1 month assessment (Bialystok & Feng, 2009), which was originally induced by the repeatedly practiced treated items during therapy to the untreated items at the 1 week assessment.

Finally, based on qualitative measures collected post-treatment, we found that participants evaluated both therapies (SP and RISP) as effective in tackling their word finding difficulties but also in improving their connected speech. Contrary to our concerns that participants may find the speed-focused RISP therapy overly challenging and possibly stressful, they not only found the new therapy acceptable, but they also assessed that it was enjoyable and positively engaging and stimulating.

7.2 Theoretical and clinical implications

7.2.1 Speed-accuracy trade-off

The most consistent finding in the thesis across different studies involving different populations and different versions of the RISP method (RISP training for neurotypical participants vs. RISP therapy for participants with aphasia) was that RISP was effective in significantly reducing picture naming latencies without inducing a speed-accuracy trade-off (Pachella & Pew, 1968; Wickelgren, 1977). That is, both older neurotypical participants and participants with aphasia could be trained/treated to reduce picture naming latencies without compromising accuracy in responses.

What was even more striking for the RISP method was that not only did it not have a speed-accuracy trade off effect, but it also encouraged both neurotypical participants and participants with aphasia to be more accurate. RISP, in comparison to SP, was significantly more effective in promoting increased accuracy at immediate post-training/post-treatment assessments (2NN in Chapter 4 and 1 week assessment in Chapter 6) but also in retaining this improvement on accuracy in the long term i.e. after the conduction of the picture description task for neurotypical participants (Chapter 4) and after 1 month for participants with aphasia (Chapter 6).
The absence of a speed-accuracy trade-off and the significant accuracy increase for RISP items is attributed to the errorless philosophy underpinning the studies’ design, according to which first accuracy was established and then a speed reduction was attempted. Pure errorless techniques used in aphasia therapy were employed for establishing accuracy: word repetition was used as a phonological cue, the target picture as a visual cue, and the written feedback as orthographic cue (Conroy et al., 2006). To attain the minimal speed-accuracy trade-off, the contribution of the method adopted for the speed reduction was also very important: (a) the ‘deadline naming’ was selected over ‘tempo naming’, because of the latter’s tendency to produce many mistakes in accuracy (robust speed-accuracy trade-off); (b) the deadline naming technique was combined with repeated presentations of the stimuli (multiple repetition priming), i.e. participants had firstly been familiarised with the items through repeated presentations before reaching the shortest deadline condition; (c) latencies were reduced gradually and in a controlled way, i.e. data-driven speed reduction pattern both in neurotypical participants’ and in clinical studies; (d) finally, the emphasis of the instructions given to participants was on both speed and accuracy as they were asked to produce both accurate and speedy responses as much as possible.

Finally, the a post-training accuracy increase for neurotypical participants in picture naming was combined with significant speed reduction for RISP items (significantly quicker compared to the baseline and compared to SP), suggesting that multiple presentations and speeded word production (RISP) did encourage the resolution of word finding difficulties in elderly participants. This finding is even more striking because of the age of the recruited participants (Hodgson & Ellis, 1998), i.e. word finding difficulties (LaBarge et al., 1986) and tip of the tongue states (Rastle & Burke, 1996) have been traditionally associated with ageing, while simultaneously slowing down both in linguistic comprehension and production is a standard characteristic of people as they grow older (e.g. Griffin & Spieler, 2006; Neto & Santos, 2012).
7.2.2 Improvement in connected speech

Another consistent finding across all studies in the thesis is that both naming methods of SP and RISP had significant carry-over effects to connected speech (Chapters 4-6), as predicted by the very strong correlation found between confrontation naming measures (accuracy and speed) and outcome measures in connected speech (accuracy and time of retrieval in picture descriptions) (Chapter 3). As for the comparison between SP and RISP, the two methods were found equally effective in promoting ‘carry-over’ effects to connected speech for neurologically intact older participants (Chapter 4). In clinical studies (Chapters 5 and 6), however, RISP led to significantly higher generalisation of targeted items to connected speech and was significantly more effective than SP in preserving the improved speech accuracy, even 1 month after the end of the treatment (contrary to SP items, whose speech accuracy almost matched this of RISP’s untreated items).

The findings for neurotypical participants in Chapter 4 implied that neurologically intact older participants show no benefit of extensive practice in naming pictures over picture descriptions and therefore that single-word primes presented only once are central to the selection of words for production in connected speech. This further suggested that the healthy older adults do not need to strengthen the phonological links between primes and targets, as was also supported by other repetition priming studies in the psycholinguistic literature (Rastle & Burke, 1996). Furthermore, the Chapter 4 finding for SP having carry-over effects to connected speech, combined with meta-analysis findings in Chapter 3 about the absence of priming from picture description to picture naming, theoretically implied that single presentation priming effects can be exerted into different contexts/tasks (i.e. from picture naming to picture description-Chapter 4). However, this depends on the condition that the prime is overt (i.e. no priming from picture description to picture naming, and particularly a single presentation in picture description does not suffice to prime picture naming-Chapter 3).

As for the clinical studies of Chapters 5 and 6, their results suggested that, contrary to the most common assumption in the literature about standard therapies’ absence of carry-over effects to connected speech, single word therapy effects can generalise to connected speech (yet without long term effects), and hence that there is a direct relationship between word finding in single word contexts and connected speech contexts across different participants with aphasia. These results had also theoretically
implied that a more demanding (related to dopamine production) but also more engaging single-word therapy that employs game-like elements of competition (‘gamification’ of therapy) can promote strong generalisation effects to more linguistically and cognitively demanding connected speech production. This had also further suggested that more anomia therapies that are interesting and engaging for patients are required for clinical practice.

What is consistent across all the thesis studies with neurologically intact older participants and participants with aphasia (Chapters 4-6) is that they demonstrated the major contribution of speed manipulation in the carry over into connected speech when combined with accuracy, i.e. accumulative effect of confrontation naming speed reduction and accuracy increase in promoting use of words in connected speech. This cumulative effect of accuracy and speed is also supported by the robust correlation findings in Chapter 3 about the contribution of both picture naming accuracy and speed on the accurate and efficient production in connected speech. Furthermore, most lexical retrieval models that are impaired in patients with brain damage were based on single word processing studies, neglecting underlying deficits as indicated by production of connected speech. Given our findings about the impact of picture naming improvement (with both SP and RISP) on picture description, models should include additional components reflecting the underlying deficits not only on a single word level but also on the more demanding speech production level.

As for the specific benefit of RISP in inducing use of the trained words in connected speech, it can be attributed to variations in different populations’ threshold. That is, the threshold in the outcome measures of the picture naming task (either in percentage for accuracy or in seconds for latencies or a combination of them) which is required for the production of the respective item in picture description, appear to be different for neurotypical participants and participants with aphasia. More specifically, single presentation’s contribution in increasing accuracy and reducing speed in picture naming for neurotypical participants was found that sufficed for using these items in connected speech. This is probably because neurotypical participants’ lexical access in connected speech was not exceedingly demanding and therefore their connected speech had a limit of maximum benefit (ceiling effect) for picture naming (maximum increase in accuracy and reduction in speed they can benefit from), and exceeding this limit with RISP was only redundant in terms of carrying this benefit over to connected speech. This limit was not evidenced in participants with aphasia (Chapters 5 and 6) who had
complications in word retrieval and therefore could show differential benefit from the more demanding RISP therapy.

Finally, the differential results of the RISP in promoting carry over to connected speech across different populations (neurotypical participants vs. participants with aphasia) are also theoretically informative on the mechanisms involved in repetition priming. Wheeldon and Monsell (1992) found evidence that strengthened lexical connections/nodes between the prime and the target account for repetition priming effects, while strengthening phonological connections (e.g. by prior presentation of homophones) could not speed naming of the target (e.g. son – SUN). Based on the study for neurotypical participants (Chapter 4), inasmuch as the repeated presentation of the RISP words contributed to the strength of phonological connections and inasmuch as no additional facilitatory priming was observed for RISP stimuli, compared to SP stimuli, we can verify the Wheeldon and Monsell (1992) hypothesis that strengthened lexical connections are responsible for priming effects even in different contexts/tasks. The Wheeldon and Monsell hypothesis was also supported by the clinical findings of Chapter 5 and 6: the equal number of presentations for both SP and RISP items excluded any differential phonological priming between the two therapies (i.e. SP and RISP items had equally strengthened phonological connections between picture naming primes and picture description targets), and therefore the increased efficiency of RISP in connected speech can only be attributed to the strengthened lexical/semantic nodes of RISP items.

7.2.3 Generalisation to untreated items

Regarding the generalisation from treated to untreated items in picture naming, both SP and RISP did not promote a significant increase in the naming accuracy or a significant reduction in the naming speed of their untreated items (UnSP and UnRISP) from baseline to the immediate post-therapy assessment (1 week). The absence of a generalisation effect to untreated items in picture naming verified that repeated presentation of control items did not suffice for attaining a therapy effect on increasing accuracy and reducing latencies in picture naming. This also supported most of the naming therapy studies in the literature, the typical finding of which was that
generalisation from treated to untreated items is weak or even non-existent (Nickels, 2002a).

However, naming accuracy for UnSP items significantly increased from 1w to 1m and naming speed for UnRISP items significantly decreased within the same time period suggesting for these items either a potential repetition priming effect for presentations that were not separated by a long time period (i.e. less than a month) or a proactive interference induced by treated items at the 1w assessment and then resolved at the 1m assessment (see Chapter 6). Furthermore, the finding for UnRISP items’ significant speed reduction from 1w to 1m, combined with RISP therapy’s increased effectiveness in preserving reduced RTs of its treated items in the long term (1m), suggested that RISP has very reliable and strong long term effects on maintaining improvements on picture naming speed for both treated and untreated items in aphasia. Finally, the fact that RTs were reduced for all untreated items from 1w to 1m (significantly for UnRISP and borderline for UnSP) while accuracy increased only for half the untreated items (only for UnSP) indicated that the mechanism of repetition priming is less sensitive with accuracy and more efficient with speed.

As for the generalisation to connected speech, aside from the improved ‘carry-over’ of target items to connected speech, both therapies (SP and RISP) led to a significant increase in the use of untreated items in post-treatment picture descriptions, compared to the baseline. This suggested that standard naming therapies as well as the newly developed RISP are effective in promoting general changes in the speech production strategy of participants with aphasia (a robust generalisation effect). In this way, improved efficiency for a subset of vocabulary in both the variables of speed and accuracy also has the positive side-effect of improved performance on the remaining words because effort for core vocabulary is reduced and can be diverted to other aspects of speech production. However, we have to be careful with the interpretation of untreated items’ increased used in connected speech post-treatment, as this could be attributed to repeated attempts at retrieving the untreated words at baseline and post-treatment assessments (possible picture description priming effect) and not to a generalisation of therapy effects (Nickels, 2002a) (see further research at 7.3).
7.2.4 Clinical implications

As for the practical implications for participants with aphasia, the increased carry-over for RISP therapy to connected speech mean that the newly developed ‘speed+accuracy’ focused therapy is potentially of functional benefit to everyday verbal communication through enhancing patients’ expressive language skills and the quality of their everyday communication. More generally, the functionally beneficial gains of RISP and participants’ receptiveness towards it further suggested that a more demanding therapy may be imperative in inducing greater therapy gains and therefore that new therapies that put the language and cognitive system under sustained pressure may need to be trialled on condition that they are delivered in a controlled way, that does not deplete performance.

7.3 Directions for further research

Further analyses on the existent data can be conducted. For example, an error analysis of the clinical data and especially for the RISP items that were named under pressure, could provide us with reliable evidence to models of lexical access for patients (i.e. bottom-up and top-down flow of activation or de-activation). Also an analysis of accuracy increase and latency reduction both between and within therapy sessions could be very informative in illuminating naming improvement patterns in aphasia e.g. speed being reduced up to a certain presentation and then reaching a plateau. Furthermore, an analysis of individual data could be conducted, yet more data from each aphasia subtype would need in order to produce reliable results (see also below for need of larger dataset).

One of the potential interpretations for the equal effectiveness of SP and RISP in promoting the use of trained items in neurotypical participants’ connected speech was the repetition of the picture description task by the same participants in two different studies (Chapter 3 and 4) (possible picture description priming effect). Furthermore, it has been found in the clinical studies (Chapter 5 and 6) that untreated items were more
efficiently retrieved in post-treatment picture descriptions and that the use of untreated items in descriptions continued to increase from the immediate post-treatment assessment to the follow-up assessment (especially for the RISP items). A meta-analysis of the two baseline assessments including the same picture description task (Chapters 5 and 6) could possibly shed more light on the picture description repetition priming effect, yet future research will need to better delineate the potential priming of picture descriptions by the same task i.e. picture description repetition priming even when conducted with a long break in between (i.e. from minutes for neurotypical participants to weeks/months for participants with aphasia).

Despite the strong group effects which support the robustness of the results in this thesis, the findings must still be considered tentative, due to the relatively low number of participants. Further research is required to determine the applicability of the results to more participants with different aphasia subtypes or aphasia severity in clinical settings. Furthermore, development of the theme of ‘gamification’ can be undertaken so that RISP can be more easily presented via computer and therefore more effectively administered to a larger set of participants. When more data are obtained, a comparison between the different types of aphasic individuals and the non-brain damaged individuals can also be made in order to obtain reference data for the different populations (Chapey, 2001). Finally, a larger dataset could support a more powerful analysis for investigating a possible correlation between baseline linguistic and cognitive skills, baseline word retrieval impairment (in naming and connected speech) and therapy benefit. That is, it is important to ascertain which individuals (with certain baseline scores) benefit most from each intervention (SP and RISP), as well as for whom the benefits are most enduring. For example, Crerar (2004) pointed to the correlation between the severity of the impairment and the post-therapy speed of patients’ speech (the slower the patients had been initially, the more their speed decreased). Similarly, the findings of another study (Lambon Ralph et al., 2010), which suggested that, among others (comprehension & phonology), measures of naming at the baseline are likely to predict the therapy outcome, could be replicated or extended.

Furthermore, RISP treatment’s increased generalisation effect for both treated and untreated items across elicitation contexts may reflect a number of different factors, not directly related to the outcome measures (i.e. confrontation naming accuracy and speed) of the tasks. RISP’s efficiency could also be attributed to other neurobiological and cognitive factors. More specifically, beating the beep was challenging and
simultaneously rewarding, and hence it potentially triggered psychological chemicals of 
excitement and satisfaction like dopamine (Fiorillo, 2013; Morita et al., 2013; Foerde et 
al., 2015). The increased ‘carry over’ of the RISP items to connected speech could also 
be attributed to the effectiveness of the RISP method in improving participants’ 
cognitive skills i.e. improved control mechanism of suppression, perceptual and 
attentional components (greater sustained attention and vigilance), and memory skills. 

The studies presented in the thesis are the first to explore these ideas. Further 
research is necessary to better delineate the essence of the speed benefit and therefore 
clarify the relation between efficient speech production and speed of naming or 
executive control and other cognitive factors in aphasia. Understanding how the lexical 
system is affected by the speed manipulation has both theoretical implications for 
models of lexical processing (both for neurologically intact and aphasic individuals) and 
practical implications for clinical management. For example, participants with aphasia 
can be trained to be quicker at the conduction of a non linguistic task (e.g. memory or 
attention task) and then investigate if the cognitive benefit can be reflected to their 
speech.

Moreover, given that the various contexts are responsible for diverse results 
when measuring word retrieval in connected speech (Conroy et al, 2009d; Croot et al., 
2014), connected speech samples can be collected in various conditions and a 
comparison of the performance in each of them can be made. Future studies can employ 
not only a picture description task (picture-supported narratives) as we did in the thesis 
studies, but they can also use a story completion method (supported retelling part of a 
story. Additionally, connected speech samples can be obtained through a less directive, 
unsupported retelling either of a more open-ended narrative e.g. retelling the Cinderella 
story or a story from a popular film (Saffran, Berndt, & Schwartz, 1989). What all these 
conditions have in common is that they ensure the elicitation of highly constrained 
samples of connected speech, appropriate to be objectively time measured, and with the 
target words being relatively restricted in narrow ranges (Conroy et al, 2009d). Given 
this restriction, completely non-directive elicitation means, such as sampling 
conversational data (Perkins et al., 1999), should better be avoided because they pose 
methodological limitations e.g. imprecise measures of conversation word retrieval 
(Mayer & Murray, 2003).

The thesis also investigated the effect of speed manipulation on picture naming, 
generalisation to untreated items and ‘carry-over’ to connected speech for nouns. It
would be both theoretically interesting and clinically relevant to extend this research to the other main word classes of verbs, adjectives and adverbs. Moreover, the linguistic properties for both nouns (e.g. simple words vs. derived words vs. compound words, animate vs. inanimate, concrete vs. abstract etc) and verbs (e.g. number or arguments related to the target item, motion verbs, change of state verbs etc) can be further taken into account. Extending the thesis findings especially to verbs appears to be of major importance if we consider verbs’ critical role in sentence production and thus in connected speech (lexical hypothesis of agrammatic speech, Saffran et al., 1980) (Marshall et al., 1998; Bastiaanse et al., 2003). Furthermore, using errorless learning techniques, we can minimise the requirement for executive control and the cognitive demands required for verb processing (Conroy et al, 2009a), and therefore RISP that adopts errorless techniques could prove even more effective for verb rather noun manipulation/treatment for neurotypical participants/participants with aphasia.

Finally, a central finding in the thesis was that participants with aphasia benefited from RISP therapy more than neurotypical participants in carrying over the confrontation naming improvement to connected speech. Given that the main difference between the two populations is the severity of their word finding difficulties (i.e. complications in word retrieval for participants with aphasia while neurotypical participants’ lexical access in connected speech was not exceedingly demanding), it would be noteworthy to replicate these findings with bilinguals (bilingual neurotypical participants or bilinguals with aphasia), who have poorer naming scores than monolinguals in both of their languages either when they have to name pictures obtained from the Boston Naming Test (Kohnert, Hernandez, & Bates, 1998; Roberts, Garcia, Desrochers, & Hernandez, 2002; Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007) or when they perform verbal fluency tasks (Rosselli et al., 2000; Gollan, Montoya, & Werner, 2002; Portocarrero, Burright, & Donovick, 2007). The bilingual disadvantage in word retrieval was also indicated in studies reporting that bilinguals are confronted with much more tip-of-the-tongue states (TOTs) comparing to monolinguals (Gollan & Silverberg, 2001; Gollan & Acenas, 2004). Regarding the variable of speed in picture naming, bilinguals were found to be not only less accurate than monolinguals but they also presented longer naming latencies, even in their dominant language (Gollan, Montoya, Fennema-Notestine, & Morris, 2005). The bilingual difficulty in word retrieval during speech production both in their non-dominant and their dominant language combined with our findings suggests that speed manipulation can be more
critical for bilinguals in deciding whether to produce an item or not in connected speech (e.g. when describing a picture). More specifically, speed of word retrieval can be crucial for vocabulary learning in neurotypical bilinguals and clinically important for treatment in bilingual aphasia, in terms of within-language generalisation, generalisation from picture naming to spontaneous speech, and cross-linguistic generalisation (i.e. improvement in lexical retrieval in the untrained language, over an established baseline, Edmonds, & Kiran, 2006; Kohnert, 2009).
References


Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14*(1), 177-208.


Appendices
Appendix 1: Composite pictures for picture description task

Picture A. Where’s Fenton.

![Appendix 1: Composite pictures for picture description task](image)

Picture B. Where’s Waldo.
Picture C. Where’s Fenton.

Picture D. Where’s Wally.
**Picture E.** Where’s Waldo

**Picture F.** Where’s Fenton.
Appendix 2: Examples of stimuli for therapy/picture naming task
Appendix 3: Means and SDs for each of the matching variables (n = 6) and statistical confirmation (t-test) of the matching of sets (n = 2) (Chapter 4 study)

<table>
<thead>
<tr>
<th>Chapter 4 study</th>
<th>Mean S1</th>
<th>Mean S2</th>
<th>SD S1</th>
<th>SD S2</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pic. Naming Accuracy</td>
<td>19.55</td>
<td>20.02</td>
<td>5.63</td>
<td>4.65</td>
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<tr>
<td>Pic. Naming Speed</td>
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<td>280</td>
<td>257</td>
<td>0.55</td>
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<tr>
<td>Pic. Description Accuracy</td>
<td>11.97</td>
<td>11.85</td>
<td>7.10</td>
<td>7.47</td>
<td>0.64</td>
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<tr>
<td>Pic. Description Speed</td>
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<td>158</td>
<td>52</td>
<td>57</td>
<td>0.25</td>
</tr>
<tr>
<td>Frequency</td>
<td>1390</td>
<td>1338</td>
<td>2274</td>
<td>2249</td>
<td>0.74</td>
</tr>
<tr>
<td>Length</td>
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<td>5.9</td>
<td>1.78</td>
<td>2.01</td>
<td>0.44</td>
</tr>
</tbody>
</table>

S1 = Set 1, S2 = Set 2, SD = Standard Deviation, Accuracy max. = 24, Picture Naming Speed in msec, Picture Description Speed in sec, t-test (2 tailed, paired t-test) = p-value for single comparison between two sets. All t-test values were > .05 (i.e. matching confirmed).
Appendix 4: Means and SDs for each of the matching variables (n = 3) and statistical confirmation (t-test) of the matching of sets (n = 4) (Chapter 5 & 6 studies)

<table>
<thead>
<tr>
<th>Chapter 5 &amp; 6 studies</th>
<th>Mean S1</th>
<th>Mean S2</th>
<th>Mean S3</th>
<th>Mean S4</th>
<th>SD S1</th>
<th>SD S2</th>
<th>SD S3</th>
<th>SD S4</th>
<th>t-test</th>
</tr>
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<tbody>
<tr>
<td><strong>No of Subjects</strong></td>
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<td>5.7</td>
<td>6.1</td>
<td>6.1</td>
<td>2.3</td>
<td>2.1</td>
<td>2.3</td>
<td>2.2</td>
<td>0.33</td>
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<tr>
<td><strong>Frequency</strong></td>
<td>646</td>
<td>673</td>
<td>616</td>
<td>666</td>
<td>826</td>
<td>905</td>
<td>860</td>
<td>933</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>5.9</td>
<td>6.2</td>
<td>6.4</td>
<td>6.4</td>
<td>2.4</td>
<td>1.9</td>
<td>2.2</td>
<td>2.6</td>
<td>0.57</td>
</tr>
</tbody>
</table>

S1 = Set 1, S2 = Set 2, S3 = Set 3, S4 = Set 4, SD = Standard Deviation, No = Number, No of Subjects max. = 10, t-test = p-value/mean of multiple comparisons across all four sets. All t-test values were > .05 (i.e. matching confirmed).
Appendix 5: Questionnaire questions on therapy effectiveness

Did you find that the two therapies were engaging/interesting/did they capture your attention? Did you find one more engaging?

Did you find that the two therapies were challenging/demanding? Did you find one more challenging?

Did you find that the two therapies were stressful/induce stress? Did you find one more stressful?

Did you find that the two therapies improved your naming/helped you to find words?

Did you find that the two therapies improved your speech/helped you to use more easily words in your everyday speech after the therapy? Do you feel that your speech improved after the therapy?

Did you enjoy/like the two therapies? Did you enjoy one more than the other?