DOCTOR OF PHILOSOPHY

Bilingual Lexical Processing

Evidence from picture naming andtranslation in aphasic and non-aphasic speakers

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Bilingual Lexical Processing: Evidence from picture naming and translation in aphasic and non-aphasic speakers

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Abstract

The question of how words from different languages are represented and accessed in bilingual speakers is the focus of much debate in the psycholinguistic literature. In this thesis, we aimed to contribute to a better understanding of the processes that underlie naming and translation abilities in bilingual speakers. Our goals were 1) to clarify the role of cognateness across tasks, languages and populations in relation to interactive activation models of bilingual lexical production and 2) to evaluate models that posit direct lexical links between words in two languages by examining the extent of semantic involvement across tasks. These questions were studied by collecting converging evidence from younger and older neurologically healthy participants and from brain-damaged participants with word finding deficits. The key results are as follows: 1) In healthy participants, robust cognate facilitation effects were present across tasks, languages and age groups. 2) Cognate effects were stronger in translation than in naming in healthy participants. 3) In aphasic participants, a consistent cognate advantage was observed when naming pictures in the weaker language, but less so when naming pictures in the strongest language or in translation. 4) Treating words in one language generalised to cognate words, with some generalisation to untreated tasks. 5) Aphasic participants produced fewer semantic errors in translation than in naming. Overall, this study clarifies the role of cognateness in bilingual language production. It is the first to examine cognateness effects in a within-subject design, using the same stimuli across tasks and participant groups in an attempt to resolve some of the inconsistencies in prior

research, which may be related to variations in experimental protocols across studies. It is also the first to use converging evidence from aphasia in an integrated study. Our findings support interactive activation models of the bilingual lexicon and dual-route models of translation.

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THESIS OVERVIEW

This thesis is concerned with the interaction of bilingual speakers' two languages. The investigation consists of four experimental studies, the overall goal of which is to contribute to our understanding of bilingual lexical processing, and to clarify the role of cognateness across tasks, languages and populations in relation to interactive activation models of bilingual lexical production. We also aimed to evaluate the extent of semantic involvement across tasks in order to determine the existence and functionality of direct lexical links between languages.

The first introductory chapter presents models of monolingual and bilingual spoken word production. The second chapter is a review of the assessment and treatment of spoken language disorders in both monolingual and bilingual speakers.

Chapter 3 explores bilingual spoken word production in neurologically healthy participants. This study investigated picture naming and word translation in neurologically healthy younger and older Welsh-English bilingual participants, with supporting evidence from English naming in age-matched monolingual control participants. It contrasts accuracy and reaction times in cognate and non-cognate stimuli, as well as the effect of age on the strength of the bilingual disadvantage in lexical processing.

Chapter 4 investigates the reliability of the cognate advantage in bilingual aphasia. This study measured the effect of cognate status on accuracy on picture naming and translation with a group of Welsh-English bilingual aphasic participants.

Chapter 5 presents an investigation of lexical processing in aphasic bilingual speakers, and more specifically the end the existence and functionality of direct lexical links between languages, with evidence from the incidence of semantic errors in picture naming and translation data from Welsh-English bilingual aphasic participants.

Chapter 6, the final experimental chapter, describes the outcome of a spoken naming treatment for bilingual anomia. We investigated whether transfer of treatment effects would occur following Welsh-English bilingual naming therapy using a sentence completion and phonological cueing treatment protocol, with decreasing rather than increasing cues. The effect of cognate words on change in treated items and on cross-language transfer was investigated. This study also explored the transfer of treatment effects to the untreated tasks of reading aloud and translation.

The final chapter comprises a discussion of the findings of the experimental chapters. The overall findings are discussed with regard to the hypotheses, and findings from the literature on normal and impaired bilingual language production. Implications for clinical provision of bilingual naming impairments are presented, as well as how the findings impact models of bilingual lexical processing.

INTRODUCTION

The present thesis is an investigation into the nature of lexical processing in bilingual speakers, with a focus on evidence from acquired language impairment. The processes involved in spoken language production can be described in terms of a network of levels, with connections between processing components.

Extensive research exists concerning the processes involved in monolingual language production, and the optimum way to treat different language disorders in monolingual people.

However, over half of the world's population speaks more than one language (Ansaldo, Marcotte, Scherer & Raboyeau, 2008, Faroqi-Shah, Frymark, Mullen & Wang, 2010), and yet the representation and organisation of bilingual speakers' languages is not yet fully understood. Grosjean (1992, p.51) defined bilingual speakers as 'those people who need and use two (or more) languages in their everyday lives'. The language needs of bilingual speakers become more complex following neurological damage such as stroke, which can result in aphasia. Moreover, investigations of impaired language can contribute to the development of cognitive neuropsychological models of lexical processing (Weekes & Raman, 2008). Understanding the extent to which the mechanisms of lexical processing are linked and separate can enable more precise diagnosis of language disorders, with the aim of focusing treatment at the appropriate level of breakdown.

Aphasia is an impairment that can affect a wide range of language skills including the comprehension and production of words and sentences. Anomia is a particular sub-type of aphasia and is a deficit of expressive language, characterised by an often frustrating and debilitating impairment of word-retrieval (Goodglass, 1993). With growing incidence of both stroke and bilingualism, Speech and Language Therapists are more likely to encounter increasing numbers of bilingual people with anomia (Faroqi-Shah et al., 2010, Marrero, Golden & Espe-Pfeifer, 2002). Bilingual anomia is therefore a subject that merits further investigation. However, to date, no conclusions have been reached as to the optimum treatment strategies for bilingual anomia, or to what extent generalisation occurs within and between languages as a result of treatment, and under what circumstances this generalisation occurs.

This thesis explores the ways in which the languages of bilingual speakers interact, with evidence from picture naming and translation tasks, and the outcome of bilingual anomia treatment. We put to test predictions of bilingual models of lexical processing, to evaluate the nature of bilingual lexical interaction, including the effect of cognate status on bilingual lexical processing across tasks and populations, and the existence and functionality of direct lexical links between languages.

A further focus will examine the robustness of the cognate advantage in impaired bilingual lexical processing, and the implications this has for cross-language generalisation of treatment effects in bilingual anomia.

Finally, we attempt to integrate established models of bilingual lexical processing in order to provide a full account of our findings across tasks, languages and populations.

The introductory chapters that follow present models of monolingual and bilingual lexical processing, following by a review of anomia and its treatment in monolingual and bilingual speakers.

CHAPTER 1: MODELS OF MONOLINGUAL AND BILINGUAL LEXICAL PROCESSING

CHAPTER 1: MODELS OF MONOLINGUAL AND BILINGUAL LEXICAL PROCESSING

1.1 Introduction

The current chapter presents a review of cognitive neuropsychological models of monolingual and bilingual lexical processing

The basic assumptions of cognitive neuropsychological models include *modularity*, i.e. that cognitive functions rely on the coordinated activity of separate and discrete cognitive processes, and *neurological specificity*, that individual cognitive processes can be damaged independently of one another (Hillis & Caramazza, 1991). Studying language impairments can help to highlight the processes that are impaired by lesions in particular brain areas, as well as indicating associations and dissociations between linguistic processes (Dell, Schwartz, Martin, Saffran & Gagnon, 1997).

Theories of bilingual word processing build on and extrapolate from existing theories of word processing in monolinguals. For this reason, it is first necessary to briefly introduce models of monolingual naming, before a discussion of the bilingual equivalents. Cognitive neuropsychological models of naming separate the language system into a series of stages and pathways, which are linked but distinct from one another (e.g. Dell, 1986). This means that while each stage of the model (e.g. the semantic system) has direct links with the next (e.g. the phonological lexicon) it is possible for neurological impairment to result in damage to only one part of the language system, while the rest remains intact. Understanding the extent to which levels and pathways in these models are separate can enable more precise diagnosis of language disorders such as aphasia, with the aim of focusing treatment at the appropriate level of breakdown. Several types of language processing models exist, and these will be discussed below, with respect to normal language processing, and to bilingualism and aphasia in the following chapters.

1.2. Models of spoken word production

1.2.1 Models of monolingual spoken word production

When considering language production models, there are several questions that remain unanswered to differing degrees. These include the number of different levels in speech production, and how, if at all, the different levels interact with each other. Most models of naming make a distinction between a word's meaning, and its lexical form, whether phonological or orthographic (Desmet & Duyck, 2007). In terms of lexical selection, the process of how the correct lexical node is selected from amongst competitors is a focus of research, as is the question of whether non-selected lexical nodes and phonological representations interfere with lexical access during speech production (Costa, Colomé & Caramazza, 2000).

The process of picture naming is typically used in models of word production as it involves most elements of the naming process on a simplified level (Costa, et al, 2000). The assumption of most cognitive neuropsychological models of speech processing (e.g. Caramazza, 1997; Dell, 1986; Levelt, Roelofs & Meyer, 1999; Roelofs, Meyer & Levelt, 1998) is that naming a visual stimulus requires access to at least three comparatively independent levels of representation. The speaker initially recognises the target and selects the correct semantic representation (the meaning) of the message they want to convey (e.g. *DOG*). In the next stage of lexical access, the semantic representation of the target word sends activation to the lexical layer, activating a set of semantically related nodes (e.g. *dog, cat, rat*). The lexical unit with the highest activation level is selected from a set of competing activated units. In normal language production this is typically the target word. Following lexical selection, the phonological properties of the word are retrieved (Costa et al., 2000). Beyond these agreed features, most speech processing models differ as to the exact nature of the process. The varying features and proponents of different accounts will be discussed below.

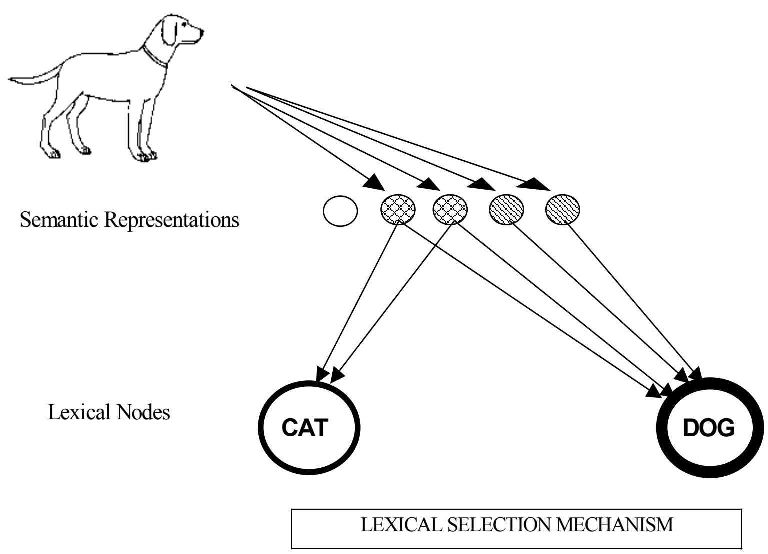


Figure 1.1. Schematic representation of spreading activation during picture naming. From Costa et al 2000.

One area where there is general consensus is that of spreading activation (Dell, 1986, Dell et al, 1997). During lexical access it is hypothesised that several semantic representations are activated that are semantically related to the target. See Figure 1.1. for a visual schematic of this process. The exact way this occurs differs between models. For example, Levelt's (1989) model proposes that activation of a conceptual node spreads activation to other associated nodes (e.g. *DOG* activates *cat, fish, mouse* etc.). Semantically related words are activated because they are connected to each other. Conversely, Dell et al's (1997) model hypothesises that word production consists of a number of connected nodes that represent distinct speech units of speech (i.e. concepts, morphemes and phonemes) that interact with one another in any direction, from the semantic representations to lexical representations on to the phonological level. The model conceives of concepts as a grouping of features (e.g. DOG= animal, furry, canine). Therefore, when a concept is activated, related concepts (e.g. CAT) which share common semantic features (e.g. animal, furry) with the target are also activated, as they share common nodes within the semantic network.

A further distinction is made between models of naming in terms of whether access to word forms necessarily requires activation of the word's syntactic features or not. The syntactic mediation hypothesis proposes that activation of a word's phonological form requires prior activation of lexical-syntactic features (e.g. Dell, 1990; Roelofs, 1992). Caramazza (1997) proposes an alternative to the syntactic-mediation models, the Independent Network (IN) model. In the IN model lexical-semantic representations are independent of syntactic and word form information and word forms can be accessed directly from the conceptual level. This is evidenced by demonstrations by patients with double dissociations in the ability to retrieve information about the syntactic properties of a word and the ability to retrieve their phonological features. However, Caramazza (1997) concedes that syntactic retrieval is a necessary part of word retrieval and both models propose the existence of semantic, word-form and phonological levels of processing. Both models are illustrated below, in Figure 1.2.

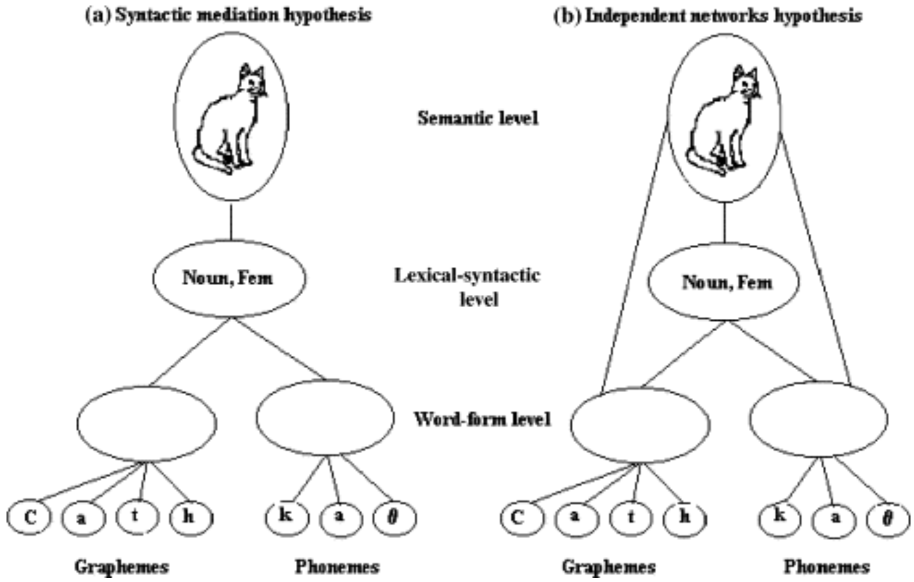


Figure 1.2: the Syntactic Mediation and Independent Networks hypotheses (image from Leek, Wyn & Tainturier, 2003).

Another aspect where cognitive neuropsychological models of naming differ is in terms of the nature of activation following the conceptual level. There is general agreement that during lexical access several semantic representations are activated that are semantically related to the target word. However, in discrete activation models, (e.g. Levelt, 1989), only the selected lexical node sends activation to the next stage of processing. Therefore unselected semantic competitors are not activated at the phonological level. Also, in discrete serial models, each stage is strictly serial, that is, information at the phonological level is not activated until after the lexical target has been selected (Levelt, 1989), and information can only flow forward from the conceptual level to the lexical level and so on.

In contrast, in cascaded activation models (e.g. Costa et al., 2000, Dell & O-Seaghdha 1992), activation flows continuously between the lexical and phonological stages in proportion to the level of activation of each lexical node (Costa et al, 2000). Thus, all activated nodes at the lexical stage activate the corresponding phonological nodes, regardless of whether they are selected as the target, and this occurs before lexical selection is completed (Costa et al, 2000). Cascaded models can either have forward only or both forward and backward (interactive) activation. (e.g. Dell et al., 1997). Dell et al.'s 1997 Interactive Activation model proposes separate semantic, word form and phonological levels, employing bi-directional spreading activation between levels. Within a single level, several competitors are activated in response to activation from an adjacent level, with the node that receives the highest level of activation being selected.

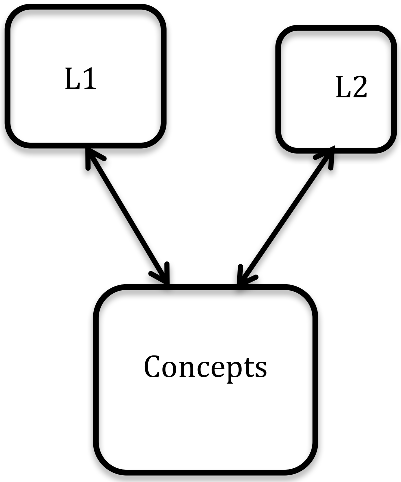
Evidence for interactive activation comes from a variety of sources, including mixed errors in naming (Levelt, 1999), which combine the phonological and semantic properties of the target word (e.g. CAT- *rat*), These mixed errors suggest that once erroneous phonological properties have been selected at the phonological level, this information is then 'fed back' to the lexical layer, resulting in a mixed semantic-phonological error type (Dell et al, 1997).

Monolingual models of naming have been used as a basis for the development of bilingual models of language processing. As will be discussed below, bilingual studies of picture naming also provide evidence in favour of a cascaded, interactive model of activation.

1.2.2. Models of bilingual spoken word production

The interaction of two or more languages complicates the issue of language processing, giving rise to further questions in comparison to monolingual language production. Much of the literature on bilingual language processing to date has been concerned with the nature of the bilingual lexicon. This relates to how separate languages are represented at different processing levels, and the extent to which they interact at different levels. Most models of bilingual naming propose that bilingual speakers have conceptual representations that are shared across languages, with separation of representations at the lexical level (e.g. Costa et al., 2000; Costa, Miozzo & Caramazza, 1999; Dufour & Kroll, 1995; Potter, So, von Eckardt & Feldman, 1984). The earliest of these models attempted to explain the nature of the connections between a bilingual speaker's semantic and lexical systems.

Two early hypotheses concerning the lexical links between bilinguals' two languages are depicted in Figure 1.3 below. The first is the *concept mediation* hypothesis, in which the lexicons for a speaker's L1 and L2 both have direct access to the conceptual store. The second is the *word association* hypothesis, in which the L2 accesses the conceptual store via the L1 lexical representations (Potter et al., 1984). The lexical links in the word association model are hypothesised to be stronger from a bilingual's weaker language (L2) to the stronger language (L1), as language learning in L2 is typically built upon existing L1 vocabulary, particularly in late L2 learners. The smaller box for L2 reflects the typically smaller vocabulary of second language learners.



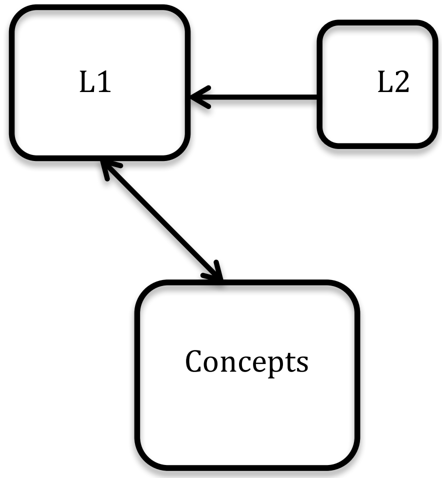


Fig.1.3. *Concept Mediation Hypothesis* *Word Association Hypothesis*
(Potter, So, Von Eckardt, & Feldman, 1984)

Potter et al (1984) found no difference in reaction times in word naming and translation, which they suggest indicates that a bilingual speaker accesses each lexicon directly from the conceptual store, with no direct lexical links between languages. They suggested that this provided evidence for the conceptual mediation hypothesis, with no direct lexical links between languages in bilingual word processing even at low levels of L2 proficiency.

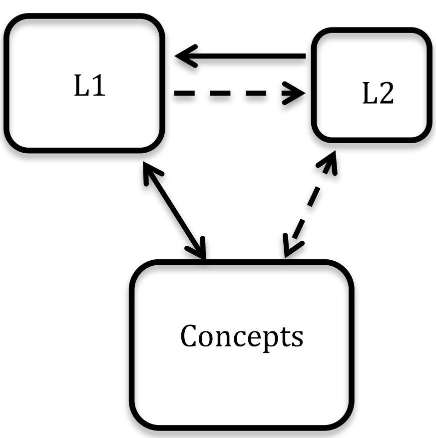


Figure 1.4: Kroll & Stewart's Revised Hierarchical Model (1994)

Kroll & Stewart's (1994) Revised Hierarchical Model (depicted in Figure 1.5.) built on the *concept mediation* and *word association* hypotheses, postulating shared semantic representations and separate lexical stores for each language, with direct but asymmetrical connections between each lexical store and the conceptual store. Each language has direct access to semantic representations, as well as a connection between the two languages' lexical stores. The theory further suggests that initially, at lower proficiency levels, a speaker accesses L2 word meanings from the conceptual store via the L1, but with increased proficiency the conceptual store can be directly accessed from the L2 lexicon. The asymmetry lies in the connections from the concept store to lexical representations and vice-versa. This means that lower-proficiency L2 speakers can easily access concepts from words, but accessing the same words from the concepts is more difficult, as the majority of L2 learners learn new words for concepts via words in the L1. (Kroll, Van Hell, Tokowicz & Green, 2010). According to this model, forward translation (L1-L2) takes place via the conceptual route, accessing semantic information, but backward translation (L2-L1) may take place via direct lexical links, at least at low levels of L2 proficiency. These direct lexical links have been hypothesised to diminish in normal language processing, as L2 proficiency improves, and the link from the L2 lexicon to conceptual representation strengthens.

The nature, functionality and strength of these direct lexical links has been the subject of some debate, with some calling into question their existence at all in proficient bilinguals (e.g. Potter et al, 1984). Kroll & Stewart (1994) compared translation in semantically categorised and randomised word lists in Dutch-English bilinguals. They observed a semantic interference effect in forward (L1-L2) translation when words were presented in categorised lists, suggesting that translation in this direction is conceptually mediated. This effect of categorisation was absent in the same participants when performing backward translation (L2-L1), from which Kroll & Stewart concluded that translation, in that instance was taking place via direct lexical links, and bypassing conceptual activation. Furthermore, translation from L2 to L1 was faster than the other way around, supporting the hypothesis that it took place via direct lexical connections and did not require conceptual activation.

Sholl, Sankaranarayanan & Kroll (1995) also observed facilitation of L1-L2 translation following picture naming of the same items in both languages. However, they did not observe the same priming effects for L2-L1 translation, which the authors suggest indicates lexical mediation of L2-L1 translation. De Groot, Dannenburg & Van Hell (1994) investigated the effect of semantic variables on translation speed, and found that characteristics such as imageability influenced forward (L1-L2) more than backward (L2-L1) translation. Sanchez-Casas, Garcia-Albea & Davis (1992) also observed slower translation for non-cognates from L1-L2 than vice-versa, though they observed no effect of translation direction for cognate items, which the authors interpret as evidence that cognate words share common lexical representations.

However, subsequent investigation has revealed mixed patterns of conceptual involvement in translation. De Groot & Poot, (1997) observed slower backward than forward translation in for three groups of Dutch-English bilingual participants, at varying levels of L2 proficiency. La Heij , Hooglander, Kerling & Van der Velden (1996) also observed slower backward than forward translation in Dutch-English bilinguals in a translation task investigating the effect of word-picture congruency on translation. They also found that participants translated words more quickly when accompanied by a congruent picture (i.e. the word SHARK accompanied by a picture of a shark) as opposed to an incongruent picture (i.e. the word SHARK accompanied by a picture of a carrot). This effect was greater in backward than in forward translation, which the authors suggest indicates a greater involvement of the semantic system in backward translation. It is important to note however that the inclusion of pictures in the task may have artificially boosted the involvement of the semantic system in the translation task.

To summarise, the extent of the involvement of the semantic system in translation is as yet inconclusive, and may vary as a function of language fluency, translation direction, and word type. This issue is addressed experimentally with Welsh-English bilingual participants with aphasia in Chapter 5 of this thesis.

1.3. Lexical activation in bilingual word production

In monolingual word production a number of lexical nodes are activated following conceptual activation, and it is hypothesised that a lexical selection mechanism is required to select the node with the highest level of activation (Costa et al, 2000). In bilingual word production the existence of separate lexical representations linked to a single, shared conceptual representation leads to the question of how bilinguals consistently manage to select the correct word in the target language.

The first question to consider is whether semantic activation results in the simultaneous activation of both lexicons of a bilingual speaker, or whether activation only extends to the language in use. In general it is thought that the semantic system does activate both lexicons (e.g. Colomé, 2001; Costa et al, 2000). For example, Colomé (2001) conducted a study in which Catalan-Spanish bilinguals decided whether a particular phoneme was part of the Catalan name of a target picture. The phonemes in question were either part of the Catalan name, its translation, or in neither. Reaction times were slower when phonemes were part of the Spanish name, indicating that the phonological representations of both languages are activated during monolingual tasks. Wu, Cristino, Thierry & Leek (2013) employed an eye-tracking paradigm to investigate whether non-target language lexical representations were activated during a task that did not require overt lexical processing. They found that Chinese-English bilingual participants looked more frequently and for greater duration at trials that included cross-language phonological overlap, indicating language non-selective lexical activation.

Secondly, following activation of lexical representations, there are two theories concerning how bilingual speakers avoid selecting the lexical representation in the non-target language. The first of these theories is that language selection is non-specific: words from both languages are considered for selection during naming and the lexical representation with the highest activation is selected. According to the language non-specific theory, lexical nodes in the non-target language act as lexical competitors in the same way as semantically related nodes within the target language. An inhibitory mechanism suppresses activation of the non-target language during word production, thus usually ensuring that the lexical representation in the correct language is selected (e.g. de Bot, 1992; Green, 1998).

The second, language specific, proposal is that nodes in both languages are activated by a stimulus, but that the lexical selection mechanism only considers activation of nodes from the target language (e.g. Costa & Caramazza, 1999; Costa, Miozzo & Caramazza, 1999). The language-specific theory posits that non-target language nodes do not compete during lexical selection as, although they are activated, they are not considered by the lexical selection mechanism. A further question on how lexical processing takes place arises when considering the effect of cognate status.

1.4. The effect of cognate status on bilingual lexical processing

Cognate words are translation equivalents which share the same meaning and overlapping orthographic-phonological form across two languages (e.g. English: *lamp/* Spanish*: lampara*, Costa et al., 2000). Several studies have observed faster processing for cognate words than non-cognate words (e.g. Costa et al, 2000; De Groot, Dannenburg & Van Hell, 1994; Hristova & Janyan, 2008; Kroll & Stewart, 1994; Rosselli, Ardila, Jurado & Salvatierra, 2012). This advantage for cognate words has been found to occur across a range of tasks, in both expressive and receptive language. For example, Costa et al (2000) found that Spanish-Catalan bilinguals named cognate words more quickly than non-cognates in both languages, whereas monolingual participants showed no difference in reaction times. A further experiment revealed a greater effect for cognate words in the participants' non-dominant language. Blumenfeld & Marian (2005) used an eye-tracking paradigm in a word identification study with German-English and found that L2 translation words were activated when the L1 target was a cognate word, but not when it was a non-cognate. The effect was stronger from L1-L2, suggesting differential effects of proficiency in parallel language activation.

Costa, Santesteban & Caño (2005) suggest that lexical retrieval is facilitated for cognates over non-cognates because the cognate word's phonological representation is activated both from the target word and its translation, which they term the cognate facilitation effect. This hypothesis is based on an interactive model of language processing such as the Interactive Activation model (Dell et al, 1997) in which lexical selection is achieved by activation from both the semantic level, and feedback from the phonological level. In the case of bilingual processing of cognates, phonological information about the non-selected items in the non-target language is 'fed back' to the lexical semantic level. Non-cognates would not receive feedback from the phonological level. See Figure 1.5. for an illustration of the cognate facilitation effect. Cascaded models predict a cognate facilitation effect because the phonological features of the target word are activated in both languages during naming, whereas discrete, feed-forward models predict that phonological activation is restricted to the target word only, with no competitors receiving activation following selection at the conceptual level.

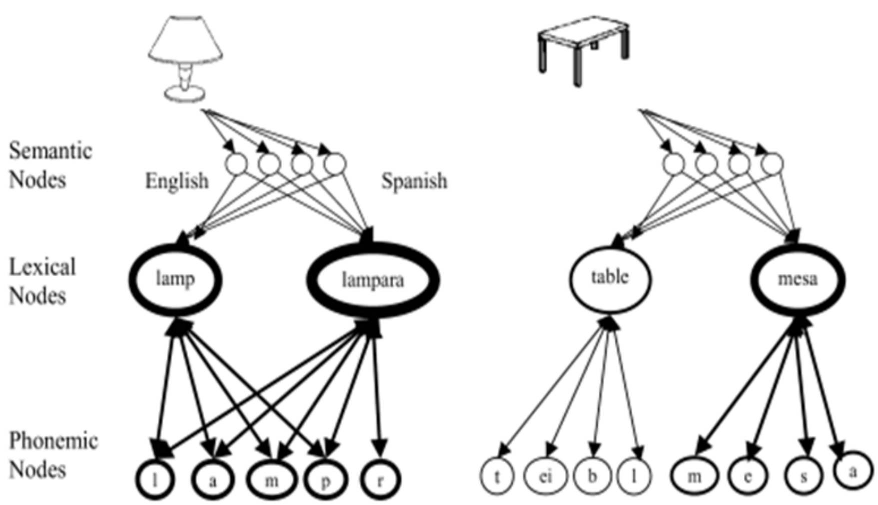


Figure 1.5: Illustration of the cognate facilitation effect (from Costa et al, 2005)

Spalek, Hoshino, Wu, Damian & Thierry (2014) observed activation of L1 phonology during L2 naming in German-English bilinguals using an ERP protocol, even though the task was carried out exclusively in English. In a naming task in English (L2) they showed significant within language phonological priming (e.g., green goat) and, critically, cross-language phonological priming when the onset of the German translation of the target picture overlapped with the adjective that preceded it (e.g., *red skirt- roter Rock*). These findings indicate that phonological representations in both languages are activated during naming in one language only, providing support for the above theory of the origin of the cognate facilitation effect.

Costa et al (2005) suggest that the cognate facilitation effect is in fact similar to a phonological neighbourhood effect. That is, if a word has many phonologically similar neighbours in the same language (e.g. cat, cap, car, can, hat, mat, bat) it is generally named more quickly and easily than a word of comparable frequency which does not have many phonological neighbours. This applies to cognate words, in that a cognate word receives activation from its translation equivalent at both lexical and sublexical levels, based on shared semantic and phonemic features, but non-cognates are only activated by their translation equivalents based on their semantic features. They suggest that this phonological overlap, whether within or across languages, has a facilitative effect on lexical activation.

It has been suggested that the cognate advantage does not remain constant through the lifespan. Siyambalapitiya, Chenery & Copland (2009) found that younger bilinguals experienced a cognate advantage in a priming task, but in older bilinguals the presence of a cognate prime resulted in longer reaction times in naming. This suggests that in older adult bilinguals, cognates cause interference as the individual is forced to choose between two alternatives for naming. The cognate advantage has also been found to be less robust in bilingual aphasic speakers. While several studies have observed a cognate advantage (e.g. Roberts & Deslauriers 1999), others have observed more limited facilitation effects for cognates (e.g. Hernandez, Costa, Caño, Juncadella & Gascón-Bayarri, 2010; Lalor & Kirsner, 2001; Siyambalapitiya, Chenery & Copland, 2013).

The cognate status of words has implications for treatment of language impairments such as anomia. The treatment of cognates has been the focus of several recent studies in the bilingual aphasia literature (Kohnert, 2004; Kurland & Falcon, 2011; Goral, Rosas, Conner, Maul & Obler, 2012), with several studies investigating the effect of cognateness on cross-linguistic generalisation of treatment. The results have been mixed, with some studies reporting greater generalisation for cognates than non-cognates, and others finding no such benefit. The findings of Siyambalapitiya et al (2009) of a reduced cognate advantage in older adults may go some way towards explaining these mixed results.

To summarise, in general, bilingual speakers tend to process cognate words differently to non-cognate words across a variety of different receptive and expressive lexical tasks, as discussed above. This difference in processing cognates and non-cognates in bilingual speakers could either be considered as a 'cognate advantage' as cognates seem to be processed more easily by bilinguals, or as a 'non-cognate disadvantage', as bilingual speakers seem to be less accurate and slower at processing non-cognates than cognates. In keeping with the extensive literature on cognate processing in bilingual participants discussed above, this difference in processing speed and accuracy for cognate and non-cognate words will be referred to as a 'cognate advantage' in this thesis to describe the observed data. When referring to theoretical explanations of the origin of the cognate advantage, the term 'cognate facilitation effect' will be used, in line with the hypothesis of Costa et al (2005) presented above.

The effect of cognate status on bilingual lexical processing is addressed experimentally in 4 chapters of this thesis. Chapter 3 reports the effect of cognate status on picture naming and translation tasks in older and younger neurologically healthy Welsh-English bilingual participants, with control data from age-matched English monolingual participants. Chapter 4 is an investigation of the effect of cognate status on accuracy in the same tasks in a group of 8 neurologically impaired Welsh-English bilingual participants. Chapter 5 compares the extent of semantic mediation in non-cognate and cognate words in translation versus naming in the same neurologically impaired participants. Finally, Chapter 6 reports the outcome of errorless sentence and phonological cueing treatment in bilingual aphasia, with a focus on the effect of cognate status on generalisation to naming of untreated items and to the untreated tasks of reading aloud and translation.

CHAPTER 2: MONOLINGUAL AND BILINGUAL ANOMIA

CHAPTER 2: MONOLINGUAL AND BILINGUAL ANOMIA

The current chapter presents a review of anomia in monolingual and bilingual populations. The nature of anomia in monolingual speakers is discussed first, leading to a review of treatment studies in anomia. Specific attention is given to studies that explore the efficacy of cueing treatments, and errorless treatment of anomia. Investigation into outcomes following therapy for language impairments has implications not only for the development of clinically effective treatment methods, but can also further our understanding of the nature of language disorders, and subsequently, normal language processing.

The central focus of the chapter is bilingual aphasia treatment and the question of cross-language generalisation of treatment effects, and the effect of the cognate status of words on this generalisation. Bilingual aphasia and its treatment will be considered with regard to the cognitive neuropsychological models of naming presented in Chapter 1 of this thesis. Detailed assessment of language impairments prior to treatment is of great importance in developing a clear profile of intact and impaired language processes; patterns of impairment can be examined with regard to models of naming in order to support diagnoses. Such models have been used as a basis for tailoring treatment methods to particular impairment types, and to develop hypotheses for treatment outcomes, such as the likelihood of within- or between-language generalisation of treatment effects. These treatment outcomes may then be used to bolster and justify predictions made by various models of naming.

There is extensive research investigating anomia types and treatment outcomes in monolingual people with aphasia. However, the study of bilingual anomia and its treatment is less well developed, with varying outcomes reported in the literature. Furthermore, detailed investigations of how treatment effects transfer from one language to another, and the implications of this on bilingual lexical processing, are relatively few. From a clinical point of view, determining treatment outcomes on both of a bilingual's languages is critical, because no universal guidelines currently exist on the optimal way to treat bilingual aphasia (Kiran, Sandberg, Gray, Ascenso & Kester, 2012).

2.1. Anomia in monolingual populations

Aphasia refers to the loss of, or impairment to, the ability to comprehend and produce language as a result of brain damage. It can result in difficulty with all aspects of language, including spoken and written comprehension, speaking, and writing (Nickels, 2001).

Anomia, which is the focus of three experimental chapters in this thesis, refers to a specific impairment of spoken naming, whereby an individual cannot retrieve the label for a particular item they want to name. Word retrieval difficulty is one of the most common causes of communication breakdown in aphasia, and for aphasic individuals, can be one of the most debilitating and frustrating (Dell, Schwartz, Martin, Saffran & Gagnon, 1997; Lambon-Ralph, Snell, Fillingham, Conroy & Sage, 2010). The failure to retrieve a word can occur at different stages of the naming processes described in Chapter 1, and the stage at which the failure occurs can have implications for the particular difficulties an anomic individual may face, and for the types of errors they produce (Nickels, 2001).

As with lexical processing in unimpaired populations, naming ability in anomia is typically measured with picture naming tasks, as the intended target is relatively unambiguous, compared to spontaneous speech (Nickels, 2001) and success can therefore be more easily measured. Moreover, picture naming minimises opportunities for avoidance of difficult-to-access vocabulary, which, in connected speech, can mask more subtle naming impairments (Dell et al, 1997).

2.1.1. Patterns of impairment in anomia

As discussed in Chapter 1 of this thesis, models of word production in both monolingual and bilingual speakers incorporate separate levels, such as a semantic level for processing word meanings, and a phonological level for processing word form information, with connections between levels of processing. In anomia, naming impairments can be described using these models of naming, and the disruption in naming localised to a particular level or a link between two levels (Drew & Thompson, 1999). A disruption at a number of levels can result in inaccurate responses, with differing error patterns depending on where the disruption has occurred. Different stages of the naming process (conceptual level, lexical level etc.) can be selectively impaired, while others are left intact. Patterns of impairment differ in terms of their symptoms across levels, and are discussed below.

Selection of the correct semantic representation is the first stage in word production, following the input of a concept through, for example, picture presentation. The semantic system is a store of meanings, or semantic representations for concepts, both for concrete items such as ‘apple’, and abstract, such as ‘happiness’. A semantic deficit, in which the semantic representations are lost or damaged, would result in semantic errors across written and spoken modalities, with comprehension and expressive language both being affected (Nickels, 2001). In semantic anomia, word retrieval deficits reflect missing, incomplete, or underspecified semantic representations, whereby target lexical entries do not receive enough activation from the semantic system to be successfully retrieved from the output lexicon (Lorenz & Ziegler, 2009). Semantic anomia error patterns include semantic paraphasias (e.g. CAT-‘*dog*’), and category specific deficits, such as a specific difficulty with living or non-living items or with manmade versus natural items (e.g. Caramazza & Shelton, 1998; Warrington & Shallice, 1984).

Following semantic processing, the next step in naming is selection of the correct lexical representation, from several semantically related items that are also activated at the lexical level according to spreading activation theories of lexical processing (e.g. Dell, 1986, Dell et al, 1997). For example when naming the target: APPLE, the semantic representations of *orange*, *banana* etc. would also send activation to the lexical level. An anomic individual may produce semantic errors (e.g. APPLE>*orange*) but be subsequently able to indicate that they know the correct meaning of the target by, for example, giving a description of the object in question, or correctly identifying the target in a receptive language task such as spoken-word to picture matching (Nickels, 2001). Errors can also occur after successful retrieval of the correct lexical representation, in the form of phonologically related errors or phonemic paraphasias (Dell et al, 1997). These errors can be phonologically related real words (e.g. CAT-'*cap'*) or non-words (neologisms, such as CAT- '*cet*'). Caramazza, Papagno & Ruml, (2000) report the case of DM, who produced many phonological errors that were almost exclusively neologisms, consistent with the hypothesis that an impairment can be localised to a selective part of the naming process.

A complicating issue with regard to identifying the locus of an anomic person's impairment in terms of where it occurs in the cognitive neuropsychological model of naming, is that it is rare for aphasic people to have a single clearly defined deficit at only one level of the naming process (Best, Greenwood, Grassly, Herbert, Hickin & Howard 2013; Hillis, 1991). For this reason extensive detailed assessment of all language processes is necessary prior to designing an intervention strategy.

2.2. Treatment of monolingual anomia

The present section presents a review of studies investigating treatment of monolingual anomia, using a variety of methods, with differing outcomes for improvement to treated items and generalisation to untreated items. Many of the methods discussed below have been used as a basis for the development of treatment methods for bilingual anomia, which is the main focus of this chapter.

2.2.1. Methods of treatment in monolingual anomia

In general, treatment of anomia focuses on the semantic or phonological features of target words. As a treatment strategy, phonological cueing has been proven effective in treating naming disorders in anomia in many single case and group treatment studies (Best et al , 2013; Best, Hickin, Herbert, Howard & Osborne, 2000; Davis & Pring, 1993; Greenwood, Grassly, Hickin & Best 2010; Hickin, Best, Herbert, Howard, & Osborne 2002; Howard, Patterson, Franklin, Orchard-Lisle & Morton, 1985; Lorenz & Ziegler, 2009; Miceli, Amitrano, Capasso & Caramazza, 1996; Nettleton & Lesser, 1991; Raymer, Thompson, Jacobs & Le Grand, 1993; Wambaugh, Linebaugh, Doyle, Martinez, Kalinyak-Fliszar & Spencer, 2001).

Hickin et al (2002) investigated treatment outcome in 8 aphasic participants using phonological and orthographic cueing therapies. Treatment resulted in significant gains on naming treated items for 7 of 8 participants. The authors suggest that phonological cueing therapy may result in strengthening links between semantics and phonology.

Greenwood et al (2010) implemented a phonological and orthographic cueing hierarchy with an aphasic participant, TE. They compared the effectiveness of single cues with a choice of cues (one cueing the target, and another cueing an unrelated foil), on picture naming, hypothesising that a task requiring more effort would result in greater gains. Both treatment types resulted in significant naming improvement, though there was no difference of cue type on naming outcome. At follow-up, items treated with a choice of cues were named more accurately than single-cue items, but this difference was not significant. TE reported preferring the single foil condition over the choice of cues, saying that the choice distracted him (Greenwood et al, 2010). The authors considered several theoretical accounts for TE's improvement following therapy, and suggested that feedback from the phonological level resulted in activation of both treated and untreated items at the lexical level, supporting an interactive model of naming (e.g. Dell et al, 1997).

Some authors postulate a direct relationship between the underlying deficit and specific effects of a particular treatment task, e.g. a difficulty with semantic access would be likely to benefit from therapy that targeted strengthening semantic representations, whereas a participant whose deficit is at the level of the phonological lexicon may be more likely to benefit from a form of therapy emphasising a word's phonological features, such as phonological cueing treatment. Several studies have directly measured the effects of different treatment types within the same participants, in order to eliminate individual differences in response to treatment. (e.g. Hillis, 1989; Howard et al, 1985; Lorenz & Ziegler, 2009). In a comparison of different cue types on naming facilitation, including sentence completion, rhyme and semantic cues, Pease & Goodglass (1978) found that phonological cues (first sounds) were the most effective for a group of 12 aphasic participants, with differing severity of naming impairments.

Drew & Thompson (1999) reported mixed results following a semantic treatment for 4 aphasic participants with similar profiles of semantic deficits: two individuals showed improvement following semantic treatment, while two further participants showed no improvement until a phonological component was added to the treatment. Nettleton & Lesser (1991) compared naming treatment targeted at the level of breakdown according to a neuropsychological model of naming ('model-appropriate' treatment) with 'model-inappropriate' treatment: 3 of 4 participants improved with treatment targeted at the level of naming breakdown, whereas the two participants whose treatment was not 'model-appropriate' did not improve.

Hashimoto (2012) conducted a treatment study with two aphasic participants, comparing Phonological Components Analysis (PCA) with Semantic Feature Analysis (SFA). The two participants had differing levels of naming breakdown- one had an impairment at the semantic-phonological level, whereas the other's deficit was at the phonological output level. Both individuals responded similarly to both treatment types.

Van Hees, McMahon, Angwin, de Zubicaray & Copland (2014) employed a similar design with 12 aphasic individuals: 7 of 8 participants improved on the items treated with PCA, as compared with 4 who improved on the items treated with SFA. Treatment success was correlated with neural activity in differing areas for each treatment type. Lorenz & Ziegler (2009) compared semantic and phonological cueing treatments with 10 aphasic participants, with varying impairment types. They implemented a model-based approach in their predictions of treatment outcome, hypothesising that the participants with a deficit of semantic origin would benefit more from semantic cues, and that the participants with deficits at the level of the phonological output lexicon would benefit more from phonological cues. In the short term, the phonological cues were more effective overall than semantic (8/10 participants demonstrated significant improvement following phonological treatment versus 5/10 following semantic treatment). In the longer term however, semantic treatment resulted in lasting effects for four participants, whereas phonological treatment resulted in lasting effects for only two participants. Deficit type was again a poor predictor of response to both treatment types. The authors concluded that although each treatment type did indeed focus on semantic or phonological attributes, the ultimate aim was for the participants to name the pictures, a task which arguably incorporates both semantic and phonological processing. They suggest therefore that both treatment types have the potential to strengthen links between semantics and phonology, thus improving naming (Lorenz & Ziegler, 2009).

Based on the findings of the above studies, the relationship between the form of impairment and the treatment that works best for an individual remains unclear (Nickels & Best, 1996) and further investigation into the relationship between deficit type and the focus of treatment is therefore necessary, in order to maximise treatment efficacy.

2.2.2. The effect of multiple cues in monolingual anomia

Some studies have investigated the effect of multiple cues, including using sentence context, on naming success, in order to activate several levels of the lexical retrieval process simultaneously (Weidner & Jinks, 1983). Linebaugh, Shisler & Lehner (2005) developed a ten level cueing hierarchy with aphasic participants. They incorporated sentence completion cues with three phonological cueing types: the silently articulated first phoneme of the target word; the first phoneme of the target said aloud, and the first two phonemes of the target word said aloud. These three combined cue types were effective and the authors found that only whole word cueing was more effective at eliciting the target response. Thompson, Kearns & Edmonds (1981, cited in Thompson, Kearns & Edmonds, 2006) utilised a 3-level cueing hierarchy (1. sentence cue, 2. sentence cue plus phonological cue, 3. sentence cue plus verbal model of target) in a multiple baseline design with a single anomic person. The participant improved on all four word lists during treatment, from below 20% correct at baseline to 90% correct following treatment. Although no statistical information is given, some improvement was maintained for several months following treatment, suggesting that the therapy was effective for this participant. However, no generalisation to semantically related, untreated items was observed.

Weidner & Jinks (1983) conducted an investigation comparing the effect of successive written, phonemic and sentence completion cues versus simultaneous presentation of the same cues with 24 mild and severe Broca's aphasic people. They found that participants with both severe and mild aphasia responded best to combined cues, and that single cues were less effective than combined cues. The participants with severe aphasia did not benefit from written cues as their reading ability was affected. The authors suggest that the redundancy of the information provided is the reason why combined cues are effective in eliciting correct responses with aphasic participants, and the combination of semantic information provided in the sentence completion cue with the phonological information of the phonemic cue stimulates impaired word retrieval at different processing levels when provided simultaneously.

As lexical retrieval for communicative purposes necessitates the linking all levels of the lexical system including conceptual representations, lexical representations and phonology, this study has significant clinical implications for therapy design. A treatment study incorporating sentence and phonological cues in bilingual anomia is reported in Chapter 6 of this thesis.

2.2.3. Errorless and errorful cueing techniques in anomia

Typical cueing treatment for anomia consists of increasing cues, whereby the anomic individual is initially encouraged to attempt naming without any cueing, and is then given cues upon failure to name an item correctly (e.g. Wambaugh, Linebaugh, Doyle, Martinez, Kalinyak-Fliszar & Spencer, 2001; Fillingham, Hodgson, Sage & Lambon-Ralph, 2003). A possible problem is that in the process of repeated failed attempts at naming during traditional, errorful, treatment, anomic speakers are experiencing a learning event, and may be reinforcing their own errors, with the result that errorful responses may become more likely in future naming attempts (Fillingham et al, 2006; Middleton & Schwartz, 2013).

One hypothesis for this is based on Hebbian learning: at a basic level, Hebbian learning refers to the idea that stimuli and responses become associated over repeated instances (Middleton & Schwartz, 2013). At a neural level, when neurons fire together, the resulting pattern of neural activity is strengthened. Therefore, in treatment using picture naming, if a certain picture stimulus results in a particular pattern of neural activity for naming, e.g. CAT- '*dog*', Hebbian learning means that the same pattern is more likely to be activated during future naming attempts of that stimulus, whether correct or not (McClelland, Thomas, McCandliss, & Fiez, 1999). In contrast, in errorless anomia treatment, the participant sees a picture and is provided with the target name immediately, along with opportunities to produce its name supported by the therapist or investigator (Raymer, McHose, Smith, Ambrose & Casselton, 2012). Thus, errorless therapy may be more effective than errorful therapy because participants are less likely to reinforce their own errors (Fillingham et al 2006). Although anomic speakers do still produce errors during errorless treatment, these are typically fewer than in errorful treatment and any errors are immediately corrected, ensuring that each naming attempt ends in success. However, it has been suggested that the effortful nature of the traditional therapy method of increasing cues may offset the impact of error learning by implementing a practice effect, thus improving subsequent naming attempts (Abel et al, 2005; Middleton & Schwartz, 2013).

Fillingham et al (2003) conducted a review of treatment studies utilising errorful and errorless treatment. Out of 92 treatment studies, 61 had employed errorful therapy, and 31 errorless. Both methods resulted in a similar success rate overall (*errorful:* 72% of participants improved; *errorless*: 79% improvement rate) and at subsequent follow-up both methods had a similar lasting effect. One area where errorful therapy out-performed errorless was in the generalisation of treatment effects to untreated words: of the studies in Fillingham et al's (2003) review, generalisation occurred for 38% of participants following errorful treatment, but in only 15% of cases following errorless treatment. However, the smaller number of errorless treatment studies as compared to errorful treatment means that further investigation into the generalisation of treatment effects following errorless treatment is necessary. It may be that errorful, or increasing cueing, treatment techniques are more appropriate for person whose deficit is one of retrieval- i.e. the lexical representation is intact in memory, and providing part of the word as a cue is all that is needed to boost activation of the target word form. In contrast, errorless cues are a method of relearning lost information- the full word is provided to the individual as it is assumed that the lexical representation is lost rather than merely inaccessible (Abel, Schultz, Radermacher, Willnes & Huber, 2005). Therefore, the effectiveness of the type of cue provided may depend on the level of the naming deficit.

Several studies have directly compared the effects of errorful and errorless naming treatments within the same people (Fillingham et al, 2005a; Fillingham et al 2005b; Fillingham et al 2006; Lacey, Glezer, Lott, & Friedman, 2004; Middleton & Schwartz. 2012; Raymer, McHose, Smith, Iman, Ambrose & Casselton, 2012). Fillingham et al (2006) compared the two treatment types in 11 anomic people; 8 participants responded equally well to both treatment types, 1 benefitted more from errorful therapy and 2 showed no improvement with either treatment type. Conroy, Sage & Lambon-Ralph (2009a) conducted errorless and errorful therapy with 9 anomic people. There was a trend towards errorless therapy being more effective than errorful therapy at both the group level and individual level for 7 of the 9 participants, but this was significant for only one person. They observed little or no generalisation to untreated items. In an attempt to investigate both the role of effort and feedback on treatment outcome, McKissock & Ward (2007) compared 3 therapy types with 5 aphasic people: errorless, errorful with feedback, and errorful without feedback. All 5 participants improved significantly on the errorless and errorless with feedback sets, with no significant differences between treatment types. They concluded from this that making errors does not impede participants' improvement in therapy. Errorful attempts at naming with no feedback, however, yielded similar results to an untreated control set, suggesting that repeated attempts at naming are not sufficient for remediation.

Errorless treatment can be further distinguished into two subtypes of treatment: error elimination treatment, where the goal of treatment is that participants make no errors at all during treatment, and error reduction training, where over the course of treatment, errors are gradually reduced in line with the participant's response to cues (Abel et al, 2005; Conroy, Sage & Lambon-Ralph, 2009b). In this case, a hierarchy of cues is provided, and cues are withdrawn as accuracy improves, i.e. when a participant can respond accurately to the full word cue for a pre-determined number of consecutive sessions, during the subsequent session the next lower cue from the hierarchy is provided. If the participant responds accurately this cue level is then maintained for the following sessions and so on. If there is an inaccurate response to the reduced cue, the next higher cue in the hierarchy is immediately provided until the participant can respond accurately. The advantage of error reducing therapy over completely errorless therapy is that effort is sustained on the part of the participant over the course of treatment, in contrast to completely error-free therapy (Conroy & Scowcroft, 2012; Lacey et al 2004) while reducing the possibility of reinforcing errors by providing immediate feedback.

Abel et al (2005) conducted an intensive cueing therapy study with 10 aphasic people, comparing items treated with increasing cues, vanishing cues and with both. Treatment continued for 20 sessions (10 for each treatment type). Five participants improved following treatment with increasing cues, three of whom also improved following treatment using vanishing cues. Only four demonstrated significant improvement on items treated using both cues. The authors found that individuals who had lower naming scores at baseline tended to improve more than participants with milder impairments, which may suggest a ceiling effect. Furthermore, the participants received increasing and vanishing cueing sessions on alternate days, which may have had an impact on the outcome as compared to a multiple baseline design.

One clinical advantage to errorless therapy techniques in anomia is that they can be quicker to administer than traditional progressive cueing treatments (Conroy et al, 2009a; Conroy & Scowcroft, 2012). This is because the target name is immediately provided alongside the picture stimulus, and can be named/repeated immediately by the participant, in contrast to progressive cueing, where the participant is given time to respond independently, before being cued if necessary. The clinical implication of this is that errorless therapy is more time-efficient as more items can be targeted in therapy sessions than when using errorful therapy (Conroy et al, 2009). Furthermore, several studies have reported that aphasic participants prefer errorless over errorful therapy, and that they find it rewarding and satisfying, whereas errorful therapy can be frustrating (Fillingham et al 2005a; Fillingham et al, 2006; Conroy et al (2009). There are presently no studies that have investigated the effectiveness of errorless treatment in bilingual anomia. This is the focus of Chapter 6 of this thesis.

2.3. Generalisation of treatment effects in monolingual aphasia

The ultimate clinical aim of anomia treatment is always to optimise the aphasic individual's functioning level on a day-to-day basis, i.e. to generalise any improvement in word-retrieval to 'real-life' settings and conversations (Francis, Clarke & Humphreys, 2002). With this in mind, the aim of therapy must be to focus on generalisation of treatment effects to untreated words and tasks wherever possible as treatment can only target a limited number of words.

Within language generalisation to untreated words following phonological cueing treatment has been observed in a number of studies following varying treatment types. Greenwood, Grassly, Hickin & Best (2010) observed generalisation to untreated items following phonological and orthographic treatment with one participant in a single-case study. Best et al (2013) investigated the efficacy of a phonological and orthographic cueing hierarchy in people with lexical retrieval impairments and those with post-lexical impairments, predicting that generalisation would only occur for the participants with impairments in phonological encoding, and preserved semantic and lexical processing. These predictions were upheld, with participants whose deficits included lexical and semantic processing only showing item specific gains.

Hickin et al (2002) observed generalisation to untreated items in only two of eight participants following orthographic and phonological cueing treatment. They suggest that this item-specific improvement supports Howard's (2000) hypothesis that improvement following treatment is based on strengthened links between semantics and phonology, which are word-specific and therefore no generalisation should be expected. As within-language generalisation to untreated items is not always possible following treatment, it has been proposed that therapy should target items that are of practical use to the aphasic individual, in order to maximise the functional gains of treatment (Hickin et al 2002).

The generalisation of naming treatment to untreated tasks has also been investigated. Hillis (1998) carried out both semantic and phonological treatment with the same aphasic individual, HG, based on the hypothesis that her naming breakdown occurred at two different levels of the word retrieval process. HG improved on naming following both treatment types, with some generalisation to untreated tasks including word repetition and word reading. Raymer, Thompson, Jacobs & Le Grand (1993) also measured generalisation to untreated items and tasks following phonological treatment with 4 participants. They observed generalisation to naming of untreated items in two of four participants, and further observed generalisation to oral reading of treated items in three of four participants. The fourth participant also demonstrated improvement but this was limited by ceiling effects. Finally, two of four participants also demonstrated generalisation to written naming of treated items.

The generalisation of naming treatment to untreated tasks, both within and across languages, may indicate shared underlying lexical processes across tasks, and is investigated experimentally in Chapter 6 of this thesis.

2.4. Bilingual anomia

An issue that complicates the assessment and treatment of bilingual aphasia is that the two languages of a bilingual do not always have similar deficits and recovery patterns across languages. Paradis (1997) described a number of patterns of bilingual language recovery following stroke. The first, and most common, pattern is that of *parallel* recovery, with both languages recovering to a similar extent, based on pre-morbid language abilities. Other patterns of recovery in aphasia include *selective* (when a person recovers one language more than the other, relative to pre-stroke levels); *successive* (one language recovers only after the first has recovered); *antagonistic* (as one language improves the other worsens); and *mixed* (the speaker's languages are inappropriately mixed which interferes with the recovery process).

Less common patterns also include alternating antagonistic recovery (Nilipour & Ashayeri, 1989), whereby one language is recovered, only to be lost as another language becomes available.

There are numerous theories concerning differing patterns of impairment and recovery across languages Ribot (1882, as cited in Paradis, 2004) hypothesised that the best recovered language in multilingual aphasia would always be the first acquired language (L1). Pitres (1895, as cited in Paradis, 2004) however, suggested that the language used most frequently immediately prior to the stroke would recover more quickly and be the least impaired, irrespective of age of acquisition. However, a number of variables can affect recovery patterns in each language following stroke. These include the site and extent of lesion, type of aphasia, age of acquisition, proficiency, language use and IQ (Gray & Kiran, 2013). These variables can have implications for the success of treatment outcomes, including whether treatment effects in one language generalise to the untreated language. A review of studies investigating treatment in bilingual anomia, including cross-language generalisation is presented below.

2.5.Treatment of bilingual anomia

The question of how to treat a bilingual person's two languages is far from simple. It is generally accepted that the two languages of a bilingual are neurologically and functionally linked (Paradis, 1997), which has practical consequences for guiding treatment design. Therefore the following review of treatment of bilingual anomia will be discussed with regard to gains in both the treated language and any resulting gains to the untreated language.

Comparatively little research has been conducted documenting the treatment of bilingual aphasia, compared to that of monolingual aphasia. Generally studies consist of single case studies, with limited investigation of pre- and post- treatment language abilities.

Many studies investigating treatment outcomes in bilingual anomia have applied semantic methods (Ansaldo, Saidi & Ruiz 2010; Edmonds & Kiran, 2006; Keane & Kiran, 2015; Kiran & Edmonds, 2004; Kiran & Iakupova, 2011; Kiran & Roberts, 2010) . Other studies have utilised mixed therapy types (e.g. Croft, Marshall, Pring & Hardwick, 2011; Filiputti, Tavano, Vorano, De Luca & Fabbro, 2002; Goral , Rosas, Conner, Maul & Obler 2012; Junque, Vendrell, Vendrell-Brucet & Tobeña 1989; Kohnert, 2004; Kurland & Falcon 2011). Few studies have explored the effectiveness of phonological strategies (e.g. Abutalebi, Della Rosa, Tettamanti, Green & Cappa, 2009; Hughes, Roberts & Tainturier, 2012). The outcomes of these different therapy types in bilingual anomia will be discussed below, with regard to gains to treated items, and cross-language generalisation of treatment effects.

2.5.1. Cross-linguistic generalisation of treatment effects in bilingual anomia

One question that remains unanswered in the study of bilingual anomia treatment is under what circumstances treatment gains in one language can transfer to another, untreated, language. Cross-language generalisation of treatment effects in bilingual anomia occurs when a person demonstrates improvement in naming words in an untreated language, following treatment in their other language. In monolingual aphasia, within-language generalisation to untreated items has been observed following semantic treatment for word naming deficits, as discussed above (e.g. Kiran & Thompson, 2003).

From a theoretical standpoint, studies of cross-linguistic generalisation of aphasia may inform theoretical models of the structure of the bilingual language process (Kiran & Roberts, 2010). If generalisation occurs for a particular language process, such as spoken naming, but not for another, such as reading, this information may be taken to inform models of language processing, including degree of cortical and functional overlap between languages. However, influencing factors on successful treatment outcomes are still a focus of research, and are not fully understood (Kiran, Grasemann, Sandberg & Miikkulainen, 2013). Several factors influencing cross-linguistic generalisation are discussed below.

The clinical implications of cross linguistic treatment effects include more efficient use of time and resources for speech and language therapists, as participants may experience improvement in both their languages in a shorter space of time following treatment in only one language. Kohnert (2004) suggests that rehabilitation of both languages of a bilingual is preferable, as it has been demonstrated that the languages of bilingual speakers are not separable into two monolinguals, but interconnect functionally and neurologically. However, treatment is not always available in both languages in clinical settings, therefore investigation into cross-language generalisation and the circumstances in which this occurs is an important area of research. Furthermore, it has been hypothesised that only one language should be treated at once, as concurrent therapy in both languages can have a negative effect on language rehabilitation (Lebrun, 1988, cited in Marangolo, Rizzi, Peran, Piras &

Sabatini, 2009). Therefore, which language should be treated first? Some suggestions for prioritising the language of therapy include the most frequently used language prior to the stroke, the most/least impaired language, the language of the present environment, or the language that means the most to the person with aphasia (Ansaldo et al, 2008).

Some suggest that rehabilitating a bilingual speaker's weaker language results in greater transfer of therapy effects to the untreated language, as it has been hypothesised (e.g. Goral, Levy & Kastl, 2010; Kroll & Stewart, 1994) that the link between the L1 and the semantic system is stronger than that between the L2 and the semantic system. Thus, in some bilinguals, the L1 'mediates' between the L2 and the semantic system, meaning that if a semantic representation of a word is strengthened by treatment in L2, it is more likely that the translation of that word in the L1 will be more easily accessed following treatment (Kroll & Stewart, 1994; Edmonds & Kiran, 2010; Miertsch, Meisel & Isel, 2009,). Kiran et al (2013) suggest that both within and between language generalisation is more likely to occur when increased activation following treatment is greater than inhibition or interference from non-target items during lexical selection. An alternative explanation for greater cross-language transfer from L2-L1 derives from investigations of bilingual lexical processing that suggest that the L2 is at a lower resting level of activation than L1, and thus requires more of a 'boost' from cross-language activation than the L1 (e.g. Marian & Spivey, 2003). Therefore, treatment in L1 may be less likely to result in cross-language activation than vice-versa.

Edmonds & Kiran (2006), conducted a semantic based treatment study with 3 Spanish-English bilinguals. All participants demonstrated improvement to treated items. One balanced bilingual demonstrated cross language generalisation from Spanish to English, and two participants showed generalisation from their weaker to their stronger language. The authors tentatively concluded that treating the weaker language may result in greater cross-language gains than treating the stronger language. This result was only partly replicated in a follow-up study by Kiran & Roberts (2010). Four bilingual participants (2 Spanish-English and 2 French-English) received semantic feature analysis treatment on non-cognate words, and while all four demonstrated gains to the treated items, only one participant showed clear cross-language gains to untreated translations of treated items. Baseline testing was stringent, with three assessments in each language. However, two of the participants who failed to show cross-language generalisation also failed to reach criterion (80% correct) on naming treated items in the treated language, which may explain their lack of generalisation.

Kiran & Edmonds (2004) and Miertsch et al (2009) found generalisation from a weaker to a stronger language (L2-L1 and L3-L2 respectively) utilising a semantic therapy protocol. Costa, La Heij & Navarette (2006) also observed greater generalisation from L2-L1 in a Spanish-English bilingual individual following semantic naming treatment. Conversely, Junque et al (1989) employed a mixed therapy design with Spanish-Catalan bilinguals, and found generalisation from L1 to L2. Kiran & Roberts (2010) also observed L1-L2 transfer in one French-English participant using a semantic treatment, but no generalisation in 3 other participants. Following semantic-based treatment with a group of 17 Spanish-English bilinguals, Kiran et al (2013) observed cross-language transfer for translations of treated items in 5 participants (three balanced bilinguals and two treated in their stronger language).

Goral et al (2012) investigated the impact of language proficiency on cross-language transfer of treatment effects and though no clear pattern emerged regarding pre-morbid language proficiency, transfer was observed for four participants following treatment of languages that were stronger post-stroke, to post-morbidly weaker languages. Croft et al (2011) noted a similar pattern for 3 of 5 Bengali-English bilingual participants.

Radman, Spierer, Laganaro, Annoni & Colombo (2015) implemented a lexical-phonological computer assisted therapy in French with a Persian-French bilingual, and observed no generalisation either within or across language. Abutalebi, Della Rosa, Tettamanti, Green & Cappa (2009) observed a similar pattern following phonological cueing therapy in Italian with a Spanish-Italian bilingual individual.

Ansaldo & Saidi (2014) conducted a systematic review of 13 treatment studies investigating cross-language transfer of therapy effects, and concluded that, based on the available data, it is not possible to establish clear patterns concerning proficiency and the likelihood of cross-language transfer.

Other influencing factors on cross-linguistic generalisation include type and severity of the naming impairment (Kiran & Roberts, 2010). For example, cross language generalisation may be more likely to occur in people with a semantic deficit than in a phonological impairment because the semantic system and the phonological lexicon differ in terms of representational characteristics and the type of processing during word retrieval. In the semantic system the representations of concepts are highly interconnected by overlapping features, and furthermore are thought to be shared across languages (e.g. Kroll & Stewart, 1994). Underspecified semantic representations might lead to problems in distinguishing between related concepts, and therefore result in semantic errors in naming. Following semantic therapy, naming should therefore improve for treated and semantically related words (Lorenz & Ziegler, 2009).

Galvez & Hinckley (2003) suggest that cueing semantically related information seems to support a more conscious retrieval process, whereas the phonological approach may be based on a more automatic retrieval process at the level of the phonological output lexicon. The fact that the retrieval process is conscious, thereby requiring the speaker to generate and work for their own cues, may strengthen representations, leading to longer term benefits, and possibly greater generalisation.

Targeting treatment at the level of the deficit may have an effect on treatment outcome. If the deficit is at the semantic level, and we assume shared semantic representations, one hypothesis is that strengthening semantic representations, or access to semantic representations, would result in improvement to both languages. This is because it is assumed that in naming, activation spreads from the semantic system to the lexicons of both languages regardless of the target language (Edmonds & Kiran 2006). In contrast, if the deficit lies in accessing phonological representations then, based on the assumption of linked phonological representations and simultaneous activation, greater activation of a word in one language could theoretically lead to activation of its translation equivalent, especially in the case of cognate words.

It can be concluded from the above studies that cross-language generalisation of treatment is likely to depend on a variety of factors, including the nature and severity of the deficit, the treatment technique used, the items used as a focus of treatment, and degree of bilingualism (Kiran et al 2013). Indeed several studies exist which found no cross-language generalisation at all following semantic (Ansaldo, Saidi & Ruiz, 2010), mixed semantic and phonological (Galvez & Hinckley (2003) and phonological treatment (Abutalebi, et al 2009; Croft et al, 2011). Keane & Kiran (2015) conducted a single case study with a trilingual aphasic participant, investigating treatment outcomes in two languages, English and French. While the participant did improve on treated items in both languages, they observed no within or cross language generalisation following either treatment phase. However, the participant presented with a deficit of cognitive control, which manifested in cross-language intrusion errors; following each treatment phase cross language intrusions increased. The authors hypothesise that training in one language results in inhibition of the untrained language, consistent with models of bilingual naming that postulate inhibitory processes (e.g. Abutalebi & Green, 2007).

The mixed results demonstrated by these studies indicates that there is a clear need for further investigation into the mechanisms of cross-language transfer of treatment effects, including the role of cognate words.

2.5.2. The impact of cognate status on cross-language generalisation of treatment effects

Cognate words, which share similar form and the same meaning across pairs of languages, (e.g. 'carped' in Welsh and 'carpet' in English) have been demonstrated to benefit from greater accuracy and faster processing in a number of lexical tasks (e.g., Costa et al 2000; Lalor & Kirsner, 2001; Roberts & Deslauriers, 1999; Rosselli, Ardila, Jurado & Salvatierra, 2012; Siyambalapitiya, Chenery & Copland, 2009). The origin of the cognate advantage is discussed in detail in Chapter 1.

Roberts & Deslauriers (1999) investigated naming of cognates and non-cognates in 15 highly proficient bilingual participants with aphasia and found that cognate words were named correctly significantly more often than non-cognates. The clinical implications for ease of production of cognates over non-cognates may be that these items can be omitted from treatment schedules- if they are more easily accessed by the participant they will not require treatment, and they can focus on the more difficult to access non-cognates (Roberts & Deslauriers, 1999). Conversely, a Speech and Language Therapist may choose to concentrate on cognates in treatment under the premise that if a cognate is treated in one language it is more likely to generalise to the second language, resulting in the improvement of two items rather than only one, meaning that the treatment is more useful and efficient for the aphasic individual.

The literature on the manipulation of cognate status in bilingual anomia therapy is scarce, with mixed results. Such studies as have investigated the effect of cognateness on treatment outcomes in bilingual aphasia, including cross-language generalisation of treatment effects, are discussed below.

In a single case study with a Spanish-English bilingual aphasic individual, Kohnert (2004), observed greater cross-language transfer for cognates than non-cognates, in both Spanish and English. However, treatment in each language consisted of only two hours, and a multiple baseline and post-test protocol in both languages was not carried out prior to and following treatment. Therefore the reliability of the results may be called into question, as aphasic individuals frequently demonstrate variability in performance from one day to the next (Kiran et al 2012). Kurland & Falcon (2011) observed greater generalisation for non-cognates than cognates following mixed treatment with a Spanish-English bilingual participant. However, the authors present no statistical analysis of treatment effects, therefore again the results must be reviewed with caution. Hughes, Roberts & Tainturier (2012) observed greater improvement for cognates than non-cognates in a Welsh-English bilingual participant with aphasia following treatment in both languages. Cross-language generalisation to untreated translations was also greater for cognate items in both languages. Control testing was rigorous, with 3 assessments in each language at baseline and post-test, and generalisation was measured not only to untreated words, but to words attempted in each treatment session with no feedback.

Additional investigation is necessary firstly into the robustness of the cognate advantage in anomia as compared to neurologically healthy populations, and secondly, to explore the potential for cross-linguistic generalisation of treatment effects in cognate words. Limited research exists to date that has systematically investigated these factors, therefore there is great scope for investigating the role of cognates in cross-language transfer of treatment effects, and the conditions under which optimum transfer of treatment effects may occur.

2.6. Summary and Introduction to Experimental Chapters

The first chapter of this thesis presented a review of the literature on theories of monolingual and bilingual lexical processing. The effect of cognate status on lexical processing tasks including naming and translation was presented, providing evidence for interactive lexical activation. Hypotheses for links between languages were discussed, with evidence for both conceptual and lexical routes to translation.

The current chapter has presented a review of the literature on the nature of monolingual and bilingual aphasia, and the efficacy of different treatment types. Finally, studies that have investigated cross-language treatment effects in bilingual anomia were presented, with a discussion of the effect of cognate status on both within language gains, and on cross language generalisation of treatment effects.

The review of the literature on bilingual aphasia treatment highlights the comparative paucity of research into the efficacy of treatment for bilingual anomia thus far. Moreover, despite many studies reporting robust cognate effects in healthy bilinguals, the effect of cognate status on treatment outcomes in neurologically impaired bilinguals is scarce, with only three studies investigating the facilitation of cognate words on cross-language generalisation effects in bilingual anomia.

The studies that follow contribute to models of bilingual lexical processing, with evidence from neurologically healthy and aphasic Welsh-English bilingual speakers.

This thesis is concerned with the interaction of bilingual speakers' two languages, including the existence and functionality of direct lexical links between languages, and how neurological impairment can affect such links. A further focus will examine the impact of lexical features including cognate status on lexical interaction. The facilitation of cognate words is investigated in naming and translation tasks with Welsh-English bilingual control participants in the first experimental chapter (Chapter 3), and with Welsh-English bilingual anomic participants in the second experimental chapter (Chapter 4). The existence and functionality of direct lexical links is explored in the third experimental chapter (Chapter 5), with evidence from semantic errors in naming and translation. The impact of cognate status on conceptual involvement in translation is also explored. The role of cognate words in cross-language transfer of treatment effects in bilingual anomia therapy is explored in the fourth experimental chapter (Chapter 6), using an errorless sentence and phonological cueing design.

CHAPTER 3: THE EFFECT OF COGNATENESS ON NORMAL BILINGUAL NAMING AND TRANSLATION

CHAPTER 3: THE EFFECT OF COGNATENESS ON NORMAL BILINGUAL NAMING AND TRANSLATION

3.1. Abstract

The present study aimed to investigate the cognitive processes that underlie picture naming and translation abilities in bilingualism, with a focus on the effect of cognate status on speed and accuracy in older and younger neurologically healthy Welsh-English bilingual speakers and monolingual control participants. We compared the effect of the cognate status of words in picture naming and translation, as well as on the strength of the bilingual disadvantage in naming.

As predicted, bilingual participants were faster and more accurate at naming cognates than non-cognates in both languages, and this effect was even larger in the translation task. In addition, the cognate advantage was larger for older than for younger participants. Finally, we observed a bilingualism disadvantage on English picture naming, although this effect was less pronounced for cognate words. Overall, this study supports theories of interactive bilingual lexical processing, such as that of Costa et al (2005) and suggests that naming and translation partly rely on different cognitive processes, with direct lexical links contributing to translation performance and enhancing the cognate advantage.

3.2. Introduction

The current study investigates naming and translation ability in two groups of Welsh-English neurologically healthy bilingual participants, comparing accuracy and reaction times on cognate and non-cognate words across the two tasks, and across participant groups. Data from older and younger bilingual participants are matched on an English picture-naming task by data from age matched monolingual English participants. The overall thesis aims to investigate the nature of the bilingual lexicon, in particular the way the two languages of a bilingual speaker interact. Investigating how cognate and non-cognate words differ in terms of participant accuracy and speed across tasks will inform our understanding of the bilingual lexicon. Bilingual models of lexical processing are typically less well developed than those addressing monolingual language processing, despite the fact that the majority of the world's population is bilingual (De Bot, 1992, Grosjean, 1992). Patterns of ability across languages and different word types contribute to our understanding of the nature of lexical interaction between languages in multilingual speakers (Paradis, 2004).

The first goal of the present study was to investigate the effect of cognate status on naming and translation accuracy and speed in bilingual participants. The second goal was to further scrutinise the data with a focus on the impact of age on lexical access and on the strength of the cognate effect. Thirdly, the performance of bilingual participants was compared to that of their monolingual counterparts to examine if bilinguals show a disadvantage in picture naming and whether it is modulated by cognateness.

3.2.1. Bilingual lexical processing

Both monolingual and bilingual lexical models posit that word production relies on distinct yet interconnected levels of processing. These include semantic, lexical and phonological stages of processing (e.g. Caramazza, 1997).

There are competing theories as to how these levels are organised in monolingual and bilingual speakers. However, it is generally agreed that bilingual speakers access shared semantic representations in both languages (e.g. French & Jacquet 2004; Kroll & Stewart, 1994; Potter, So, Von Eckhardt & Feldman, 1984). Evidence for a common semantic store comes from semantic priming tasks, which require participants to recall and classify words. Tasks such as these, which require access to semantic information, have been demonstrated to result in cross-language semantic priming effects (e.g. Caramazza & Brones, 1980) suggesting that semantic information is shared across languages.

Additionally, most studies of bilingualism hypothesise separate lexical representations for each language. However, the way in which the lexical representations connect across languages remains a matter of dispute. Two early hypotheses were the *Conceptual Mediation* and *Word Association* hypotheses, depicted in Figure 3.1. The *Word Association* hypothesis (Potter et al, 1984) posits direct links between L1 and L2 lexicons, with a connection from L1 to the conceptual level, but no link from L2 to the conceptual level. This model best describes bilingual speakers with low L2 proficiency who have learnt their L2 with reference to their L1. According to this model, when translating from L1 to L2 the conceptual store would not necessarily be accessed, and, in translating from L2 to L1, access to concepts would not be possible.

Conversely, the *Conceptual Mediation* Model (Potter et al, 1984) suggests that there are no direct links between languages at the lexical level, but direct links between both L1 and L2 and the conceptual level. According to this model, word translation would always go via the conceptual level, never directly from one lexicon to the other. It was suggested that this model would best describe a bilingual speaker with high proficiency in both languages, with strong lexical-conceptual connections in both languages.

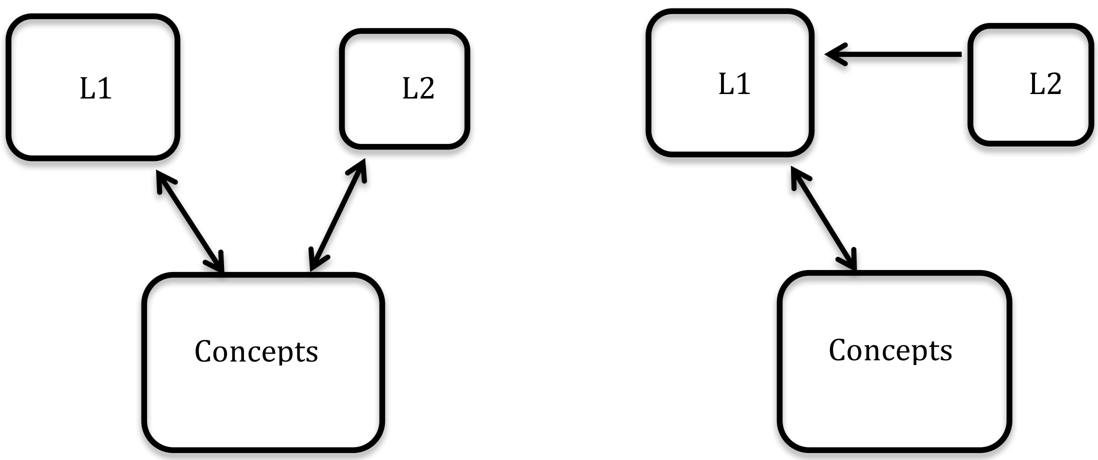


Figure 3. 1: Concept Mediation & Word Association Hypotheses (Potter, So, Von Eckhardt & Feldman, 1984)

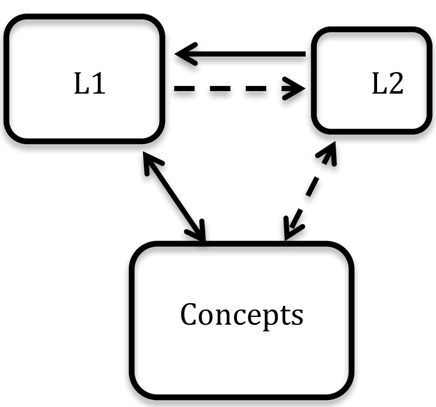


Figure 3.2: Kroll& Stewart's 1994 Revised Hierarchical Model of Bilingual Lexical Processing

Kroll & Stewart's (1994) Revised Hierarchical Model (depicted left) built on the Concept Mediation and Word Association hypotheses, postulating shared semantic representations and separate lexical stores for each language, with direct but asymmetrical connections between each lexical store and the conceptual store. The model hypothesises that each language has direct access to the semantic representations, as well as a connection between the two languages' lexical stores. The theory further suggests that initially, at lower proficiency levels, L2 word meanings are accessed from the conceptual store via the L1, but with increased proficiency the links between the L2 lexicon and the conceptual level are strengthened, and therefore play a greater role in translation. The solid and dashed lines represent stronger and weaker connections between levels of processing respectively. However, these connections would be of comparable strength in balanced bilinguals.

3.2.2. Naming and translation in neurologically healthy bilingual speakers

Picture naming and translation abilities in bilingual speakers have been the focus of much research to date (e.g. Costa, Caramazza & Sebastien-Galles, 2000; Ivanova & Costa, 2008; Kroll & Stewart, 1994). Typically, studies have focused on the effect of lexical characteristics such as word frequency, concreteness, and cognateness, as well as effects of translation direction, in order to uncover the processes involved in bilingual lexical processing. Some studies have directly compared performance on picture naming and translation tasks in order to uncover the lexical process underlying each (e.g. Potter et al, 1984; Kroll & Curley, 1989; Kroll & Stewart, 1994). It is assumed that picture naming requires access to conceptual representations. However, as discussed above, the question of conceptual access in translation is more ambiguous.

What are the mechanisms at play in translation versus naming? In other words, as Snodgrass (1993) put it, how does translating a word from one language to another compare to translating a picture stimulus into its name? Picture naming requires the ability to recognise pictorial stimuli and the ability to retrieve and vocalise the appropriate label for each stimulus. In translation, though the output is the same, the input is lexical- i.e. the task is to recognise a spoken or written word, and convert it into the target language. The process by which this occurs- either via conceptual representations or direct lexical connections- is a subject of continuing debate, and is addressed further in Chapter 5 of this thesis.

Potter et al (1984) measured reaction times on translation and naming tasks in proficient (Chinese-English) and less proficient (English-French) bilingual speakers and found that both groups were faster at picture naming in L2 than translating into L2. Picture naming and translating into L1 were only compared in the Chinese-English participants, and similar results were found as in the L2 tasks. The authors conclude from the results that translation in both directions takes place via conceptual mediation. It must be noted that the target items in the naming and translation tasks were not the same in this study. Furthermore the authors do not report that the lexical characteristics of stimulus sets were matched across tasks. Finally, the effect of cognate status on reaction times across tasks was not measured.

Kroll & Curley (1988) compared reaction times on picture naming and translation in proficient and less fluent English-German participants. The proficient group of participants was found to have equal response times across tasks when the language of output was L2, whereas picture naming was faster than translating when the language of output was L1. The less fluent participants were faster at translating than picture naming when the language of output was L2, but demonstrated the reverse pattern when the language of output was L1. These data indicate that less fluent bilingual speakers were employing a direct route for translation at least for L1-L2, whereas the more fluent bilinguals were translating via conceptual mediation.

3.2.3. The effect of cognate status on task performance in healthy bilingual speakers

Research has shown that bilingual speakers' ability to retrieve words is affected by cognate status (Gollan & Acenas, 2004; Rosselli, Ardila, Jurado & Salvatierra (2012). Cognate words share similar form and the same meaning across pairs of languages (e.g. 'carped' in Welsh and 'carpet' in English) and have been demonstrated to benefit from greater accuracy and faster reaction times across a number of different lexical tasks including lexical decision (Sanchez-Casas, Davis & Garcia-Albea, 1992), picture naming (e.g. Costa et al, 2000; Rosselli et al, 2012; Strijkers, Costa & Thierry, 2009) and translation (e.g. De Groot, Dannenburg & Van Hell, 1994; Janyan & Hristova, 1997, Kroll & Stewart, 1994; Sanchez-Casas, Davis & Garcia-Albea, 1992). The effect has also been documented in different language pairs, including, but not limited to, Spanish-Catalan (Costa et al, 2000), Spanish-English (Sanchez-Casas et al (1992), Dutch-English (De Groot & Poot, 1997) and Bulgarian-English (Janyan & Hristova, 2007).

One hypothesis for the 'cognate facilitation effect', depicted in Figure 3.3. below, assumes language non-selective activation and interactivity between levels of processing and between languages. Costa, Santesteban & Caño, (2005) propose that when a word is retrieved for naming, both the target and its translation equivalent in the non-target language are activated at the phonological level. Thus, cognate words receive extra activation: 'top-down' semantic activation from the semantic representation, which is assumed to be language non-specific, and 'bottom-up' phonological activation from representations in both languages, whereas non-cognate words would not receive supporting phonological activation from the translation of the target.

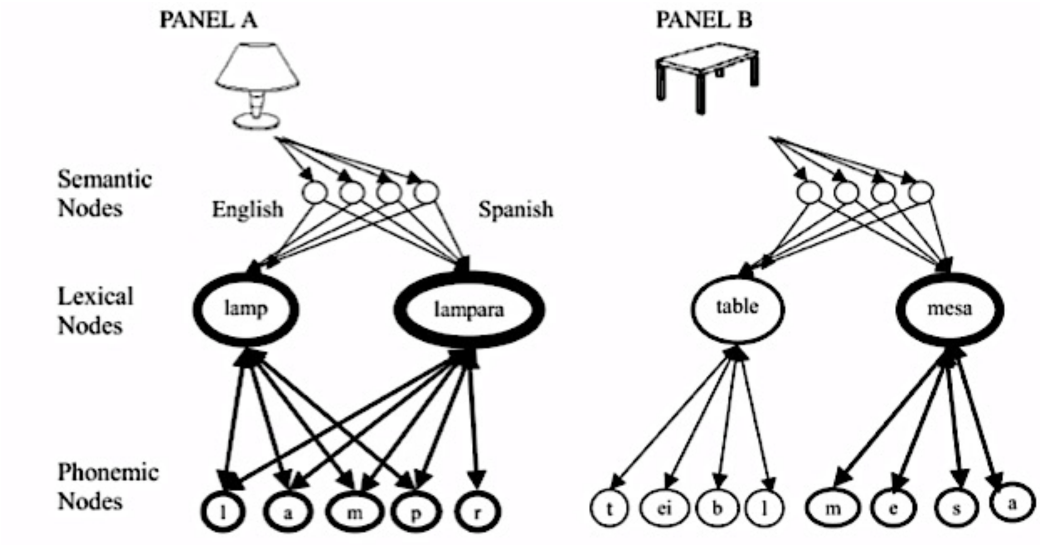


Figure 3.3: Schematic representation of the cognate facilitation effect (from Costa et al, 2005)

In neurologically healthy participants, several studies investigating picture naming have reported that cognate words are named more accurately and more quickly than non-cognates. Costa et al (2000) observed faster naming for cognates than non-cognates in a group of Catalan-Spanish bilinguals when naming in L2 Spanish. In a subsequent experiment, the authors investigated the effect of language dominance on the cognate effect, and found that while there was a significant effect of cognateness on naming speed in L1 and L2, the effect was larger when participants named in their L2. Rosselli, Ardila, Jurado & Salvatierra (2012) investigated naming ability on the Boston Naming Test in balanced and non-balanced Spanish-English bilingual participants. Both groups were more accurate for cognates than non-cognates in both languages; however, while this effect was similar across languages for the balanced bilinguals, the non-balanced bilinguals again demonstrated a larger cognate effect in their L2. Gollan, Fennema-Notestine, Montoya & Jernigan (2007) found similar language dominance effects on naming cognates in a group of older Spanish –English bilinguals.

These findings of greater advantage for cognates in the non-dominant language than the dominant language suggest that the extra phonological activation from L1 may have a larger effect on retrieval in L2 than vice-versa. This may be because lexical units in the L2 require more activation to reach threshold than those in the L1 and as a result benefit more from the phonological feedback from L1. In addition, the fact that L2 representations are weaker also means that during L2 production they will produce weaker phonological activation and therefore less feedback to the L1 (e.g. Costa, Caramazza & Sebastien-Galles, 2000).

Several studies have measured the effect of cognate status on translation speed and accuracy in different language pairs. De Groot & Poot (1997) observed faster translation of cognates than non-cognates in both high and low proficient Dutch-English bilingual participants, in both directions of translation. Sanchez-Casas et al (1992) observed faster translation for cognate than non-cognate items in Spanish-English bilingual participants, in both directions of translation. Hristova & Janyan (2008) compared translation latency of concrete and abstract cognate and non-cognate words from Bulgarian to English (L1-L2) and vice-versa. Overall, both abstract and concrete cognates were translated more quickly in both directions than non-cognates. This was observed in both high- and low-proficient participant groups. They found that cognates were translated more quickly from L1- L2 than from L2-L1 while non-cognates showed the opposite pattern. The authors suggest that this is due to the transparency of the Bulgarian orthographic system resulting in faster recognition than English orthography. They also observed a reversal of the concreteness effect, in that abstract words were translated more quickly than concrete words from L2-L1, which the authors suggest is indicative of direct lexical processing of these words, due to the fact that abstract words share fewer conceptual features across languages.

Kroll & Stewart (1994) measured the effect of semantic categorisation on reaction times in a translation task in a group of Dutch-English bilinguals. They observed longer reaction times for categorised than random lists when L1 was the language of output, but no effect of list type when L2 was the language of output, supporting previous results, indicating that L2-L1 but not L1-L2 translation was semantically mediated. Although they found that cognate words were translated more quickly than non-cognates, there was no interaction between cognate status and the effect of category interference- which they interpret as indicating that L2-L1 translation is conceptually mediated for cognates and non-cognates alike. However, de Groot (1992) found that the effects of semantic variables were smaller for cognates than for non-cognates in a translation task, suggesting that cognate words may be linked more strongly at the lexical level than non-cognates.

Nevertheless, the cognate advantage is not universal; some studies have found limited, or even reversed cognate effects in bilingual participants. Ivanova & Costa

(2008) observed a cognate advantage for high-frequency words only in a picture naming task, and only when the participants were naming in their L2. The authors suggest that this finding provides support for phonological feedback being the origin of the cognate facilitation effect: the higher resting activation of high frequency L1 as opposed to L2 words would result in more activation being sent to their corresponding L2 translations. However the authors do note that this finding was the result of post-hoc analysis and also caution that there were unequal numbers of stimuli in the cognate and non-cognate word lists. Roberts & Deslauriers (1999) measured naming accuracy in a group of 15 French-English neurologically unimpaired older bilingual participants and observed no significant difference in accuracy on naming cognates and non-cognates, however this may be accounted for by participants' high accuracy levels, which were close to ceiling. Reaction times were not measured.

Siyambalapitiya, Chenery & Copland (2009) observed faster reaction times for cognates in a repetition priming task with younger bilingual Italian-English participants, but in a group of older Italian –English participants, they observed a cognate effect only in same-language L2 repetition priming. In all other tasks they observed a reversal of the cognate effect, i.e. faster reaction times for non-cognates, indicating a detrimental effect of the phonological similarity of cognates for older bilinguals, rather than a facilitatory effect as has been previously observed (e.g. Costa et al, 2000; De Groot et al, 1994). The authors suggest that this is due to a difficulty with lexical selection with increased age, based on weakened inhibitory mechanisms. However, it must be noted that the presentation of words was auditory for the older participants, but was written for the younger participants, in order to avoid literacy issues, therefore the comparison between the two groups is less straightforward than initial analysis suggests. The inclusion of monolingual control participants for within-language priming effects could also have strengthened their conclusions.

The fact that most studies of cognate processing have presented results from younger participants, combined with the above findings of a limited cognate advantage with older bilingual participants, highlights the need for further investigation of the universality of the cognate advantage. Furthermore, few studies have directly compared accuracy and latency in naming and translation and none have done so with cognates and non-cognates, with the same target items, and included comparisons with data from monolingual control participants.

3.2.4. Monolingual versus bilingual lexical processing

Typically, speaking more than one language is thought to be associated with better performance on non-linguistic tasks requiring cognitive control, such as the Stroop and Simon tasks and executive function tasks (e.g. Bialystok, Craik, Grady, Chau, Ishii, Gunji, Pantev, 2005; Costa, Hernandez & Sebastien-Galles, 2006). This advantage is thought to be related to the extra effort required to control two languages during lexical activation. However, it has been suggested that the effort of controlling two languages may also result in disadvantages as compared to monolingual participants in terms of processing speed during lexical retrieval (e.g. Gollan, Montoya, Fennema-Notestine & Morris, 2005), which has been hypothesised to arise as a result of two possible effects. The first is based on the fact that bilinguals necessarily use words in each of their languages less often than do monolinguals, and therefore words in each language have relatively lower frequency for bilinguals than for monolinguals (e.g. Gollan, Montoya, Cera & Sandoval, 2008). The alternative explanation is based on cross language lexical competition causing interference and therefore slower reaction times (e.g. Costa et al, 2000). Gollan et al (2005) compared picture naming and classification speed in Spanish-English bilinguals and English monolinguals, and found that bilingual status affected naming but not classification, indicating that the difference in processing delay between bilinguals and monolinguals occurs following conceptual retrieval. The authors report that cognate stimuli were included in the study, on the premise that it is common for language pairs to share many cognate translations, however they did not report the effect of cognate status on reaction times. Gollan et al (2008) investigated picture naming accuracy and speed in Spanish-English bilinguals and English monolinguals, in a study investigating non-cognate words only. They found that the bilingual disadvantage was more pronounced for low-frequency words, and also that the frequency effect was greater for the participants' L2, for both younger and older participants.

Ivanova & Costa (2008) investigated naming speed of cognates and non-cognates in Spanish in 3 groups of participants: Spanish monolinguals, Spanish-Catalan bilinguals (L1 Spanish) and Catalan-Spanish bilinguals (L1-Catalan). The monolinguals were faster at naming than both sets of bilinguals. Additionally, there was an effect of frequency on the magnitude of the bilingual disadvantage, in which the difference between bilinguals and monolinguals was greater for low frequency than for high frequency words, indicating that the slower reaction times were the result of lower relative frequency for bilingual speakers. They also observed a reduction in the bilingual disadvantage for cognate words, when participants named high frequency words in their L2 only. Gollan & Acenas (2004) compared Tip of the Tongue (TOT) states in bilingual and monolingual participants on a picture naming task, and found that bilinguals only had more TOT's than monolinguals for non-cognate stimuli. For cognate stimuli, monolinguals and bilinguals presented with similar TOT rates, again indicating that the bilingual disadvantage in lexical retrieval is modulated by cognate status.

One goal of the present study was to investigate the effect of cognate status on naming speed and accuracy, in older and younger bilinguals, in comparison to age-matched monolingual English controls. Our predictions for the effect of age and cognate status on the bilingual disadvantage in lexical processing will be made below.

3.2.5 Rationale, aims and hypothesis

This study presents an investigation into picture naming vs. translation in two groups of neurologically healthy Welsh-English bilingual participants. All participants named pictures in Welsh and English, and the same target items were assessed in a translation task from Welsh to English, and from English to Welsh. Both cognate and non-cognate words were tested, in order to investigate the impact of cognateness on accuracy and reaction times. Two age-matched groups of monolingual English participants were also assessed on English picture naming.

While many studies have found an advantage for cognate words in naming, recent investigations have found less robust effects, with some studies even observing inhibitory effects for cognates, and others observing a reversal of the cognate effect in older participants. The research questions being asked here are as follows:

1. *Is there a cognate advantage in picture naming?*

   We hypothesise that participants will be faster and more accurate at naming cognates than non-cognates. Previous studies have observed greater accuracy and shorter reaction times for cognates than non-cognates in different lexical tasks including picture naming and lexical decision (e.g. Costa et al, 2000; Rosselli et al, 2012). Picture naming data from Welsh-English bilinguals will be supported by control data from age matched English monolingual participants in the English picture naming task to ensure that any effects of cognate status are indeed due to bilingualism.

2. *Is the cognate advantage comparable in translation?*

   Our second hypothesis concerns the strength of the cognate advantage in translation as compared to naming, with the same target items, in both directions of translation. Fewer studies have investigated the effect of cognateness in translation than naming. However, several studies, as discussed above, have observed faster translation for cognate words than non-cognates. However, to our knowledge no studies have directly compared the size of the cognate advantage in naming and translation. We expect a stronger cognate advantage in translation than in naming. This is due to the fact that, in addition to the process described for naming, cognate words should also be directly activated by the spoken input. In other words, based on the hypothesis of non-selective activation, the phonology of "cat" would directly activate "cath", in addition to other phonological neighbours (e.g., "pat", "cot", "cap") in the two languages. In contrast, co-activation in naming should be primarily driven by semantics.

3. *Does the cognate effect vary with age?*

   Older participants have previously been found to benefit less from the cognate advantage than younger participants, although this needs to be established more strongly. Previous studies have found that the cognate effect may diminish with age (e.g. Siyambalapitya et al, 2009), and it is possible that older bilinguals may have difficulty selecting between two highly similar lexical competitors when trying to access a cognate word, therefore we predict that the cognate effect may be more pronounced for younger than older bilinguals.

4. *How do bilingual participants differ from their monolingual counterparts in terms of accuracy and reaction times? What effect does cognate status have on this difference, and what does this tell us about the process of lexical activation in bilingual speakers?* Previous studies have found that bilingual speakers are slower at naming than monolinguals, and less accurate (e.g. Gollan et al, 2005), but this disadvantage has been found to be modulated for cognate words (e.g. Ivanova & Costa, 2008). Bilingual speakers have two lexical representations for each concept, therefore they must access and activate the correct lexical representation in the correct language when naming. Furthermore, because bilinguals spend less time speaking each of their two languages than monolinguals do their only language, each word in each language is of relatively

lower frequency for bilinguals than monolinguals. However, based on interactive models of bilingual lexical processing, cognate words receive phonological activation from the non-target language during naming (e.g. Costa et al, 2005). We therefore hypothesise that bilinguals will be slower than monolinguals on the English picture naming task, however, due to the facilitating effect of cognate words on lexical retrieval, we predict that the bilingual disadvantage may be modulated by cognate status.

3.3. Method

3.3.1. Participants

Four groups of participants took part in the present study. All bilingual participants were highly proficient speakers of Welsh and English and had acquired both languages in early childhood. All monolingual English participants were highly proficient speakers of English, acquired in early childhood. All participants lived in North Wales at the time the study took place. Prior to assessment taking place, written consent was obtained for all participants (see Appendix A).

The initial cohort was a group of 37 neurologically healthy Welsh-English bilingual participants. All participants completed language and medical questionnaires prior to inclusion in the study, see Appendix B. Following initial administration of all tasks to this group of participants, several pictures in both language versions of the naming test were deemed to be ambiguous, therefore testing was repeated with a new set of stimuli in which the ambiguous items were replaced for 35 of the 37 participants, as two participants were no longer available for testing.

A period of several months separated the first and second administrations of the test, and no feedback was given on either occasion therefore no learning of any items was deemed to have taken place. The items administered twice are listed in Appendix C.

Following initial data analysis, and removal of items, described in the stimuli and procedure section below, three further groups of participants then took part in the study, younger Welsh-English bilingual participants, older English monolingual participants and younger English monolingual participants. The data from participants from all four participant groups, who completed all relevant tasks, can be seen below in Table 3.1. Several further participants in each participant group were recruited to the study but were not included in the present analyses as they did not complete all tasks.

Table 3.1. Details of participants age, gender and background assessment scores (number of participants in parentheses).

	Younger monolinguals	Younger Bilinguals	Older Monolinguals	Older Bilinguals
Number of participants	19	20	20	35
Mean Age	20.73	26.3	59	62.5
Gender	12 f, 7 m	17 f, 3 m	8 f, 12 m	19 f, 16 m
BPVS* (mean score, N)	93.7 (17)	80.52 (19)	102.7 (19)	94.5 (35)
PGC (mean score, N)**	N/A	72.3 (19)	N/A	90.2 (35)
Mean SES	2	1.65	1.9	1.77

*British Picture Vocabulary Scales, Dunn et al, 1997
**Prawf Geirfa Cymraeg, Gathercole & Thomas, 2007

3.3.2. Stimuli

The purpose of the investigation was to examine the effect of cognateness and frequency on accuracy and reaction times in a picture naming task and a translation task in Welsh and English.

A picture naming and translation test containing 200 words (100 each of English and Welsh) was developed in order to assess accuracy and response times in Bilingual Welsh-English speakers. In each language, the items were divided into the following 4 categories according to length and frequency (n=25 in each category): i) High Frequency Long; ii) High Frequency Short; iii) Low Frequency Long; iv) Low Frequency Short. The words were grouped into high and low frequency categories according to the following criteria:

- High frequency: above 25 occurrences per million (English words: Celex lexical database (Baayen, Piepenbrock & Van Rijn, 1993); Welsh words: Cronfa data electroneg o Gymraeg (Ellis, O'Dochartaigh, Hicks, Morgan, & Laporte, N. 2001)). In Welsh, words are mutated depending on sentence position, and CEG provides a frequency value which includes all mutated forms of each word (such as CI, which can be mutated into *gi, chi, nghi* depending on sentence position). This lemmatised version of each word was used to avoid cross language differences in frequency as a result of mutations). In both languages, the lemmatised version also includes the plural and inflected forms of words
- Low frequency: between 1-25 occurrences per million (databases: as above).

Items were determined to be short if they consisted of 4 phonemes or fewer (RP non-rhotic English accent) and to be long if they had 5 phonemes or more. Each sub-section contained 25 items, 7 of which were Welsh-English cognates, and consequently were the same target items in both languages. Cognateness was determined based on the following criteria:

- Number of Common Phonemes: Welsh-English translation equivalents to share at least 50% of their phonemes but less than 100% so as to be able to distinguish them.
- Letter similarity: Welsh-English translation equivalents to share at least 50% of their letters, but less than 100% so as to be able to distinguish them.
- Semantics: The word must have the same meaning in both languages.
- Between-language similarity: Welsh-English translation equivalents to correspond across both languages in frequency and phoneme/letter length; e.g. a word had to be, for example, low frequency (<25 occurrences per million) and short (<4 phonemes) in both English *and* Welsh.

Fewer cognate items than non-cognates were included in order to mask the intent of comparing accuracy and naming latency in cognates versus non-cognates. A further consideration was the difficulty of finding pictureable items that matched across languages for frequency and length.

Following word selection, for the picture naming task, clipart images or photographs available for non-commercial use were chosen from an online search engine to correspond with each word.

Following initial administration to the older Welsh-English bilingual participants, several items were considered to be outliers in terms of accuracy. The reason for this is that the purpose of the task was to be an assessment of naming ability in Welsh-English bilingual participants with aphasia. Therefore, high accuracy in control participants was necessary in order to determine naming impairments in aphasic participants. The cut off for outliers in the item analysis was set at 75% accuracy. That is, if fewer than 75% of the control participants accurately named a particular item, it was removed from the final assessment. Details about those items that were removed from the final test, and those items which remained in the assessment administered to the three further participants groups, can be found in Appendix C. Following item removal, both the English and Welsh naming and translation tests consisted of 80 words each.

The English picture naming task was then administered to a further three participant groups: Older English monolingual participants, younger Welsh-English bilingual participants and younger English monolingual participants. The Welsh picture naming task and both translation tasks were administered to the younger bilingual Welsh-English participants.

Upon further administration to the three extra participant groups discussed above, several further items in both language versions of the naming and translation test were removed as they proved to be ambiguous in terms of either picture name or translation target/stimulus. For example, in the translation task the item ‘bull’ was heard as ‘ball’ by several of the participants and was therefore judged to be unclear. If an item proved problematic in one task or participant group it was removed from all analyses in order to enable comparison across tasks and participants. Items were considered to be ambiguous if they had an accuracy score of more than 2.5 standard deviations below the mean number correct for any one participant group. Items removed from tasks can be seen in Appendix C, along with the final word lists.

Following item removal, the English naming and translation task consisted of 75 items, and the Welsh naming and translation consisted of 77 items. The lexical characteristics of the target items in each assessment can be seen in Table 3.2 below.

Table 3.2: lexical characteristics of target words in English and Welsh picture naming and translation tasks

Word group	**Log 10 frequency Mean (SD)**		**Phoneme length Mean (SD)**		**Number of items**	
	English	*Welsh*	*English*	*Welsh*	*English*	*Welsh*
ALL ITEMS	1.44 (0.54)	1.43 (0.58)	4.36 (1.56)	4.41 (1.22)	75	77
High frequency (all)	1.96 (0.28)	1.93 (0.25)	4.05 (1.55)	4.23 (1.09)	34	39
Cognates	1.86 (0.22)	1.75 (0.29)	4.00 (1.41)	4.08 (1.16)	10	12
Non-cognates	2.01 (0.31)	2.01 (0.19)	4.08 (1.67)	4.30 (1.10)	24	27
Low frequency (all)	1.01 (0.21)	0.91 (0.56)	4.61 (1.52)	4.62 (1.31)	41	38
Cognates	1.05 (0.19)	0.75 (0.31)	4.76 (1.35)	4.93 (1.14)	16	14
Non-cognates	0.98 (0.22)	1.00 (0.30)	4.50 (1.69)	4.42 (1.41)	25	24

Independent samples t-tests were conducted to investigate differences in frequency and phoneme length across language. With all items considered together there was no significant difference in frequency across languages, $t(150)=.151$, $p=.88$).

No significant difference was observed in phoneme length across languages (all items) $t(150)=-.243$, $p=.81$.

Further independent samples t-tests were conducted to measure differences in frequency and phoneme length in cognate items, non-cognate items, high frequency items and low frequency items across languages.

Within non-cognate items, there was no significant difference in frequency across languages (English: $M=1.49$, $SD=0.58$; Welsh: $M=1.53$, $SD=0.56$), $t(97)=-.371$, $p=.711$. There was no significant difference in phoneme length across languages (English: $M=4.3$, $SD=1.67$; Welsh: $M=4.35$, $SD=1.25$), $t(97)=-.207$, $p=.836$.

Within cognate items, there was no significant difference in frequency across languages (English: $M=1.34$, $SD=0.45$; Welsh: $M=1.21$, $SD=0.59$), $t(51)=.94$, $p=.351$. There was no significant difference in phoneme length across languages (English: $M=4.48$, $SD=1.39$; Welsh: $M=4.5$, $SD=1.21$), $t(51)=-.159$, $p=.875$.

Within high frequency items, there was no significant difference in frequency across languages (English: $M=1.96$, $SD=0.29$; Welsh: $M=1.93$, $SD=0.26$), $t(71)=.491$, $p=.63$. There was no significant difference in phoneme length across languages (English: $M=4.05$, $SD=1.57$; Welsh: $M=4.23$, $SD=1.11$), $t(71)=-.544$, $p=.58$.

Within low frequency items, there was no significant difference in frequency across languages (English: $M=1.00$, $SD=0.21$; Welsh: $M=.91$, $SD=0.32$), $t(77)=1.62$, $p=.109$. There was no significant difference in phoneme length across languages (English: $M=4.61$, $SD=1.55$; Welsh: $M=4.61$, $SD=1.33$), $t(71)=-0.14$, $p=.989$.

In summary, all sets were well matched within and across languages for frequency and phoneme length.

In terms of accuracy, all participants achieved scores within 2.5 standard deviations of the mean score for both the English and Welsh versions of the picture-naming and translation tasks, therefore no participant outliers were identified or removed from the analysis.

3.3.3. Procedure

Picture naming and translation tasks were administered in each language. The same target items were probed in both tasks in each language, but never in the same session, i.e. participants were not required to both name and translate items within a single testing session. All testing sessions focused on one language only.

Participants were either visited in their home and tested using a laptop computer, or they visited Bangor University for testing on a desktop computer. In all cases testing took place in a quiet room with no distractions. Participants were given breaks in order to minimise fatigue effects. All sessions were audio recorded on Mp3 format for post-test verification of responses and errors. For all tests, a spoken and written explanation of the task was given to the participants prior to testing in the target language, to ensure that participants understood what was required of them. This is recorded in Appendix D. All assessments were administered on a computer using e-Prime, during sessions which comprised reading, spelling and cognitive assessments as part of a larger battery of tasks.

Before the main test, 10 practice items were administered, in the same format as the main test. If the participant made any errors on these items, feedback was given. During the main test, no feedback was given. Testing was carried out by English, monolingual, post-graduate and undergraduate students during the English sessions, and by Welsh-English bilingual post-graduate students and research assistants during the Welsh sessions. In order to minimise cross-language intrusions during testing English and Welsh sessions were carried out by different testers. Only the target language of the session was spoken by the tester, before and during testing.

For the picture naming task, participants were shown a picture of an object on a computer screen and asked to name the item in the target language as quickly and accurately as possible. For the translation task, stimulus words were recorded by a Welsh-English bilingual speaker and presented via headphones. Participants were asked to translate the word into the target language as quickly as possible. Stimuli were repeated if the participant misheard them, and this was noted by the tester.

3.3.4. Scoring and Statistics

The analyses below evaluate accuracy and reaction times on picture naming in Welsh, and translation from Welsh to English and vice versa for the two Welsh-English bilingual participants groups. Accuracy and reaction times for picture naming in English are evaluated for the two Welsh-English bilingual participant groups and for the two English monolingual participant groups (older and younger).

Each task will be discussed separately below. Owing to the different numbers of items within word groups (high and low frequency; non-cognate and cognate) accuracy scores have been converted into percentages in order to enable comparison of participant accuracy across word groups.

An item was judged to be correct if the target item was named or translated correctly, or if a synonym for that item was produced. In the case of cognates, alternatives were not allowed as correct answers, as the purpose of including cognate items in the test was to investigate their effect as compared to non-cognate items.

Reaction times were measured by the E-Prime software, using a serial response box and voice key connected to a microphone. The software was calibrated to each participant's vocal levels prior to assessment. When the participants began to speak the sound activated response box recorded the naming latency. In the picture naming task, all reaction times were measured from the time the picture appeared on the screen to the time the participant began to respond to the stimulus in the Picture naming task. In the translation task, reaction times were measured from the beginning of the spoken stimulus to the onset of the spoken response. All reaction times were used in the following analysis, except in the following cases where RT's were excluded:

i) If the participant responded incorrectly.

ii) If the participant self-corrected from an incorrect response to a correct one.

iii) If the participant's response was below 300ms or above 9000 ms. Reaction times below 300 ms were assumed to be a 'microphone error' based on research that has found that it takes a minimum of 400ms to react to a stimulus and produce a lexical response. Reaction times above 9000ms were considered to be outliers.

All sessions were also recorded in order to check responses manually. When a reaction time was inaccurate on the ePrime measurement due to the participant or tester involuntarily making a noise, for example coughing, the correct reaction time was measured manually using Wavepad software. Median reaction times were computed, rather than means, in order to reduce the effect of extreme reaction times on the analyses.

Due to ceiling effects affecting the distribution of scores, non-parametric tests were used for analysis of accuracy (Wilcoxon signed-ranks test for paired-sample comparisons, and Mann-Whitney U test for independent sample comparisons). Mixed Anova was used for all reaction time analyses. Because performance tended to be high in all tasks and groups, the results section will give more emphasis to the reaction time analyses. One-tailed p-values are reported for those comparisons where we had a priori predictions as to the direction of the possible difference between stimulus types or participant groups. Two-tailed p-values are reported for other contrasts, or when the observed difference was in the opposite direction to what was predicted.

3.4. RESULTS

The accuracy and reaction times results will first be presented for each task, followed by comparisons across tasks. All four participant groups completed the English picture-naming task. Only the older Welsh-English bilingual participants and the younger Welsh-English bilingual participants completed the remainder of the tasks (Welsh naming, English-Welsh translation and Welsh-English translation).

3.4.1. Preliminary analyses in the English Picture Naming Task

3.4.1.1. Accuracy

Table 3.3: Mean accuracy and standard deviations (%) in the English picture naming task

Group	Total	High Frequency Cognates	High Frequency Non-cognates	Low Frequency cognates	Low Frequency Non-Cognates
Older bilinguals	97.7 (2.7)	96.8 (6.7)	98.3 (2.7)	97.2 (3.3)	97.9 (3.1)
Older monolinguals	97.3 (2.2)	94 (9.4)	97.9 (3.2)	96.7 (3)	98.3 (2.5)
Younger bilinguals	94 (3.5)	90.5 (6.8)	95.2 (4.5)	94.1 (5.4)	94.2 (5.1)
Younger monolinguals	96.7 (1.4)	91.5 (8.3)	98 (2.9)	96.9 (4.9)	97.4 (2.8)

As can be seen in Table 3.3 above, accuracy was high for all categories of items and participants. Unexpectedly however, high frequency cognates generated more errors than the other categories; in particular, they were less accurate than low frequency cognate words. This is discussed further below.

3.4.1.2. Reaction times

Table 3.4. shows the reaction time results for all four participant groups in the English picture naming task. Here again, we observed an anomalous performance on high frequency words that mirrors what was reported in the accuracy analyses. This leads to a reversal of the customary frequency effect.

Table 3.4: Mean of median reaction times and SD in the English picture naming task.

		Stimulus Type			
Group	Total	High Frequency Cognates	High Frequency Non-Cognates	Low Frequency Cognates	Low Frequency Non-Cognates
Older Bilinguals	1001.32 *(194)*	1107.71 *(296.62)*	1013.22 *(152.8)*	887.8 *(121.98)*	1006.89 *(180.32)*
Older Monolinguals	867.49 *(189.29)*	1025.96 *(285.79)*	875.22 *(135.42)*	788.2 *(149.85)*	828.13 *(160.76)*
Younger Bilinguals	955.2 *(202.04)*	1059.17 *(305.74)*	946.16 *(162.89)*	868.4 *(142.54)*	967.39 *(194.2)*
Younger monolinguals	856.99 *(174.47)*	1025.17 *(243.2)*	837.76 *(140.65)*	779.33 *(108.64)*	840.8 *(153.27)*

Examination of the results by item (see Appendix E for all accuracy results) revealed that four high frequency cognate words were outliers in their own category (being 2.5 SD below the mean in accuracy or above the mean for reaction times). This appeared to be due to these items being less pictureable and/or compatible with more than one answer (e.g., pilot: captain, airman). A similar problem was observed in the Welsh naming task that makes use of the same pictures (see Appendix E). Our interpretation as to the cause of these anomalous results is reinforced by the fact that these items did not pose any particular problem in the translation tasks where normal frequency effects are observed (see below). It was not possible to remove these items as the N for high frequency cognate is low (due to the difficulty of finding suitable cognate stimuli that were of comparable frequency across languages); in addition, there was not a full overlap across participant groups in the words that met the outlier criterion of 2.5 SD below the mean. For this reason, we decided to base our analyses on low frequency words only. Note that none of our predictions are specifically related to frequency, which justifies limiting our analyses to low-frequency words.

3.4.2. English Picture Naming Task

In this section we report the results for low frequency words only. The accuracy and reaction time data can be seen in Tables 3.3 and 3.4 above and are analysed below for low frequency words only. Significant effects only are reported in the text.

3.4.2.1 Accuracy

As expected, cognates (M=96.8) were more accurate than non-cognates (M=95.4) in the bilingual group z=-2.705, p<.01, r=-.36. In addition, younger participants (M=95.6) were less accurate than older ones (M=97.6) z=-2.78, p<.01, r=-.28). There was no difference in accuracy between monolingual (M=97.4) and bilingual (M=96.4) participants (p>.10).

3.4.2.2. Reaction times

We conducted a 2x2x2 Anova comparing the effect of cognateness as a function of age and language group (monolingual vs. bilingual). This analysis reveals that, overall, cognates were named more quickly than non-cognates (Cognates: M: 823 ms, SE: 16.4; Noncognates: M: 868 ms, SE: 18.96; F(1,90) =21.75, p<.001), and bilingual participants were slower than monolinguals (bilinguals: M= 908 ms, SE: 22.5; monolinguals: M= 783 ms; SE: 25.7, F (1, 90)= 13.7, p<.001). There is also a non-significant trend for older participants to be slower than younger participants (younger: M= 823 ms, SE: 25.7; older: M= 869, SE=22.5). Crucially, we observe the predicted interaction between language group and cognateness (F(1, 90)= 10.78, p<.01), which is due to the cognateness effect being larger in bilinguals than in monolinguals (see Figure 3.4, below). No other effects were significant.

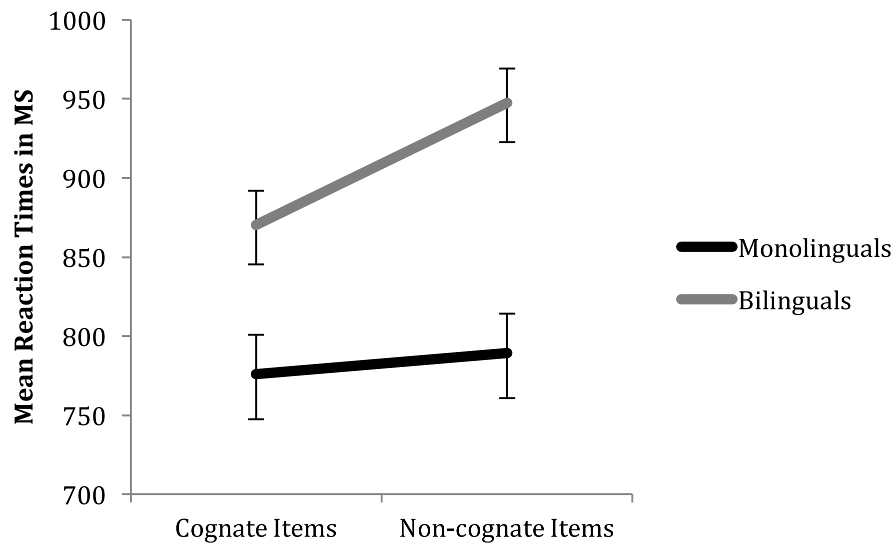


Figure 3.4: Interaction between language group and cognate status on reaction times in the English picture naming task.

To further examine the interaction between language group and cognateness, two 2X2 Anovas were performed which test the effect of cognateness for the monolingual and the bilingual participants separately (collapsed across age groups as age did not interact with language group and cognateness).

These analysis confirm that there is no effect of cognateness in monolingual participants (Cognates: M= 776 ms, SE: 24.83; Non-cognates: M=789, SE: 28.45; F (1, 38)=.964, p=.332) but that cognates are named significantly faster in bilingual participants (Cognates: M = 870ms, SE: 21.72; Non-cognates: M=961 ms, SE: 24.98, F (1, 54)=40.52, p<.001).

Furthermore, the main effect of language group confirms our prediction that bilinguals would be slower than monolinguals. This factor interacts with cognateness because, as can be seen in Figure 3.4, the bilingual disadvantage is less pronounced for cognates than non-cognates. However, follow up one-way Anovas indicate that bilingual participants are slower both for cognates [$F(1,92)=10.36$, $p<.01$] and for non-cognates [$F(1,92)=20.76$, $p<.0001$].

In summary, we have confirmed the existence of a cognate advantage in English picture naming and further established that this advantage is specific to bilingual participants, which eliminates the possibility that cognate items may be easier to access for other reasons. In addition, we have shown that the cognate effect is of comparable size in younger and older participants. Finally, bilingual participants are slower than monolinguals.

This being established, we will now examine how the cognateness effect applies to a Welsh picture naming task and a translation task.

3.4.3. Welsh picture naming task

3.4.3.1. Accuracy

Table 3.5. below shows the accuracy results for the older and younger Welsh-English bilingual participant groups in the Welsh picture naming task. Similar to what was observed in the English picture naming task, cognate words (M=92.9) tended to be produced more accurately than non-cognates (M=91.1) (z=-1.24,p=.09 2-tailed, r=-.16), and younger participants (M=85.9) were less accurate than older ones (M=95.9) (z=-3.5, p<.001; 2-tailed, r=-.47). We also compared production in Welsh and English. This revealed that younger participants were more accurate in producing English (M= 94.2) than Welsh (M=85.9) (z= -2.73, p<.01, 2-tailed, r=-.61).

Table 3.5: Mean % correct in the Welsh picture naming task for low frequency items (SD)

Participant Group	Total	Cognates	Non-cognates
Older bilinguals	95.9 (6.28)	97.48 (3.3)	93.76 (7.2)
Younger bilinguals	85.9 (18.08)	90 (18.13)	80.38 (17.4)

3.4.3.2. Reaction times

Table 3.6 below shows the reaction time results for both participant groups in the Welsh picture naming task.

Table 3.6: Mean of median response time in the Welsh picture naming task for low frequency items (SD)

Group	**Total**	**Cognates**	**Non-cognates**
Older bilinguals	1094.04 (235.3)	1007.98 (178.01)	1167.24 (299.09)
Younger bilinguals	876.35 (125.15)	842.52 (116.9)	777.22 (240.55)

In order to study cognateness effects in Welsh and to compare their magnitude in English vs. Welsh, we conducted a 2x2x2 Anova comparing the effect of cognateness as a function of age group (younger vs. older) and language (English vs. Welsh). This analysis shows that, overall, cognates were named faster than non-cognates (Cognates: *M*: 897ms, *SE*: 21.61; Non-cognates: *M*: 988ms, *SE*: 30.89; $F(1,53)=30.5$, $p<.01$). In addition, it reveals that naming in Welsh was slower than naming in English (Welsh: *M*: 976ms, *SE*: 28.27; English: *M*: 908ms, *SE*: 25.78; $F\ (1,53)=13.18$, $p<.01$) and that older participants took longer to respond than younger ones (Older: *M*: 1021ms; *SE*: 30.61; Younger: *M*: 864ms; *SE*: 40.49; $F(1,53)=9.52$, $p<.01$), an effect that did not reach significance when English naming was considered in isolation and when both monolinguals and bilinguals were included in the analysis (see previous section). There is also an interaction between age group and cognateness ($F(1,53)=4.36$, $p<.05$) linked to a larger effect of cognateness in older participants (See Figure 3.5).

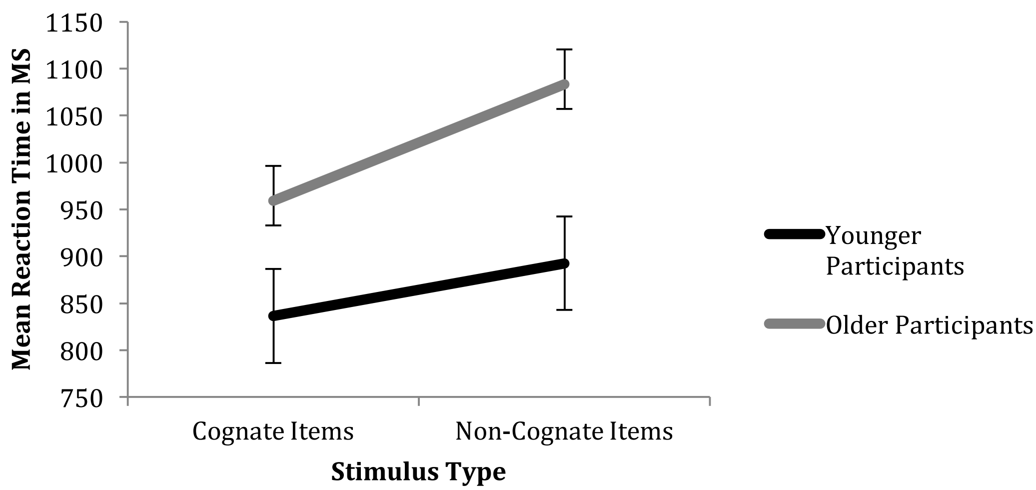


Figure 3:5 Interaction between age group and cognate status on reaction times in a picture naming task, collapsed across languages

In addition, there was an interaction between age group and language of test, such that only older participants were slower in Welsh than in English (Welsh: *M*: 1087ms, *SE*: 34.09; English: *M:* 954ms; *SE*: 31.09; $F\ 1,53)=11.97$, $p<.01$) (see Figure 3.6). No other effects were significant.

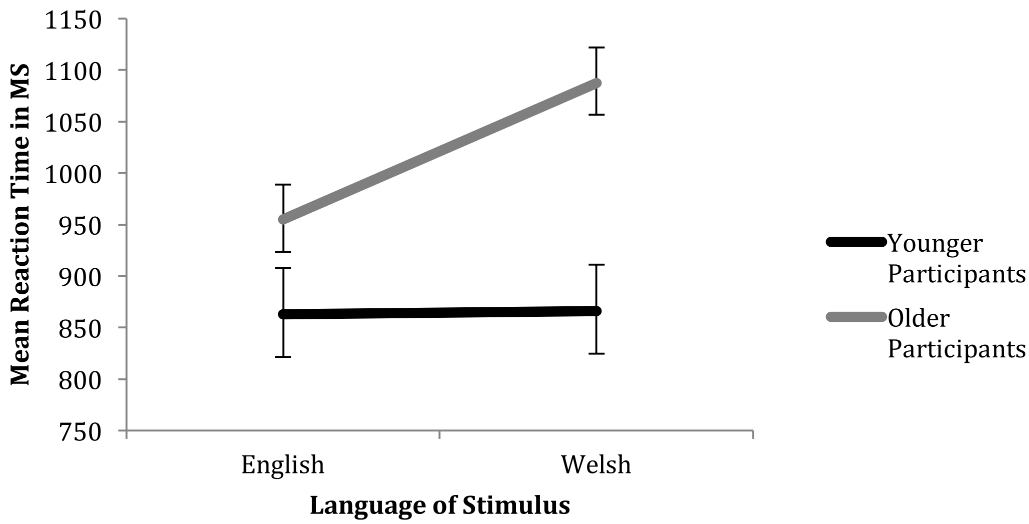


Figure 3.6 Interaction between age group and language of task on reaction times in a picture naming task.

3.4.4.Welsh-English and English-Welsh translation tasks

3.4.4.1. Accuracy

Table 3.7 below shows the accuracy results for the older and younger Welsh-English bilingual participant groups in the Welsh-English and English-Welsh translation tasks.

Table 3.7: Mean % accuracy in the English and Welsh translation tasks for low frequency items (SD)

Participant Group	**Stimulus Type**			
	Welsh-English Cognates	Welsh-English Non-cognates	English-Welsh Cognates	English-Welsh Non-cognates
Older Bilinguals	91.55 (4.82)	85.95 (10.11)	96.33 (7.63)	94.4 (6.33)
Younger Bilinguals	92.5 (11.25)	71.2 (27.09)	81.43 (13.78)	80.83 (9.74)

In the Welsh to English translation task, cognate words were more accurate than non-cognates both in younger (cognates: *M*=90.3; non-cognates *M*=78.3) and older (cognates: M=96.9; non-cognates M=93.8) participants (Younger: z=-3.26, p<.001, r=-.73; Older: z= -2.4, p<.01, r= 4.1). The same was true in the English to Welsh translation task for younger (cognates: M=92.1; non-cognates M=84.3) and older (cognates: M=96.3; non-cognates M=94.4) participants (Younger: z=-2.43 p<.01, r=-.54; Older: z= -1.9, p<.05, r= .325). As before, younger participants were less accurate than older ones; Welsh-English translation z=-4.38, p<001, r=-.97; English-Welsh translation: z=-2.54, p<.02, r=-.43, all 2-tailed). These analyses are based on low-frequency words only to match what was done in the naming tasks. However, it should be noted that in the translation tasks we observed a standard frequency effect, as in both groups and tasks high-frequency words were produced more accurately than low-frequency ones (all four p<.01). This supports our interpretation that the unexpected reversal of frequency effects in the picture naming tasks was likely due to the presence of ambiguous pictures in the high-frequency cognate set, a problem that is eliminated when the input is a spoken word instead of a picture. As for picture naming, we also compared accuracy when producing Welsh vs. English but there were no significant difference in either younger or older participants (both p>.10)

3.4.4.2. Reaction times

The following analysis was done on the low-frequency items only in order to enable comparison with the analysis of the picture naming task.

Table 3.8. below shows the reaction time results for both participant groups in the Welsh-English and English-Welsh translation tasks.

Table 3.8: Mean of median response time in the English and Welsh translation tasks for low frequency items (SD)

Participant Group	Stimulus Type			
	Welsh-English Cognates	Welsh-English Non-cognates	English-Welsh Cognates	English-Welsh Non-cognates
Older Bilinguals	1293.91 (144.3)	1540.14 (268.5)	1319.9 (301.1)	1551.5 (220.02)
Younger Bilinguals	1105.02 (122.3)	1204.5 (197.7)	1176.6 (151.8)	1287.4 (142.7)

As for the naming task, we conducted a 2x2x2 Anova comparing the effect of cognateness as a function of age and language (English vs. Welsh). This analysis reveals that, overall, cognates were named faster than non-cognates (Cognates: *M*: 897ms; *SE*: 21.61; Non-cognates: *M*: 988ms; *SE*: 30.89; F (1, 53)=30.59, p<.01). In addition, older participants took longer to respond than younger ones (Older: *M*: 1021; *SE*: 30.61; Younger: *M*: 864ms; *SE*: 40.49; F (1,53)=9.52, p<.01). Contrary to what was observed in naming, translation in Welsh is not significantly slower than in English although there is a numerical trend in that direction (Welsh: *M*: 1154ms, *SE*: 23.55; English: *M*: 1097ms; S*E*: 20.3; F(1,53)=2.186, p=.145, *n.s.*). We also observe an interaction between age group and cognateness (F (1,53)=11.6, p<.01) linked to a larger effect of cognateness in older participants (See Figure 3.7), as was observed in the naming tasks. No other effects were significant.

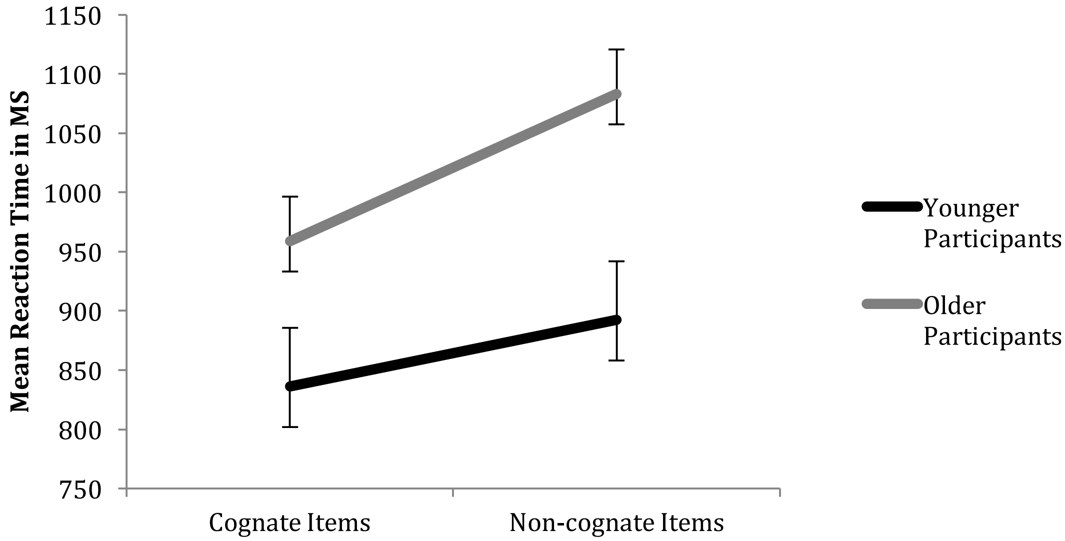


Figure 3.7 Interaction between age group and cognateness on reaction times in the translation tasks.

To examine further the interaction between age group and cognateness, two further 2X2 Anovas were performed that examine the effect of cognateness and language for younger and older participants separately. These analysis show that the cognate advantage is significant in both younger ($F(1,19)=8.88$, $p<.01$) and older participants ($F(1,34)=110.6$, $p<.001$). In addition, younger participants were slower translating into Welsh than into English ($F(1,19)=6$, $p<.05$).

3.4.5. Comparison of cognateness effects across tasks

The main aim of this analysis is to determine if the cognateness effect is of similar magnitude in naming and translation. We also examine if any of the other main or interaction effects reported above are affected by task. For this purpose, we performed a 2x2x2x2 Anova with cognateness, language and task as within subject factors and age group as a between subject factor.

As previously, this analysis shows that cognates are produced faster than non-cognates (Cognates: *M*: 1059ms; *SE*: 19.13; Non-cognates: *M*: 1191, *SE:* 23.36; $F(1,53)=78.32$, $p<.001$), that older participants are slower than younger ones (Older: *M*: 1222ms, *SE*: 24.12; Younger: *M*: 1028ms; *SE*: 31.91; $F(1,53)=23.44$, $p<.001$), and that producing words in Welsh is slower than in English (Welsh: *M*: 1154ms, *SE*: 23.5; English: *M*: 1097ms; *SE*: 20.3; $F(1,53)=9.69$, $p<.01$). In addition, this analysis reveals that translation is slower than picture naming (Translation: *M*: 1308ms, *SE*: 21.9; Naming: *M*: 942ms, *SE*: 25.38; $F(1,53)=206.7$, $p<.001$), although it should be noted that the two tasks are not directly comparable in terms of overall reaction times given that the inputs differ (in particular, reaction times are measured from the onset of the auditory stimulus in translation, which may partly explain why latencies in this task are longer).

The Anova also revealed three interaction effects. First, there is an interaction between age group and cognateness [$F(1,53)=11.92$, $p<.01$] which is due to the cognate advantage being larger in older participants (see Figure 3.8 below); this interaction has already been shown to be significant in each task analysed separately (see previous sections). Second, there is an interaction between Task and Cognateness [$F(1,53)=15.27$, $p<.001$], such that the advantage in producing cognates is larger in the translation task (see Figure 3.9 below) Third, there is an interaction between Task, Language and Age Group ($F(1,53)=7.26$, $p<.01$). This interaction is depicted in Figures 3.10 a and b, and appears to be due to older participants being slower in Welsh in the naming task only, with the opposite being true for younger participants. As this interaction does not involve the cognateness factor and does not relate to our main research questions, it will not be analysed further.

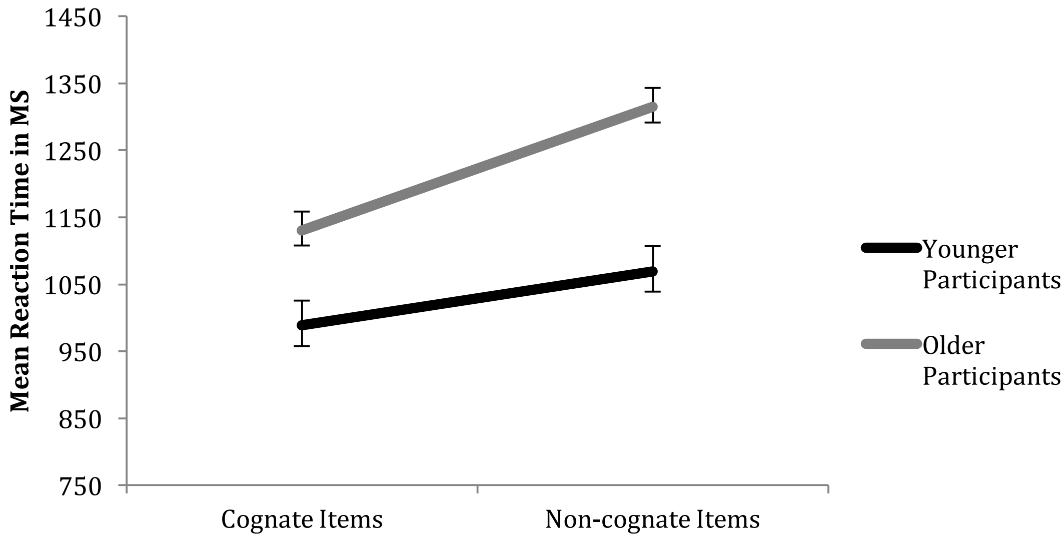


Figure 3.8 Interaction between age group and cognateness on reaction times on translation and naming tasks analysed together (error bars show SE).

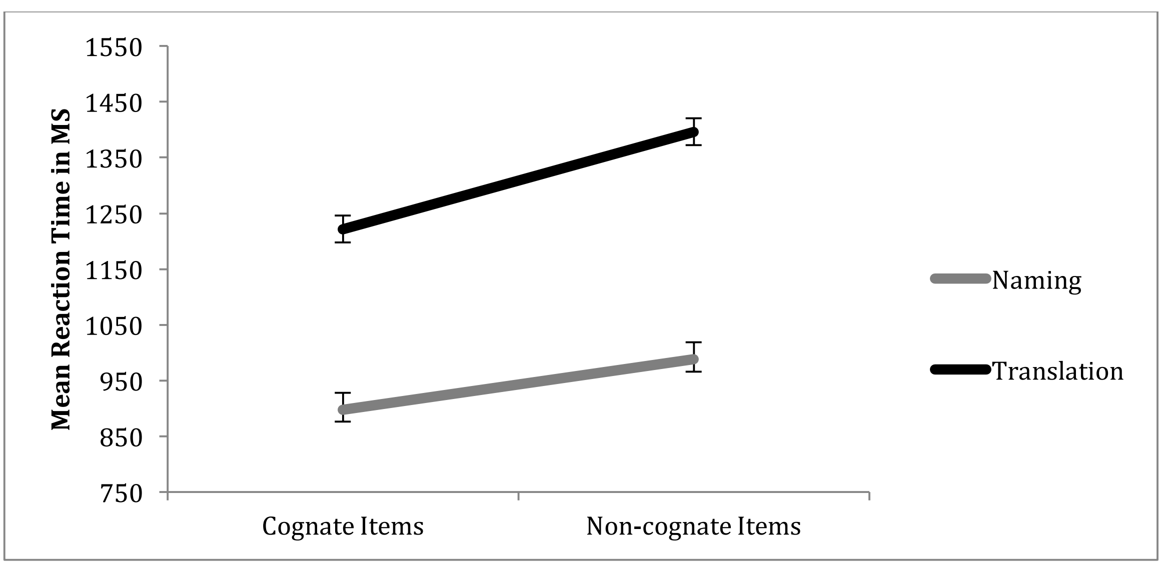


Figure 3.9 Interaction between task and cognateness on reaction times on translation and naming tasks analysed together (error bars show SE).

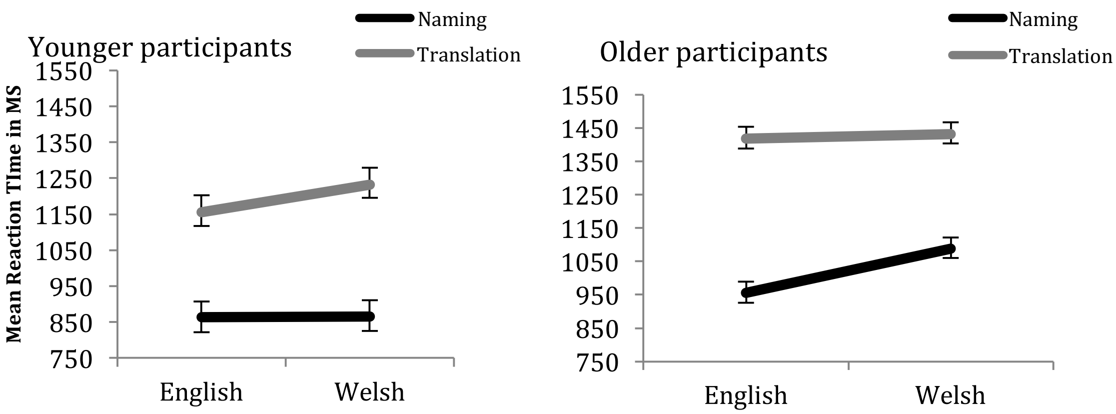


Figure 3.10 a & b: Interaction between age, task and language on reaction times on translation and naming tasks analysed together (error bars show SE).

3.5. Discussion

The present study investigated the effect of cognate status on naming and translation accuracy and response times in bilingual and monolingual neurologically healthy participants. As predicted, bilingual participants were faster and more accurate at naming and translating cognates than non-cognates in both languages. The cognate effect was larger in translation than in naming, and was larger for older participants than younger participants. Younger participants were less accurate than older participants on all four tasks, and older participants were slower than younger participants on all tasks. Monolingual participants were faster than bilinguals on English naming. This finding was less pronounced for cognates than non-cognates, though still significant. These results will be discussed below in relation to our hypotheses.

3.5.1. The cognate advantage in picture naming

We predicted that participants would be faster and more accurate at naming cognates than non-cognates. This prediction was upheld in both English and Welsh picture naming for accuracy and reaction times. This finding is in line with previous investigations of the cognate advantage in bilingual speakers (e.g. Costa et al, 2000). The data on the English picture naming task were supported by results from monolingual English participants, who showed no corresponding advantage for cognates in terms of either accuracy or response times which validates the conclusion that the cognate advantage is indeed due to bilingualism rather than to uncontrolled factors in the stimuli.

3.5.2. The cognate advantage in translation

Fewer studies have investigated the effect of cognate status on translation accuracy and speed as compared to picture naming, and none have directly compared the two tasks in relation to the effect of cognateness. However, we predicted that the effect of cognateness would be more pronounced for translation than for naming due to a direct co-activation of phonological forms in the two languages by the spoken input, which should increase as a function of the degree of phonological overlap between stimuli and lexical representations. This prediction was upheld, as the cognate advantage was significantly larger in translation than in naming, in both Welsh and English.

3.5.3. Bilingual versus monolingual processing

We compared naming accuracy and reaction times of bilingual and monolingual participants on an English picture naming task, and predicted that monolingual participants would be faster at naming than bilinguals, though this bilingual disadvantage may be modulated by cognate status. The first part of our prediction was upheld; both older and younger monolinguals were faster at naming than their bilingual counterparts. The significant interaction between language group and cognate status indicates that our second prediction concerning cognateness was also upheld: even though bilingual participants were slower than monolinguals both for cognates and non-cognates, the bilingual disadvantage was reduced for cognate words.

This result conflicts with findings by Ivanova & Costa (2008), who observed a modulation of the bilingual disadvantage for high frequency cognate words in the participants' L2 only. While our analyses were limited to low frequency words due to methodological issues, we did nevertheless observe a reduction in the bilingual disadvantage for cognates as compared to non-cognates. Our findings provide support for theories of language non-selective activation and interactivity between levels of processing and between languages (e.g. Costa et al, 2005).

3.5.4 The effect of age on the cognate advantage

We investigated the effect of age on the cognate advantage, and, based on previous findings in the literature (e.g. Siyambalapitiya et al, 2009), predicted a stronger effect of cognate status for the younger participants group. However, we observed a stronger cognate advantage for older participants than for younger participants, in both the naming and translation tasks, despite having slower reaction times overall, which conflicts with those of Siyambalapitiya et al (2009). Although we observed robust age effects, the cognate advantage was actually larger in older participants than in younger in both naming and translation tasks.

A possible explanation for the conflicting results of our study and that of Siyambalapitya et al (2009) is that the Siyambalapitiya study utilised two different task designs with older and younger participants, namely orthographic stimuli with younger participants, and phonological stimuli with the older group. This means that the performance of the two age groups was not as directly comparable as in our study.

3.5.5. Contributions & Implications of the present study

The present chapter reports an investigation into naming and translation in older and younger bilingual participants, investigating the effects of task and age on the strength of the cognate advantage. In general, the facilitatory effect of cognate words was robust across bilingual participant groups and across tasks, supporting interactive models of bilingual processing, such as that posited by Costa et al (2005).

We observed a stronger cognate advantage for translation than for picture naming, which may provide support to hypotheses that suggest translation of cognate words and non-cognates relies to differing degrees on the contribution of the semantic and lexical routes to translation (e.g. De Groot, 1992). That is, translation of cognates may rely more on direct lexical associations, whereas translation of non-cognates may need to be conceptually mediated to a larger extent, due to the fact that the spoken input of cognate stimuli should directly activate the phonological representation of the target translation.

3.5.6 Limitations & Future Directions

The present study extended the reach of most investigations of bilingual lexical processing, in that accuracy and speed of both naming and translation were investigated in the same participants, with the same target items, with a further focus on the impact of age and cognate status on processing. Moreover, these data were supported by control data from age matched English monolingual participants.

As discussed above, some pictures were found to be problematic in the naming tasks, resulting in reverse frequency effects and longer reaction times for certain stimuli. In the cognate items, this problem was exacerbated by the fact that there were fewer items in each cognate category than non-cognates due to the smaller pool to draw from and due to strict pairwise matching criteria across languages in terms of length and frequency. As a result, the analyses were restricted to low-frequency words, Despite these methodological issues, the cognate effect was robust across tasks, and across participant groups, but we cannot generalise our findings to words in the full frequency spectrum, which could be the focus of future investigations.

Inclusion of well-controlled high and low frequency stimuli would enable an investigation of the interaction between age-related slowing and the effect of word frequency, alongside the effect of cognateness. Strijkers et al (2009) observed an interaction between word frequency and cognateness on speed of picture naming with a group of younger Catalan-Spanish bilinguals, with a larger cognate effect for high frequency words. Gollan et al (2008) observed longer latencies for L1 naming in older participants in low frequency words only, but in L2 the age-related slowing was limited to high frequency items. However they did not investigate the effect of cognate status. Furthermore, the participants in the present study were more balanced than those in the Gollan et al study. A future investigation could broaden the scope of the present findings by investigating this effect to include less balanced bilinguals.

A further possible limitation concerns the use of spoken stimuli in the translation task. Reaction times were measured from stimulus onset so that several hundred milliseconds had to elapse before the stimulus could be identified. This makes it difficult to directly compare overall reaction times between picture naming and translation. However, this is unlikely to have affected the interaction patterns that formed the basis of our predictions and conclusions. In addition, it is impossible to evaluate the time needed to process the pictures themselves, prior to lexical access. Nevertheless, it would be interesting to replicate this study using a written to spoken translation task to ensure that the effects generalise across variants of the same tasks.

3.5.7. Conclusions

The present study investigated the effect of cognate status on naming and translation in older and younger bilingual participants. A consistent cognate advantage was observed across tasks and participant groups, with supporting evidence from monolingual English speakers. The findings of the present study support theories of interactive lexical processing such as that proposed by Costa et al (2005). This study strengthened prior evidence concerning the robustness of the cognate facilitation effect on accuracy and speed in picture naming and translation in bilinguals and provides new evidence that naming and translation partly rely on different cognitive processes, with direct lexical links contributing to translation performance and enhancing the cognate advantage.

There is scope for future investigation to explore how the effects that we have reported may interact with a number of factors such as language proficiency, the semantic and lexical properties of the stimulus words and experimental conditions in various languages and populations.

CHAPTER 4: NAMING AND TRANSLATION IN BILINGUAL ANOMIA: EFFECT OF COGNATE STATUS & TASK ON ACCURACY

CHAPTER 4: NAMING AND TRANSLATION IN BILINGUAL ANOMIA: EFFECT OF COGNATE STATUS & TASK ON ACCURACY

4.1. ABSTRACT

It is generally agreed that there is a cognate advantage in lexical processing in healthy participants. However, there is little research concerning the effect of cognateness in aphasic participants and preliminary findings have been inconsistent and have been limited to picture naming. The present study aimed to determine if there is a cognate advantage in naming and translation performance in neurologically impaired participants with lexical access deficits. A group of 8 bilingual anomic participants completed naming and translation tasks in English and Welsh. In each language, the same items were tested in each task, and the stimulus set included cognate and non-cognate words. Our results revealed a robust cognate advantage in naming words in the weaker language (Welsh) but not in the other tasks where the effect was highly variable across participants. We conclude that cognateness effects are generally more variable in brain-damaged participants. This is likely to result from variability in the type and extent of deficits to the cognitive processes that lead to robust effects in healthy participants, cross-linguistic co-activation and phonological feedback in particular.

4.2.INTRODUCTION

The current chapter presents the outcome of an investigation into naming and translation accuracy in a group of Welsh-English bilingual aphasic participants. The overall thesis aims to investigate the nature of the bilingual lexicon, in particular the way the two languages of a bilingual speaker interact. Investigating how cognate and non-cognate words differ in terms of participant accuracy across tasks will inform our understanding of the bilingual lexicon. This chapter seeks to evaluate the reliability of the cognate advantage in bilingual anomia and whether this effect is comparable for picture naming and translation. The effect of linguistic variables on accuracy, such as word frequency and cognateness, will be investigated in order to explore in detail the functional nature of the bilingual lexicon in impaired naming and translation.

Patterns of ability across languages and different word types contribute to our understanding of the nature of lexical interaction between languages in multilingual speakers (Paradis, 2004). Despite the majority of the word's population being bilingual (De Bot, 1992; Grosjean, 1992), models of bilingual lexical processing are less well developed than those addressing monolingual language processing. This means that predictions for language recovery following stroke, and for treatment success, can be challenging. Anomia is one of the most common communication impairments following stroke; therefore research concerning lexical activation patterns in bilingual aphasia has both theoretical and clinical relevance.

4.2.1. Naming and translation in bilingual aphasia

Naming ability in bilingual aphasia has been the focus of much research to date, including investigations of the effect of cognate status on accuracy and reaction times, and on cross-language generalisation of treatment effects following therapy. Less investigation has been made into the effect of aphasia on translation ability (however, see a discussion of Detry, Pillon & De Partz, 2005; Goral, Levy, Obler & Cohen, 2006 &

Hernandez et al, 2010, below), and on the effect of cognate status on translation ability.

4.2.2. The effect of cognate status on bilingual lexical processing

Cognates are words from two languages that share the same meaning (translation equivalents) and have similar phonology (e.g., English: CAT; Welsh: CATH). The role of cognateness in bilingual language production has been the focus of much investigation. In neurologically healthy participants, several studies have reported that cognate words are named more accurately and more quickly than non-cognates (e.g., Costa, Caramazza & Sebastien-Galles, 2000; Rosselli, Ardila, Jurado & Salvatierra, 2012). Several studies have also observed faster translation latencies for cognates than for non-cognates (e.g. De Groot, Dannenburg & Van Hell, 1994; Hristova & Janyan, 2008; Kroll & Stewart, 1994). However, the findings are not unequivocal. Siyambalapitiya, Chenery & Copland (2009) report a reversal of the cognate effect in older participants on a lexical decision task. Note that we did not replicate this effect (see Chapter 3 of this thesis): in neurologically healthy Welsh-English bilinguals, we observed a cognate advantage in both naming and translation that was actually stronger for older than for younger participants.

In terms of interpreting the cognate advantage, Costa, Santesteban & Caño (2005) hypothesised that the cognate faciliation effect results from automatic co-activation of both the target language and the language not in use, from a single semantic input that is shared across languages. Costa et al (2005) posit that during word retrieval, both the target and its translation equivalent in the non-target language are activated at the phonological level (see Figure 4.1). Within the framework of an interactive spreading activation model, the phonological activation feeds back to the lexical level, facilitating both languages in the case of cognate words due to their overlapping phonology (Costa, La Heij & Navarette, 2006). See Chapter 1 for a more detailed discussion of this. The cognate facilitation effect has been measured in participants' stronger and weaker languages, and several studies have observed a greater effect in the weaker language (e.g. Costa et al, 2000; Gollan et al, 2007; Rosselli et al 2012). A possible explanation for this asymmetry is that words from the stronger language have stronger representations that can thus send stronger phonological feedback to words from the weaker language (Costa et al, 2000).

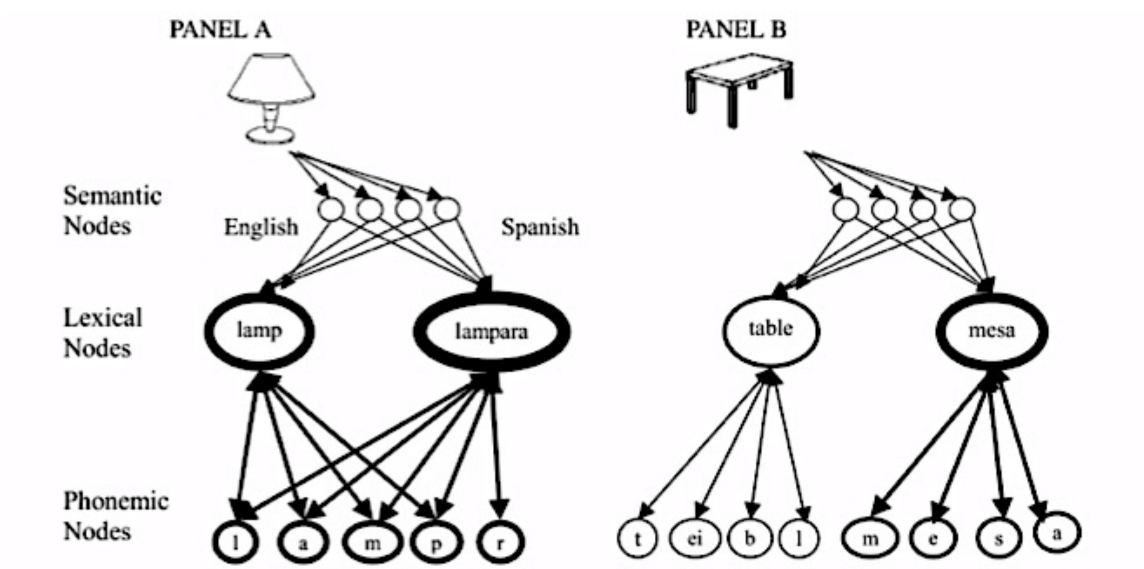


Figure 4.1: Schematic representation of naming cognates and non-cognates in Spanish by Spanish–English bilinguals. From Costa, Santesteban & Caño, 2005

4.2.3. The cognate effect in aphasic participants

In aphasic participants, a cognate advantage has been reported in several studies using different tasks, with suggestions that the effect may vary depending on task and individual participants. In a group study, Roberts & Deslauriers, (1999) investigated naming accuracy of cognates and non-cognates in 15 French-English balanced bilingual participants with aphasia. At the group level, there was a significant effect of cognateness in English (L2) picture naming, but not in French (L1). Reaction times and individual participant results were not reported. Lalor & Kirsner (2001) investigated the effect of cognateness on written picture naming and written lexical decision in a multilingual aphasic participant, JA. English and Italian were assessed in both tasks. Only one effect of cognateness was observed in the naming task, which was that low-frequency Italian cognate words with high-frequency English translation were named more quickly than low frequency Italian cognates with low frequency English translations. In the lexical decision task, latency was not affected by cognate status. However, JA did make more errors on non-cognate items than on cognates. Kuzmina, Chekmaev, Skvortsov & Weekes (2014) did not observe cognate facilitation effects in naming in a Mordovian-Russian bilingual participant with aphasia. Tiwari & Krishnan (2015) investigated cognate and non-cognate naming across the two languages of a bilingual aphasic participant, and reported a selective *deficit* for naming cognates in relation to non-cognates in the participant's L2. However, it must be noted that the participant's performance on non-cognates in each of his languages was not stated, and furthermore, no inferential statistics were reported. Following therapy in both languages of a bilingual Spanish-English aphasic participant, GLP, Kurland & Falcon (2012) noted greater improvement for spoken naming of non-cognates than cognates, indicating that cognates were inhibiting rather than facilitating cross-language generalisation. As the participant also presented with an impairment of cognitive control, they interpreted these findings in the context of Abutalebi & Green's (2007) model of bilingual lexical processing and cognitive control. The authors do report increased language mixing during the course of treatment, indicating that GLP was unable to inhibit more strongly activated translations of target words.

Detry et al (2005) assessed picture naming, word-picture verification and translation in a single case study with SM, a French-English bilingual participant with aphasia. SM demonstrated a cognate advantage in all three tasks, across both languages, which the authors suggest is an indication of greater resilience to neural damage for cognates than non-cognates. SM was also more impaired at naming in English (L2) than in translation from French to English (L2-L1). The opposite pattern was observed for French naming and translation from English to French. The authors suggest that this shows evidence for a direct lexical processing route from L1 to L2. As discussed in Chapter 3, two routes to translation have been hypothesised; the conceptually mediated route, in which semantic representations are activated during translation, and the direct lexical route, which occurs in the absence of activation of semantic representations (Potter et al, 1984; Kroll & Stewart, 1994). Moreover, it has been suggested that cognate status affects the translation process. De Groot (1992) hypothesised that translation of cognates may rely more on direct lexical associations, whereas translation of non-cognates may need to be conceptually mediated. The existence and functionality of such direct processing links will be discussed further in Chapter 5 of this thesis.

To summarise, the bilingual aphasia literature on the cognate advantage in naming is comparatively scarce. The effect of cognate status on translation in bilingual aphasia has been the focus of even fewer studies to date. Goral, Levy, Obler & Cohen (2006) investigated translation in all three languages of a trilingual aphasic participant. They observed no effect of cognateness in any translation direction in terms of either accuracy or latency. Conversely, Hernandez et al (2010) report the effect of cognate status on both picture naming and translation in JFF, a Spanish-Catalan bilingual participant with a semantic deficit due to Alzheimer's disease. JFF presented with no effect of cognate status in picture naming, and was in fact slightly more accurate at naming non-cognates in both languages, though this was non-significant. However, he showed a clear advantage for translating cognates than non-cognates, in both translation directions, and as a result was much less impaired at translation than picture naming.

In sum, the "cognate advantage" is by no means consistent in participants with aphasia, across varying languages and lexical tasks, and in some cases can be inhibitory rather than facilitatory. Most studies to date have employed single case designs, therefore further investigation, using the same target items across tasks and participants is necessary. Moreover, cognateness might have a clearer effect on participants with relatively selective lexical access deficits. Comparison of outcomes across studies is difficult when the nature of the participants' naming impairment differs, or is not clearly defined in the context of cognitive neuropsychological models of lexical processing.

4.2.4. Rationale, Aims & Hypothesis

This study presents an investigation into the effect of cognate status on accuracy in picture naming vs. translation in 8 Welsh-English bilingual participants with aphasia. All participants named pictures in Welsh and English, and the same target items were assessed in a translation task from Welsh to English, and from English to Welsh. Both cognate and non-cognate words were tested, in order to investigate the impact of cognate words on accuracy. The research questions being asked here are as follows:

- How reliable is the cognate advantage effect in people with aphasia?
- Does task type (naming vs. translation) interact with cognateness?
- Does language (English vs. Welsh) interact with cognateness?

We predict that participants will show a picture naming advantage for cognate items, particularly in their weaker language, based on previous findings in neurologically healthy bilinguals (e.g. Costa et al, 2000; Gollan et al, 2007; Rosselli et al 2012). The expectations in translation are less clear. On the one hand, the auditory presentation of a word in one language could further facilitate access to cognates due to an increased input from phonology, which would be consistent with our findings with neurologically healthy participants, reported in Chapter 3. On the other hand, the direct activation of the phonological representation of the word to be translated could interfere with the retrieval of cognates as the phonemes of the stimulus would need to be inhibited to avoid repeating rather than translating the word. Furthermore, people with aphasia often have co-occurring cognitive control deficits, which result in difficulties inhibiting the non-target language (Green & Abutalebi, 2008; Kurland & Falcon, 2012). Therefore, the pattern of the cognate facilitation effect may vary between neurologically healthy and aphasic participants, and may also vary between different aphasic participants.

4.3. METHOD

4.3.1. Participants

Eight Welsh-English bilingual aphasic participants with word-finding deficits were selected to take part in the study. All participants were highly proficient speakers of Welsh and English and had acquired both languages in early childhood. All participants lived in North Wales at the time the study took place, an area where a large proportion of the population is bilingual. Participants were referred by speech and language therapists and by the Psychology Neurological Patient Research Panel. Following referral, spoken and written information was provided to participants about the study, and written consent to participate was obtained, prior to any testing taking place (see Appendix F).

Ethical approval for the study was granted by Bangor University. Ethical procedure followed Bangor University protocol. NHS ethical approval was also granted by the North Wales Research Ethics Committee (REC reference:

10/WNo01/67). For ethical and practical reasons, selected participants were in reasonably good health. We assumed that each participant had the capacity to make a decision unless concerns to the contrary. In order to assess capacity we followed the Mental Capacity Act (England and Wales) ensuring the participant 1) understood the information relevant to the decision; 2) could retain the information; 3) could use or weigh the information to arrive at a choice; 4) could communicate the decision e.g., to friends and family. If the participant failed any part of the test they were deemed to lack capacity and were not included in the study. Prior to assessment taking place, written consent was obtained for all participants (see Appendix F).

All participants were a minimum two years post-neurological insult. The majority of participants had experienced left hemisphere stroke, but see Table 4.1 for details of all participants' neurological profiles.

Table 4.1: Participant gender, age and summary of medical history

ID	Age	Gender	Years post onset	Handed-ness (pre, post)	Aetiology and lesion localisations
CWS	**66**	**M**	**16**	R,R	Extensive RH stroke inc. ischemic lesion of motor& pre-motor cortex, part of Broca's area
DE	**27**	**M**	**3**	R,L	LH haemorrhage: extensive damage to L frontal & parietal matter & part of IFG including part of Broca's area
GW	**62**	**F**	**4**	R,B	Multiple CVA/TIA events over 4 years; no visible lesion on scan
KJ	**45**	**F**	**2**	R,R	LH stroke, damage to IFG inc Broca's area. Part of Wernicke's area damaged at the posterior superior temporal gyrus
LM	**48**	**F**	**4**	R,L	Left MCA stroke involving posterior segments of left inferior and middle frontal gyri, pars opercularis of Broca's area
MB	**79**	**F**	**5**	R,R	LH stroke: involves parts of the left inferior and middle frontal gyri including part of Broca's area, the frontal operculum, anterior insula and subjacent extreme capsule.
MGD	**77**	**F**	**3**	L,L	LH haemorrhagic infarct in frontal region
WRP	**52**	**M**	**2.5**	R,R	HSVE resulting in lesion with extensive destruction of temporal pole, extending to medial temporal, amygdala and hippocampus

Language Assessment

All participants took part in extensive language assessment in order to confirm their suitability for inclusion in the present study. Participants were assessed on the picture naming and translation tasks presented in Chapter 3 of this thesis. The main criteria for inclusion was that each participant scored significantly lower (p <.05) than age-matched controls (N=35) on at least one of the tasks using the modified t-tests for single cases (Crawford & Howell, 1998). Although several of the participants demonstrated semantic impairment, the main difficulty was with word retrieval. Data from tests of non-verbal and verbal comprehension and word repetition are included below to ensure that the naming difficulties of the participants are at least for the most part the result of lexical access deficit and not restricted to semantic or post-lexical processing (see Tables 4.2 & 4.3 for details). Although most participants demonstrate mild impairments of comprehension, participants' main impairments were in lexical retrieval.

Table 4.2: Participant performance on assessments of non-verbal and verbal comprehension, and in receptive vocabulary (impaired scores in bold type; - denotes that the task was not completed)

ID	**PPT* 3 pictures (M: 51, Cutoff: 49**	**CCT** pictures (M: 58.95; Cutoff: 51.28)**	**BPVS*** (spoken, written) standardized score**	**PGC*** (spoken, written) %**
CWS	51/52	53/64	83, 81	78%, **59%**
DE	**42/52**	**50/64**	**67, 66**	**46%, 36%**
GW	-	58/64	**61, 41**	**-, 62%**
KJ	-	**51/64**	**66, 41**	**44%, 39%**
LM	50/52	54/64	**70, -**	**59%, -**
MB	52/52	**41/64**	79, 86	**56%, 62%**
MGD	**48/52**	**46/52**	89, 102	78%, 86%
WRP	**47/52**	**51/64**	**68**, 94	83%, **66%**

*Pyramid & Palm Trees Test, Howard & Patterson, 1992
**Camel and Cactus Test, Bozeat et al, 2000
***British Picture Vocabulary Scales, Dunn et al, 1997
****Prawf Geirfa Cymraeg, Gathercole & Thomas, 2007 (impaired score- 2.5 SD's below mean score of age-matched controls)

Table 4.3: Percent accuracy on assessments of real (RW) and non-word (NW) repetition (impaired scores in bold type- denotes that the task was not completed)*

ID	Welsh RW repetition (%)	Welsh NW repetition (%)	English RW repetition (%)	English NW repetition (%)
CWS	100	100	100	100
DE	95.8	**87.5**	100	**91.6**
GW	-	**-**	-	**-**
KJ	91.6	**66.6**	100	**83.3**
LM*	**27.7**	**5.5**	**32.5**	**1.25**
MB	100	83.3	100	100
MGD	100	100	100	100
WRP	100	100	100	100

*All word lists comprised 24 concrete items for all participants except for LM. LM's English repetition data come from PALPA 9, with 80 items, and her Welsh data come from an in-house test comprising 36 words and 36 non-words.

Table 4.3 presents all participants' accuracy on assessments of real and non-word repetition in English and Welsh. As can be seen, participants demonstrated an ability to repeat real words accurately in most cases. Several participants had greater difficulty with repeating non-words, however this was not an issue for the purposes of this study because the focus was on naming and translating real words. LM's impairment at repetition is likely exacerbated by an impairment at the level of the phonological input lexicon, as well as an impairment of post-lexical processing (added to her lexical retrieval deficit), which is discussed in detail in Chapter 6 of this thesis. GW did not complete the task, however she did not have any articulation difficulties and was therefore considered to be appropriate for inclusion in the study.

Preliminary assessment of picture naming revealed evidence of word-finding difficulties in all participants, in Welsh and English. Details of individual participants' performance will be presented in detail below.

4.3.2.Stimuli

The stimuli used in this assessment are the same as those in the study on naming and translation in neurologically unimpaired Welsh-English bilinguals presented in Chapter 3 of this thesis. The same target items are used in the Welsh to English translation task as in the English picture naming task, and the same target items are used in the English-Welsh translation and Welsh picture naming tasks. The words were grouped into high and low frequency categories according to the following criteria:

- High frequency: above 25 occurrences per million (English words: Celex word database, accessed through N-Watch. Welsh words: Cronfa data electroneg o Gymraeg,(Ellis, O'Dochartaigh, Hicks, Morgan, & Laporte, 2001)). In Welsh, words are mutated depending on sentence position, and CEG provides a frequency value for which includes all mutated forms of each word (such as CI, which can be mutated into *gi, chi, nghi* depending on sentence position). This lemmatised version of each word was used to avoid cross language differences in frequency as a result of mutations.
- Low frequency: between 1-25 occurrences per million (details as above).

Items were classified as short if they consisted of 4 phonemes or fewer (non-rhotic English accent), and as long if they had 5 phonemes or more. Each word list contained a number of items that were Welsh-English cognates, and these were initially the same target items in both languages (i.e. in English tasks 'carpet' was a target word and in Welsh tasks its translation 'carped' was also a target). However, following assessment of control participants, as detailed in Chapter 3 of this thesis, a number of items were removed due to low accuracy, with other items removed to balance groups in terms of frequency and cognateness. Following this removal, not all cognate items were assessed in both languages. The criteria used to determine cognateness are presented in Chapter 3, with details of the process of analysis with 4 groups of control participants. In brief, cognate words were translation equivalents that shared a minimum of 50% phonemes and letters in English and Welsh. Table 4.4 presents the lexical characteristics and number of items in the English and Welsh tasks, organised by frequency and cognate status. As can be seen, all word lists were very closely matched across languages. See Chapter 3 for more details of statistical analysis of lexical characteristics.

Table 4.4: lexical characteristics of target words in English and Welsh picture naming and translation tasks.

Word group	**Log 10 frequency Mean (SD)**		**Phoneme length Mean (SD)**		**Number of items**	
	English	*Welsh*	*English*	*Welsh*	*English*	*Welsh*
ALL ITEMS	1.44 (0.54)	1,43 (0.58)	4.36 (1.56)	4.41 (1.22)	75	77
High frequency (all)	1.96 (0.28)	1.93 (0.25)	4.05 (1.55)	4.23 (1.09)	34	39
Cognates	1.86 (0.22)	1.75 (0.29)	4.00 (1.41)	4.08 (1.16)	10	12
Non-cognates	2.01 (0.31)	2.01 (0.19)	4.08 (1.67)	4.30 (1.10)	24	27
Low frequency (all)	1.01 (0.21)	0.91 (0.56)	4.61 (1.52)	4.62 (1.31)	41	38
Cognates	1.05 (0.19)	0.75 (0.31)	4.76 (1.35)	4.93 (1.14)	16	14
Non-cognates	0.98 (0.22)	1.00 (0.30)	4.50 (1.69)	4.42 (1.41)	25	24

4.3.3. Design and Procedure

Picture naming and translation tasks were administered in each language. The same items were probed in both tasks and languages, but never in the same session, i.e. participants were not required to both name and translate items within a single testing session. All testing sessions focused on one language only.

Participants were either visited in their home and tested using a laptop computer, or they visited the university for testing on a desktop computer. In all cases testing took place in a quiet room with no distractions. Participants were given breaks in order to minimise fatigue effects. All sessions were audio recorded on Mp3 format for post-test verification of responses and errors. For all tests, a spoken and written explanation of the task was given to the participants prior to testing in the target language, to ensure that participants understood what was required of them. This is recorded in Appendix D. All assessments were administered on a computer using e-Prime.

Before the main test, 10 practice items were administered, in the same format as the main test. If the participant made any errors on these items, feedback was given. During the main test, no feedback was given. Testing was carried out by English, monolingual, post-graduate students and research assistants during the English sessions, and by Welsh-English bilingual post-graduate students and research assistants during the Welsh sessions. In order to minimise cross-language intrusions during testing English and Welsh sessions were carried out by different testers. Only the target language of the session was spoken by the tester, before and during testing.

For the picture naming task, participants were shown a picture of an object on a computer screen and asked to name the item in the target language as quickly and accurately as possible. For the translation task stimulus words were recorded by a Welsh-English bilingual speaker and presented via headphones. Participants were asked to translate the word into the target language as quickly as possible. Stimuli were repeated if the participant misheard them, and this was noted by the tester.

4.3.4. Scoring and analysis

For both tasks a target item was judged to be correct if the target item was named or translated correctly, or if an acceptable synonym for that item (also previously produced by control participants) was produced. In the case of cognates, alternatives answers were not allowed as they would not be cognates and therefore be unsuitable for comparing cognate items to non-cognates. If a participant produced an erroneous response, and immediately self-corrected, the final response was recorded.

The analyses below evaluate the effects of cognateness on accuracy by comparing the number of items produced correctly in each lexical category, for each task. For the group analysis, the analyses are based on the percentage of items correctly produced as the number of items varied between categories. Group results were analysed using Anova and individual results using Fisher's exact test. To follow from Chapter 3 and for the same reasons, the analyses below are restricted to low frequency words (but see Appendix G for the full dataset).

4.4. RESULTS: overall accuracy

4.4.1. Group results

The results of this study are shown in Figure 4.2. These results were analysed by means of 2X2X2 repeated measure Anova with Cognateness, Language and Task as factors. This analysis revealed a main effect of Task [$F(1,7)=16.98$, $p<.005$], due to the naming tasks being more accurate overall than the translation task. In addition, the Anova showed a marginal interaction between the three factors [$F(1,7)=5.04$, $p=0.06$]. Follow-up paired sample t-tests indicate that, as suggested in Figure 4.2., the effect of cognateness is only significant in the Welsh naming task [$t(7)=3.28$, $p<.01$, one tailed; all other contrasts $p>.10$].

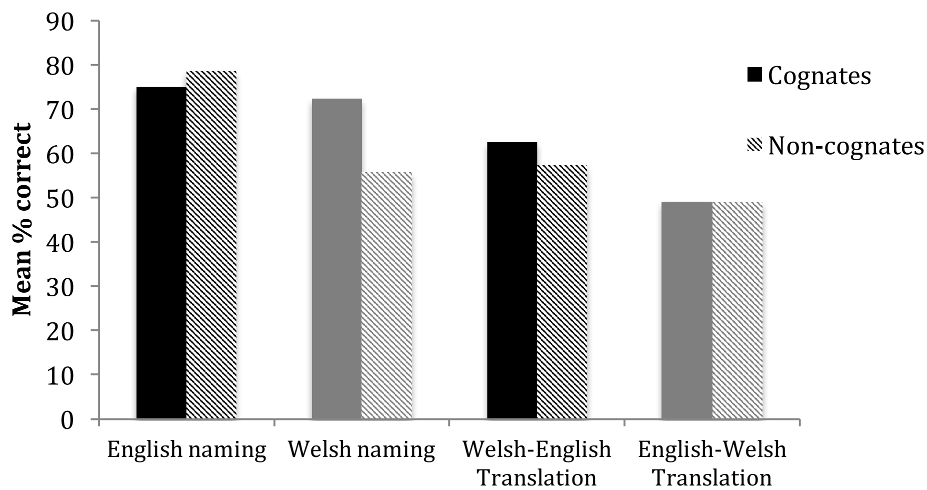


Figure 4.2: Mean % correct on naming and translating cognates and non-cognates

4.4.2. Individual accuracy patterns across tasks as a function of cognateness.

Table 4.5: Participant's mean % accuracy on English and Welsh naming and translation tasks

	English Naming		**Welsh-English translation**		**Welsh Naming**		**English-Welsh Translation**	
	Cognates	Non-cognates	Cognates	Non-cognates	Cognates	Non-cognates	Cognates	Non-cognates
CWS	82.35	79.17	29.41	50.00	78.57	75.00	78.57	62.50
DE	94.12	91.67	82.35	50.00	57.14	33.33	42.86	45.83
GW	88.24	100.00	70.59	70.83	85.71	83.33	64.29	83.33
KJ	88.24	87.50	76.47	70.83	85.71	58.33	28.57	50.00
LM	0.00	0.00	0.00	4.17	21.43	4.17	7.14	0.00
MB	70.59	87.50	70.59	41.67	78.57	37.50	64.29	33.33
MGD	88.24	91.67	82.35	91.67	78.57	79.17	7.14	29.17
WRP	88.24	91.67	88.24	79.17	92.86	75.00	100.00	87.50
Group Mean (SD)	75.00 (31.08)	78.65 (32.3)	62.50 (31.11)	57.29 (27.25)	72.32 (23.04)	55.73 (28.16)	49.11 (33.59)	48.96 (29.01)

Table 4.5 presents the individual results as a function of cognateness, task and language. As can be seen, the effect of cognateness is highly variable across participants and tasks. In English picture naming, no participant showed a significance difference between cognates and non-cognates (all p values >.10).

In Welsh picture naming, 7 of 8 participants demonstrated a trend towards greater accuracy for cognates than non-cognates. This cognate advantage was significant for MB, p=.01 and marginally significant for KJ, p=.059. No other contrasts were significant.

Table 4.5 shows that the results are also highly variable in the translation tasks. In Welsh-English translation, 4 of 8 participants (DE, KJ, MB and WRP) demonstrated a trend towards greater accuracy for cognate than non-cognate items. This contrast was significant for DE and MB (both, p<.05). The remaining 4 participants demonstrated slightly greater accuracy for non-cognates, though none of these contrasts were significant.

In English-Welsh translation, 4of 8 participants (CWS, LM, MB & WRP) showed greater accuracy for translating cognates than non-cognates, and this cognate advantage approached significance for MB [χ^2 (1)= 3.42, *p*=.065]. No other contrasts were significant. Four of 8 participants were more accurate at translating non-cognates than cognates, though none of these contrasts were significant.

4.5. Discussion

The present study investigated the effect of cognate status on naming and translation accuracy in a group of bilingual aphasic participants. The purpose of the investigation was to evaluate whether cognate and non-cognate words differ in participant accuracy across tasks in impaired language processing. Overall, participants were more accurate at picture naming than translation in both languages, and more accurate at the English tasks than the Welsh tasks.

4.5.1 Effect of cognate status on accuracy: picture naming

We predicted that participants would be more accurate at naming pictures with cognate names in both languages. This prediction was upheld for Welsh picture naming only at the group level. At the individual level, 7 of 8 participants demonstrated a trend towards greater accuracy for cognates than non-cognates, though this was only significant for one participant, MB, and close to significance for KJ (*p*=.07). For the English picture naming task, only two participants demonstrated a trend for greater accuracy for cognate items, though neither was significant. Therefore, the predictions were only partly upheld. However, this finding of an inconsistent cognate effect is in line with previous investigations of the effect of cognate status on picture naming (e.g. Costa et al, 2010; Lalor & Kirsner, 2001; Roberts & Deslauriers, 1999). The findings also support prior evidence of a stronger effect of cognateness in the weaker language (e.g. Costa et al, 2000; Gollan et al, 2007; Rosselli et al 2012). Performance of several participants in the present study was quite high on English picture naming, which may account for the absence of a cognateness effect on the English picture naming task.

4.5.2 Effect of cognate status on accuracy: translation

Predictions for a cognate effect in the translation task were less clear, as hypotheses for both facilitation and inhibition due to the method of stimulus presentation were considered. At a group level, there were no effects of cognate status in either translation task. At an individual level, the results were highly variable, with equal numbers of participants showing trends for greater accuracy for both cognates and non-cognates on the English-Welsh translation task, though only two contrasts were significant, both showing greater accuracy for cognates (MB & DE). In Welsh-English translation, four participants again demonstrated trends for greater accuracy for cognates, though this approached significance only for MB. Therefore, predictions for either a cognate facilitation or inhibition effect were not upheld at the group level. However, the individual data suggest that cognateness can have different effects, facilitatory or inhibitory, in different participants.

4.5.3 Cognate advantage: General discussion

In general, the effect of cognate status on accuracy was inconsistent. At the group level, a cognate advantage was only observed in Welsh picture naming. At the individual level, one participant, MB, showed a cognate advantage for three of four tasks. The only task for which she did not show a cognate advantage was for English naming, which was MB's highest accuracy score and is subject to a ceiling effect. Overall, the cognate effect was much clearer in the Welsh picture naming task which is the weaker language of most of our participants. This finding is consistent to a degree with Roberts & Deslaurier's (1999) finding of a selective L2 advantage for cognate items in a picture naming task. However, another participant in the present study, DE, demonstrated a similar pattern of overall accuracy across tasks to that of MB, but the only task for which he showed a significant cognate advantage was translating from Welsh into English. Moreover, participant GW demonstrated greater accuracy for non-cognates for all four tasks, though this was non-significant in all tasks. In sum, there was a high degree of variation within and between individual participants and across tasks, so that no clear evidence of a consistent cognate advantage was found. The results from the present study do not support the hypothesis put forward by Costa et al (2005); however the findings may have been affected by methodological limitations, as discussed below. In addition, cognateness effects were not stronger in translation, which is at odds with the results from healthy participants reported in Chapter 3. This shows that participants with bilingual aphasia may process words in a way that differs qualitatively from healthy controls; this may vary as a function of the specific nature of their deficits.

Speaking two languages requires a very fine tuned language regulation system, involving both cross-language facilitation and inhibition (e.g. Abutalebi & Green, 2007). The effect of cognate status is likely to vary as a function of how brain damage affects not only lexical activation, but also this regulatory network (e.g. Keane & Kiran, 2015). Furthermore, the effect of brain damage on lexical processing also varies across individuals. This fact, combined with individual patterns of ability across languages, means that the 'cognate facilitation effect' is likely to vary greatly.

Green's (1998) inhibitory control (IC) model describes the mechanisms of activation and inhibition within and across languages, and how they interact in normal bilingual processing. The IC model posits that during lexical production in the target language, a language task schema inhibits production of the non-target language. This inhibition means that bilingual speakers are able to avoid cross-language intrusions by suppressing lexical representations in the non-target language. However, in impaired language processing, such as anomia, these control mechanisms may be impaired. Abutalebi et al (2009) observed L1 inhibition following L2 treatment in a Spanish-Italian bilingual with aphasia. The authors interpreted this interference as resulting from a cognitive control impairment. If a bilingual speaker with aphasia is unable to inhibit the non-target language, this may result, not only in erroneous responses in the non-target language, but also in increased 'no response' errors, or even semantic errors, if the participant's lexical selection mechanism is impaired. This hypothesis can be extended to translation; the IC model suggests that backward translation is more accurate and quicker than forward translation, because it is easier to inhibit the L2 stimulus and produce the L2 target than vice-versa. In impaired language processing, this difficulty may extend to both languages, due to difficulties with cognitive control. Moreover, the effect may be greater in some participants for cognate words, due to the overlap in phonology of the stimulus and target words.

The limited cognate advantage observed here can also be described in the context of a bilingual interactive spreading activation framework (Costa et al, 2005). In typical bilingual processing, cognates receive extra facilitation during naming due to extra feedback from the phonological level to the lexical level, across languages. However, during naming in aphasia, one or more levels of the naming process are impaired or weakened. Thus, for the participants in this study who demonstrated inconsistent or no cognate advantage, the feedback part of the naming process may be weakened across languages. Accordingly, in the schematic illustrated in Figure 4.1, the bidirectional links for cognates between the phonological and lexical levels may be less functional than in unimpaired bilinguals, or than in impaired bilinguals whose deficit does not affect this stage of lexical retrieval.

These data may also be considered in the context of the Revised Hierarchical Model (Kroll & Stewart, 1994). The RHM posits two routes to translation, the direct lexical route (thought to be used by less proficient bilinguals) and the conceptual mediation route, hypothesised to be used by more proficient, balanced bilinguals. Thus, in less proficient bilinguals, translation is more affected by form related distractors, and in more proficient bilinguals, semantic distractors have more of an impact on translation latency. It has been suggested (e.g. Hernandez et al, 2010) that, even in more proficient bilinguals, both routes exist, although the relative influence of each route on performance may vary depending on a number of factors, including translation direction, and cognate status. De Groot (1992) hypothesised that cognate words are more likely to share direct lexical connections than non-cognates, which are more likely to be conceptually mediated than cognates. Furthermore, these routes are suggested to be separable, and therefore may be individually weakened or spared in neurological damage. If we consider our data from this perspective, the participants who demonstrated a trend towards greater accuracy for cognates than non-cognates may be using direct lexical links for translation, and those who showed the opposite pattern may have weakened direct links, thus eliminating the cognate advantage in translation.

Further evaluation of the effect of cognate status in naming and translation in bilingual participants with language impairments is therefore necessary. Analysis could focus on error types and speed as well as accuracy.

4.5.4. Limitations

This study utilised the same stimuli as those described in Chapter 3 of this thesis, and a detailed analysis of the limitations of these stimuli is outlined there. In brief however, some stimulus items were found to be visually ambiguous in the picture naming task, which may also have influenced participant accuracy here. These items were removed from the present analysis, however as a result the number of items named per participant is relatively low, especially for cognateness, which limits the power of the analyses. In addition, the number of participants is not very large, although larger than in most prior studies in bilingual aphasia.

Reaction time data were available for this task, however these were not analysed due to the high variability in accuracy which in some cases meant there were too few accurate items to perform a meaningful analysis of RTs. Further analysis of the data to include reaction times would have added to the accuracy data presented here, and enable further comparison of the strength of the cognate effect between picture naming and translation, and future investigations will include such analysis.

The data from the translation task also present with some limitations. The stimuli presented in the current study were spoken, rather than written, which is the typical format for translation tasks. For many aphasic participants written input can be more problematic than spoken.

4.5.5. Considerations for future study

The present study extended the scope of most investigations of bilingual aphasia, in that both naming and translation accuracy were investigated, at both the group and individual level. As discussed above, future analysis could include investigation of response times in order to extend the potential findings from the data, especially given the relatively small sample size. This would also enable analysis of data from participants with milder language impairments.

Further investigations could also include the relationship between concreteness and cognateness on translation ability. Concrete translation equivalents tend to share more conceptual features across language pairs than abstract words (Van Hell & De Groot, 1998) and the effect of cognateness on this relationship may inform our understanding of translation processes. Often people with aphasia experience greater difficulty with abstract words than concrete words; therefore the beneficial effect of cognateness may be stronger for those words which are more difficult to retrieve.

Further analysis of these data to include reaction times and error types may contribute to a better understanding of the processes underlying translation and naming of cognate and non-cognate words in impaired bilingual lexical processing.

4.5.6. Conclusions

The present study investigated the effect of cognate status on naming and translation ability in 8 Welsh-English bilingual participants with aphasia. Our study demonstrates that cognateness effects are not as robust as previously reported in the literature or as hypothesised by some authors (e.g. Costa et al, 2005). The present findings emphasise the lack of complete understanding of the different mechanisms required in picture naming and translation tasks and of how they can be affected by brain damage. The findings of the present study contribute to the bilingual aphasia literature in that few studies have investigated both naming and translation ability in a case series design, using the same target items across tasks and participants. The results of a mixed effect of cognate status also support the findings of some previous investigations with bilingual aphasic participants (e.g. Goral et al 2006; Lalor & Kirsner, 2001; Roberts & Deslauriers, 1999).

CHAPTER 5: SEMANTIC MEDIATION IN TRANSLATION: EVIDENCE FROM BILINGUAL APHASIA

CHAPTER 5: SEMANTIC MEDIATION IN TRANSLATION: EVIDENCE FROM BILINGUAL APHASIA

5.1 ABSTRACT

The present study aimed to investigate the cognitive processes that underlie picture naming and translation abilities in bilingualism, with a focus on the extent of semantic involvement in the two tasks. It has been proposed that translation could be less dependent on the semantic system as it could take place via direct cross-linguistic connections at the lexical level. To test this hypothesis, we compared the incidence of semantic errors in Welsh and English picture naming and translation tasks in a group of bilingual brain-damaged participants with word finding deficits. As predicted, the participants produced significantly fewer semantic errors in translation than in naming the same items in both their languages. This effect was robust at the group level as well as for most individual participants. Thus, this study provides strong evidence for a reduced degree of semantic involvement in translation as compared to naming. This is consistent with dual-route theories of the translation process, whereby translation can take place via direct cross-linguistic lexical connections in addition to the semantic route used in naming.

5.2 INTRODUCTION

The current chapter presents the outcome of an investigation of error types in naming and translation tasks, in a group of Welsh-English bilingual aphasic participants. The overall aim of the thesis is to investigate the nature of the bilingual lexicon, in particular the way that bilingual speakers' two languages interact.

Investigating how error types differ across tasks will inform our understanding of the bilingual lexicon. This chapter aims to investigate the existence and functionality of direct lexical links between the languages of bilingual speakers, with evidence from error types to indicate the relative involvement of the semantic system in both tasks

Patterns of ability across languages and different word types contribute to our understanding of the nature of lexical interaction between languages in multilingual speakers (Paradis, 2004). Despite the majority of the word's population being bilingual (De Bot, 1992, Grosjean, 1992), models of bilingual lexical processing are less well developed than those addressing monolingual language processing. This means that predictions for language recovery following stroke, and for treatment success, can be challenging. Anomia is one of the most common communication impairments following stroke; therefore research concerning lexical activation patterns in bilingual aphasia has both theoretical and clinical relevance.

5.2.1. Naming and translation in bilingual speakers

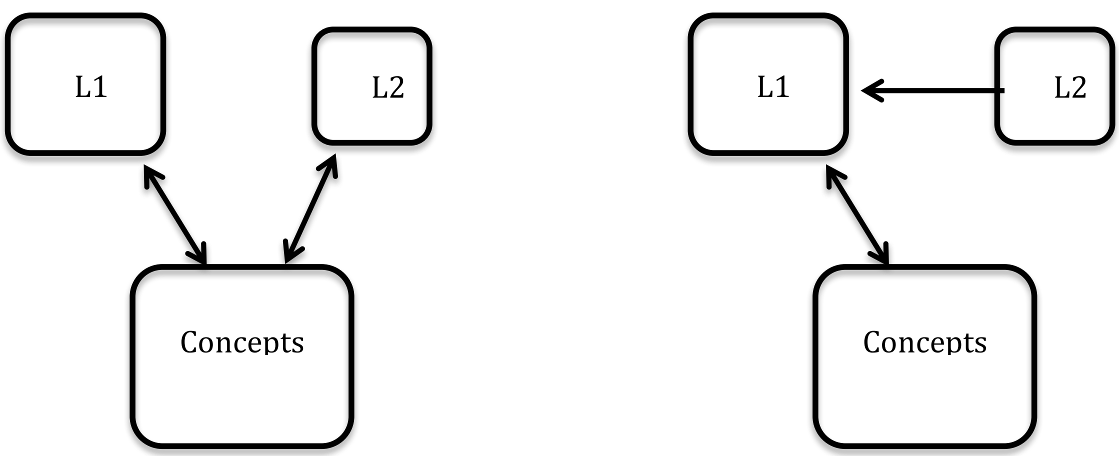
Naming ability in bilingual aphasia has been the focus of much research to date, including investigations of the effect of cognate status on accuracy and reaction times, and on cross-language generalisation of treatment effects following therapy. See Chapter 4 of this thesis for a discussion of the cognate effect in bilingual aphasic participants. Less investigation has been made into the effect of aphasia on translation ability (however, see a discussion of Detry, Pillon & De Partz, 2005; Goral, Levy, Obler & Cohen, 2006 & Hernandez et al 2010, below) and on the involvement of the semantic system in translation as compared to picture naming in bilingual aphasia.

Below is a discussion of picture naming and translation processes in bilingual speakers.

5.2.2. Translation in unimpaired bilingual speakers

Picture naming and translation abilities in bilingual speakers have been the focus of much research to date (e.g. Costa, Caramazza & Sebastien-Galles, 2000; Ivanova & Costa, 2008; Kroll & Stewart, 1994). Typically, these studies have focused on the effect of lexical characteristics such as word frequency, concreteness, and cognateness, as well as effects of translation direction, in order to uncover the processes involved in bilingual lexical processing. Picture naming requires the ability to recognise pictorial stimuli, access the target semantic representation, to retrieve and vocalise the appropriate label for each stimulus. See Chapter 3 for a discussion of studies that have investigated picture naming in healthy bilinguals. In translation, though the output is the same, the input is lexical- i.e. the task is to recognise a spoken or written word, and convert it into the target language. Translation between languages has been the focus of several investigations with neurologically healthy participants, with the aim of evaluating the existence and functionality of direct links between languages at the lexical level. The involvement of the semantic system in picture naming is undisputed. However, it has been proposed that translation could take place via direct lexical links between L1 and L2 word forms in addition to or instead of via semantic representations (i.e., with translation going from a spoken word in L1, accessing its conceptual representation and this meaning then leading to the retrieval of the translation equivalent in L2). Should such links exist, successful translation could hypothetically take place without the need to access semantic information.

Two hypotheses were originally proposed concerning the connections between bilinguals' two languages. These are depicted in Figure 5.1 below. The *concept mediation* hypothesis proposes that the lexicons for a speaker's L1 and L2 both have direct access to the conceptual level, but no links at the lexical level. The *word association* hypothesis, in contrast, proposes that words in the L2 access the conceptual store via the L1 lexical representations (Potter, So, Von Eckardt & Feldman 1984). The lexical links in the word association model are hypothesised to be stronger from a bilingual's weaker language (L2) to the stronger language (L1), as language learning in L2 is typically built upon existing L1 vocabulary.



Concept Mediation Hypothesis *Word association hypothesis*

Figure 5.1: Depictions of the Concept Mediation and Word Association hypotheses, Potter, So, Von Eckhardt & Feldman, 1984

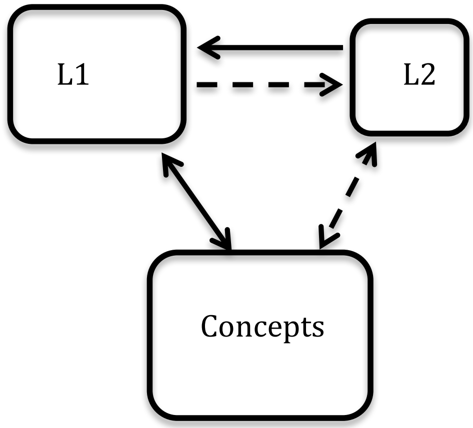


Figure 5.2: Depiction of the Revised Hierarchical Model, Kroll & Stewart, 1994

Kroll & Stewart's (1994) Revised Hierarchical Model (depicted above in Figure 5.2) built on the concept mediation and word association hypotheses, postulating shared semantic representations and separate lexical stores for each language, with direct but asymmetrical connections between each lexical store and the conceptual store. Each language has direct access to the semantic representations, as well as a connection between the two languages' lexical representations. The theory further suggests that initially, at lower proficiency levels, a speaker accesses L2 word meanings from the conceptual store via the L1, but that with increased proficiency the conceptual store can be directly accessed from the L2 lexicon. The asymmetry hypothesised by the model lies in the connections from concept store to lexical representations and vice-versa; lower-proficiency L2 speakers can easily access concepts from words, but accessing the same words from the concepts is more difficult, as the majority of L2 learners learn new words for concepts via words in the L1 (Kroll, Van Hell, Tokowicz & Green, 2010). With increasing proficiency, the RHM proposes increasing reliance on the conceptual route, and decreasing use of the direct lexical route. Preliminary evidence from studies with language impaired bilinguals, in which translation can be preserved despite impaired conceptual processing, suggests that translation can take place via a direct lexical route (Garcìa, 2015). This is discussed in more detail below.

Potter et al (1984) compared picture naming and translation latencies in 24 proficient college age Chinese-English bilinguals, who had learnt English in school and had lived for at least one year in an English-speaking country. They found no difference in reaction times in L2 picture naming and L1-L2 written-word translation, which they suggest indicates that a bilingual speaker accesses each lexicon directly from the conceptual store, with no direct lexical links between languages. Similar results were observed in a group of 28 less proficient English-French bilinguals, though the actual means are not reported. L1 picture naming and L1-L2 translation were not investigated. They suggested that this provided evidence for the conceptual mediation hypothesis, with no direct lexical links in bilingual word processing.

Kroll & Curley (1988) compared reaction times on picture naming and translation ability in proficient and less fluent English-German participants. The proficient participants had equal response times across tasks when the language of output was L2, whereas picture naming was faster than translating when the language of output was L1. The less fluent participants were faster at translating than picture naming when the language of output was L2, but demonstrated the reverse pattern when the language of output was L1. These data indicate that less fluent bilingual speakers were employing a direct route for translation at least for L2-L1, whereas the more fluent bilinguals were translating via conceptual mediation.

Sholl, Sankarayanan & Kroll (1995) investigated the relationship between picture naming and translation in 24 English-Spanish bilingual college students. They were native English speakers and had, on average, studied Spanish for 9.3 years. Participants named pictures in both languages, then translated words that had either been previously named in one of the picture naming tasks, or were new, and had not been seen previously during the experiment. Forward translation, previously found to be conceptually mediated, was faster for items that had been named in the picture naming task, but backward translation was not affected by prior picture naming. The authors suggest that this demonstrates differing relative influence of semantics on forward and backward translation.

More recent studies have attempted to resolve the question of direct lexical links using evidence from the effect of semantic factors on translation, such as semantic blocking. There is conflicting evidence in the psycholinguistic literature as to the extent of semantic mediation in translation (Potter et al, 1984; Kroll and Stewart, 1994).

Kroll & Stewart (1994) investigated reaction times in two translation tasks with fluent Dutch-English bilingual university students. On average, the participants acquired English at the age of 12.25 years. One translation task involved translating lists of words all from one semantic category (Blocked), the other involved translating word from mixed semantic categories (Mixed). In forward (L1-L2) translation, reaction times were slower for blocked lists than for mixed lists. The authors concluded that this indicated semantic involvement in forward translation. However, in backward, (L2-L1) translation, no effect of semantic blocking was observed, suggesting that L2-L1 translation may take place in larger part via direct lexical links, indicating at least reduced semantic involvement in backward translation as compared to forward.

A further contrast of interest has been the effect of concreteness on conceptual involvement in translation. Concrete words tend to be translated more quickly than abstract words (e.g. de Groot, 1992; van Hell & de Groot, 1998) and this effect is considered to indicate semantic involvement in translation. One reason that abstract words are translated more slowly than concrete words is that concrete translations tend to share more conceptual features across languages than abstract words, which can have subtle differences in meaning across languages (Garcìa, Ibàñez, Huepe, Houck, Michon, Lezama, Chadha & Rivera-Rei (2014).

In a study investigating translation in unbalanced bilinguals with Dutch as the L1 and English as the L2, De Groot et al (1994) also found that semantic variables, such as familiarity and concreteness, play a slightly more important role in forward than in backward (L2-L1) translation of non-cognates but less so in cognates. This finding supports a weak version of the asymmetry model put forward by Kroll & Stewart (1994). They suggested that cognate translation in both directions may often take place via direct connections at the lexical level, and that there may be symmetrical involvement of semantics in translating cognates (L2-L1 = L1-L2), but asymmetric reaction times in translation of non-cognates (L2-L1 faster than L1-L2).

Hristova & Janyan (2008) investigated the effect of concreteness and cognateness in translation on reaction times in translating concrete and abstract cognate and non-cognate words with two groups of Bulgarian-English bilinguals: proficient university teachers of English and university students studying English.

They observed faster translation of cognates from L1-L2 than from L2-L1 in proficient bilinguals. Non-cognate words showed the opposite pattern. In lower proficiency bilinguals there was no asymmetry in translation latency for cognates, whereas for non-cognates forward translation was slower than backward. The authors also observed faster translation for concrete than abstract words in forward (L1-L2) translation for both proficiency groups, but the opposite pattern in backward translation, which they interpret as evidence for a stronger involvement of direct L2-L1 lexical links for abstract words, due to the fact that they share fewer conceptual features between languages than concrete words.

Garcìa et al (2014) investigated word reading and translation in two groups of Spanish-English bilingual participants. They observed no effect of cognateness or concreteness in word reading, but both (high and low proficient) groups translated concrete and cognate words more quickly than abstract and non-cognate words. Moreover, they only observed an effect of translation direction (i.e. L2-L1 faster than L1-L2) for less proficient bilinguals.

It is clear from the above studies that in proficient bilingual speakers, translation is largely conceptually mediated, with factors such as cognateness and concreteness affecting the extent to which conceptual activation takes place. One issue that has been raised concerning the function of direct lexical links in translation is that the lexical and conceptual routes may both be active simultaneously in proficient bilingual speakers, and may reinforce each other to result in successful translation (Hernandez, Costa, Caño, Juncadella & Gascon-Bayarri, 2010). In unimpaired lexical processing then, untangling the degree of involvement of each route is a complex task.

However, in participants with impaired language processing it may be possible to differentiate more clearly the processing routes active in naming versus translation, if one or other of the routes is impaired or weakened.

In sum, few studies have directly compared naming and translation in terms of the relative influence of semantic variables on translation. None have done so in both languages of language impaired bilinguals, comparing the same target items in both tasks, and investigating the influence of cognateness on semantic mediation. If there are no direct links between languages at the lexical level, then the effect of semantic factors should be equivalent in translation and picture naming. However, if there is some involvement of direct lexical links in translation, the semantic influence on translation should be less than that on naming.

5.2.3. Naming and translation in bilingual aphasia

Differential patterns of translation ability in aphasia have been reported. Gastaldi (1951, cited in Fabbro, 1999) reported an aphasic participant who was unable to translate from one language to another despite being able to name in both of his languages. Conversely, Perecman (1984, cited in Fabbro, 1999) reported spontaneous translation in a bilingual aphasic participant. Finally, Veyrac (1931, cited in Fabbro, 1999) described an English-French bilingual aphasic individual who, despite severe comprehension impairment, was able to translate sentences that she did not understand from one language to the other, possibly indicating that she was not accessing conceptual representations, and instead was translating via direct lexical connections.

In a single case study, Detry et al. (2005) compared word-picture verification, picture naming and translation ability in a French-English bilingual participant with aphasia. They observed impaired picture naming, especially in the L2, along with comparatively accurate word-picture verification and better performance for translation than naming in both languages. More specifically, translation into L2 was better preserved than naming in L2. The authors also observed better performance for cognates than non-cognates in both tasks. The authors suggest that this implies impaired lexical-semantic connections in the L2, but better preserved direct connections between word forms at the lexical level, active during word translation.

Goral, Levy, Obler & Cohen (2006) investigated cross-language lexical connections in a Hebrew-French–English trilingual participant with aphasia. The first focus of the study was on inter-language connections in conversation, as reflected in code switching during connected speech. These were found to be highest between English and French, the participant's L2 and L3 respectively, rather than between either of these two languages and Hebrew, the participant's L1. The authors also investigated translation and found symmetrical reaction times for translating words between French and English in both directions, which the authors propose suggests strong lexical connections between these two languages. Stronger lexical connections between languages that share portions of their vocabularies may have been what determined the activation of French rather than Hebrew during English production. The authors suggest that the results imply that a third language may be learned in connection with a previously learned L2, and thus develop strong lexical connections with that language.

More recently, Hernandez, Costa, Caño, Juncadella & Gascón-Bayarri (2010) investigated the existence of direct lexical links in naming and translation in a single case study with JFF, a proficient bilingual Spanish-Catalan speaker with Alzheimer's disease and a semantic deficit leading to naming difficulties, and production of semantic errors in naming.

Semantic errors in naming or translation are responses that are related in terms of meaning to the target (e.g. DOG>'cat'). Hillis & Caramazza (1995) proposed that semantic errors can arise from a deficit at several levels of the naming process. By comparing error types across tasks, it is possible to pinpoint the locus of the naming impairment. For example, Hillis & Caramazza (1995) report the case of KE, who made similar rates of semantic errors across tasks including picture naming, word-picture matching and oral reading, indicating that damage was localised to lexical semantic processing. On the other hand, participant RGB made significantly more semantic errors when the task involved spoken output, such as picture naming or oral reading, than in tasks using spoken or written input such as spoken word/picture matching. This pattern of errors (as part of a detailed battery of assessments) led Hillis & Caramazza to conclude that RGB's semantic errors in spoken output arose from an impairment in activating or selecting the correct lexical phonological representation.

Hernandez et al (2010) compared JFF's accuracy and rate of semantic errors on naming and translating the same set of items in L1 and L2. JFF demonstrated an effect of cognateness on both directions of translation, but not in naming in either language. He was more accurate on translation than naming, which was due to his greater accuracy at translating cognates than non-cognates. He did not show a cognate effect in naming. In translation, JFF demonstrated no effect of task type on the number of semantic errors when L2 was the language of output, but produced significantly fewer semantic errors and more phonologically related errors when translating into L1 than when naming in L1. However, as he produced a comparable number of semantic errors in backward (L2-L1) translation as in L1 naming, the authors concluded against the existence of functional direct lexical links to support translation. Moreover, the authors suggest that functional lexical links should have resulted in error-free translation. However, most language impaired participants have co-occurring deficits at more than one level of lexical processing such that participants with semantic disorders can also have deficits in activating lexical phonology (Best, Greenwood, Grassly, Herbert, Hickin & Howard 2013). This would affect both naming and translation as access to lexical phonology is required both for naming and translation, whichever route to translation is employed. Furthermore, the involvement of conceptual access in translation is well documented (Kroll & Stewart, 1994; Potter et al, 1984), and the more pertinent question is whether both lexical and conceptual routes exist concurrently in bilinguals. A hypothesis that translation *only* takes place via direct lexical links might lead to predictions of unimpaired translation in a person with a pure semantic deficit, but if we take the view that translation may take place via either or both routes, a finding of significantly fewer semantic errors in translation than naming does indicate reduced conceptual involvement in translation.

In sum, the mixed findings from both neurologically intact and impaired participants, suggest that further investigation of lexical connections between languages in bilingual speakers is required. The goal of the present study was to explore this issue further in a larger sample of proficient bilingual Welsh-English participants with aphasia and word finding difficulties in both languages. More specifically, we compare the rate of semantic errors produced in picture naming vs. translation tasks.

5.2.4. Rationale, Aims & Hypothesis

This study presents an investigation into the production of semantic errors in picture naming vs. translation in 8 Welsh-English bilingual participants with aphasia in order to examine the degree of conceptual mediation in the two tasks. All participants named pictures in Welsh and English, and the same target items were assessed in a translation task from Welsh to English, and from English to Welsh. Both cognate and non-cognate words were tested, in order to investigate the impact of cognate words on the incidence of semantic errors.

The effect of language and lexical features including cognateness will also be measured. The research questions being asked here are as follows:

- Do at least partly functional lexical links exist between translation equivalents?
- Is there an effect of cognateness on the functionality of such links?

We propose that if there is equal involvement of the semantic system in naming and translation tasks, then there should be no difference in the rate of semantic errors produced in the two tasks. However, if there are at least partly functional direct lexical links between translation equivalents, then we should observe fewer semantic errors in translation than in naming. Our second hypothesis concerns the effect of cognate status on the incidence of semantic errors in translation. This question is less clear:

similar phonological forms may result in stronger direct lexical links for cognates than non-cognates due to increased lexical activation. However, if lexical links exist due to bilingual speakers accessing the conceptual representations of L2 words via the L1 lexicon in early acquisition, the predictions may be that cognate words benefit earlier from direct conceptual access due to their more easily recognisable phonological form, and therefore do not develop strong lexical links between languages.

5.3. Method

5.3.1. Participants

Eight Welsh-English bilingual aphasic participants with word-finding deficits were selected to take part in the study. As the participants also took part in the study described in Chapter 4, detailed participant background information and language assessment results are presented there, as well as information on recruitment and ethical approval for the study. The main criteria for inclusion was that each participant scored significantly lower ($p < .05$) than age-matched controls ($N=35$) on at least one of the tasks using the modified t-tests for single cases (Crawford & Howell, 1998), and made semantic errors on naming tasks in both languages. Although several of the participants demonstrated some semantic impairment, the main difficulty was with word retrieval.

5.3.2.Stimuli & Design and Procedure

The stimuli and procedure used in this analysis are the same as those described in Chapter 4 of this thesis. Accuracy performance on all tasks is presented there. The present analysis focuses on the incidence of semantic errors across naming and translation tasks.

5.3.3. Scoring and statistics

See Chapter 4 for complete accuracy results across tasks, and an investigation of the impact of cognate status on accuracy.

The involvement of the semantic system in naming versus translation is evaluated by comparing the number of semantic errors produced in naming versus translation tasks.

All items that were not named correctly were included in the present analysis, and errors were recorded as follows: if the participant did not respond at all to the stimulus, a 'no response' error was recorded. If the participant made a single word response that was semantically related to the target, this was coded as a semantic error. If the participant made a multi-word response that was semantically related to the target, this was coded as a circumlocution error. Phonologically related words and non-words were coded as phonological errors. If the participant produced the target word in the non-target language this was coded as a translation error. All other error types were coded as 'other'. For the purposes of this investigation, which was to measure the incidence of semantic errors in naming versus translation, semantic and circumlocution errors were grouped together and regarded as semantic errors, as both error types can be considered to contain semantic information related to the target word.

The incidence of semantic errors as a proportion of total errors in the picture naming task was compared with that in the translation task, in English and Welsh. The data were analysed by means of repeated measures Anovas for group analyses. The incidence of semantic errors as a proportion of total errors in the picture naming task was compared with that in the translation task, in English and Welsh.

For individual participants, Fisher's exact test was used to compare the incidence of semantic errors as a proportion of total errors in naming versus translation in both languages.

5.4. RESULTS

5.4.1. Group results

The incidence of semantic errors in the picture naming and translation tasks is presented in Figure 5.3. A 2X2 repeated measure Anova revealed a main effect of task [$F(1,7)=34.62$, $p=.001$], of language [$F(1, 7)=5.8$, $p=.05$] as well as an interaction between the two factors [$F(1,7)=7.67$, $p=.03$]. As can be seen in the Figure, the interaction stems from the fact that the proportion of semantic errors is smaller in Welsh than in English naming. However, follow up paired-sample t-tests show that more semantic errors are produced in naming than in translation both in English [$t(7)=5.53$, $p<.001$, one-tailed] and in Welsh [$t(7)=2.22$, $p<.05$, one –tailed]. Note that these effects cannot be explained by a reduced overall error rate in translation as in fact participants were more accurate in naming (M=70% overall) than in translation (M=59%).

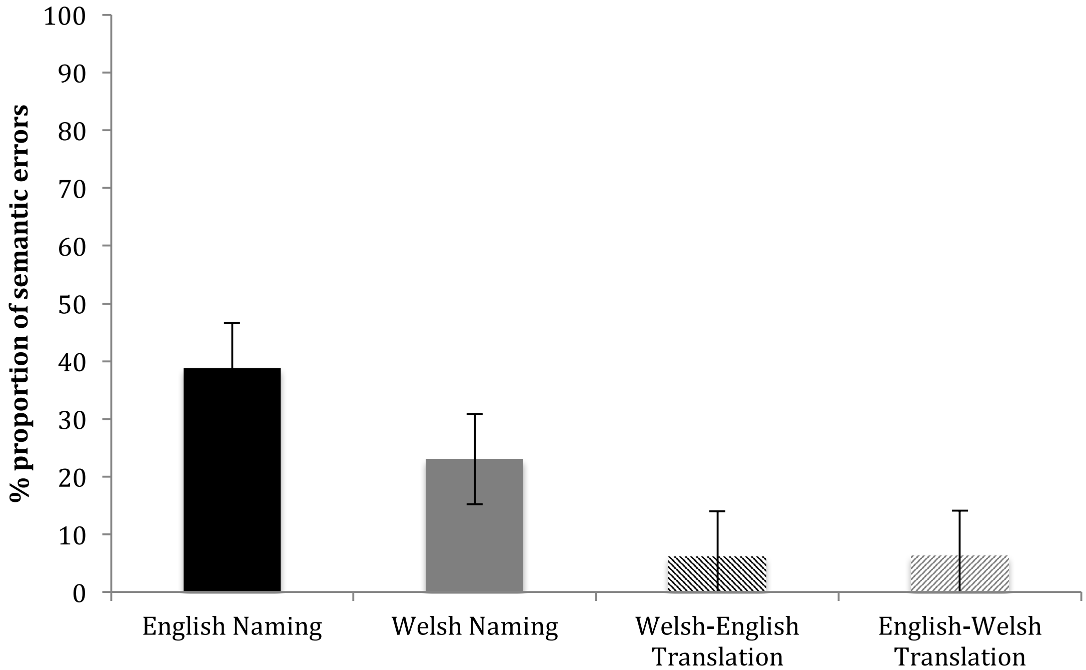


Figure 5.3: Mean % proportion of semantic errors in naming versus translation (out of total errors)

The effect of cognate status on the frequency of semantic errors in naming versus translation was also analysed. A 2X2X2 repeated measures Anova revealed a main effect of task [$F(1,7)=23.80$, $p=.002$] with no other main effects or interactions. In other words, the higher proportion of semantic errors in naming than in translation applied to a comparable extent to cognate and non-cognate items.

5.4.2. Incidence of other error types

We also investigated the incidence of the other most common error types between tasks, namely, phonological errors, language intrusion errors and 'no response' errors. See Appendix H for raw values of these error types across participants and tasks. We observed no difference in the number of phonological errors across task (English: Naming: M=0.62, Translation: M=1.12; Welsh: Naming: M=, 1; Translation, M= 1.12). In naming, participants made more language intrusion errors in both languages than in translation, though this was only significant for Welsh tasks (English: Naming: M= 1.6 , Translation: M=0.75; Welsh: Naming: M=9.37, Translation, M=1.62), $t(7)=2.48$, $p<.05$, 2-tailed. This was to be expected, as a language intrusion error in translation would simply be a repetition of the stimulus. Participants made significantly more 'no response' errors in English in translation (M=20.4) than naming (M=8.5), $t(7)=-4.8$, $p<.01$. Participants also made significantly more no response errors in Welsh translation (M=30.6) than naming (M=9.5), $t(7)$ =-3.9, $p<.01$.

5.4.3. Individual results

Table 5.1 presents the proportion of semantic errors produced by each participant in both languages out of the total number of errors. Raw number of errors in each language can be found in Appendix H.

Because of the relatively small number of items and because most participants showed the same trends in the two languages, the Welsh and the English data were combined in one analysis, save for one participant who showed trends in the opposite directions in the two languages. With both languages combined, 6 of 8 participants made significantly fewer semantic errors on translation than on picture naming (all $p<.05$). CWS showed the same trend but in his case the difference was not significant overall nor in either language analysed separately (all p values >.10). GW had contrasting results in Welsh and English. Like the other participants, she made significantly fewer errors in English translation than she did in naming (p<.05); she tended towards the reverse effect in Welsh tasks but the difference between tasks was not significant(p=.22).

Table 5.1: Proportion of semantic errors out of total errors on naming vs. translation tasks (%)

Participant	**Naming**		**Translation**	
	English	Welsh	English	Welsh
CWS	14.29	15.79	9.38	11.76
DE	57.14	28.89	12.50	5.88
GW	75.00	14.29	7.69	37.50
KJ	57.14	39.13	5.88	7.89
LM	19.18	15.15	0.00	0.00
MB	60.00	12.20	0.00	4.76
MGD	85.71	38.46	42.86	1.85
WRP	71.43	50.00	0.00	25.00

5.4.4. Effect of cognateness on semantic errors at the individual level

The effect of cognate status on the frequency of semantic errors in naming versus translation was also analysed at the individual level, again combining across languages except when the two languages did not show the same trends, which only occurred for one participant. For non-cognate items (see Table 5.2), six participants produced more semantic errors in naming than in translation (all p≤.01); CWS demonstrated a non-significant trend in the same direction (p=0.167). However, GW showed the same trend in English *(p*=.2), though the opposite trend in Welsh (p=.559).

Table 5.2: Proportion of semantic errors out of total errors on naming vs. translation tasks for non-cognate items only (English: N=49; Welsh N=51).

Participant	**Naming**		**Translation**	
	English	Welsh	English	Welsh
CWS	28.57	14.29	4.35	10.71
DE	40.00	29.17	0.00	9.52
GW	100.00	16.67	11.11	42.86
KJ	50.00	37.50	10.00	4.76
LM	19.15	11.11	0.00	0.00
MB	37.50	20.00	0.00	3.13
MGD	80.00	50.00	20.00	2.94
WRP	80.00	75.00	0.00	33.33

For cognate items (see Table 5.3), 5 of the 6 participants who showed the effect for non-cognates also produced more semantic errors in naming than in translation for cognates (all $p \leq .01$). WRP showed trends toward more semantic errors in naming than translation in both languages (p=.3). GW demonstrated the same trend in English tasks (p=.143) , but the opposite (non-significant) trend in Welsh (p=.54), and CWS had more semantic errors in naming than translation in Welsh (p=.73) but showed the opposite, but again non-significant trend in English (p=.6).

Although CWS, WRP and GW did not show significant differences, no conclusion can be drawn as these three patients produced too few semantic errors in naming cognates for any meaningful comparison with translation to be possible (total number of semantic errors in naming are 1, 2 and 3 respectively). This is likely due to there being fewer cognate than non-cognate items.

In summary, the individual results are highly consistent with the group analysis in showing that the higher incidence of semantic errors in naming than translation is comparable for cognates and non-cognates.

Table 5.3: Proportion of semantic errors out of total errors on naming vs. translation tasks for cognate items only (%) (English: N=26; Welsh N=26).

Participant	Naming		Translation	
	English	Welsh	English	Welsh
CWS	0	20	22.22	16.67
DE	100	46.15	66.67	0
GW	66.67	20	0	33.33
KJ	100	60	0	11.76
LM	19.23	25	0	0
MB	75	14.29	0	10
MGD	100	50	100	0
WRP	50	100	0	0

5.5. DISCUSSION

The present study investigated the effect of task on the incidence of semantic errors in naming and translation in a group of Welsh-English bilingual aphasic participants. The purpose of the investigation was to evaluate whether bilingual participants with aphasia made fewer semantic errors on translation than naming, using the same target items, in order to evaluate the involvement of the semantic system in translation. As predicted, fewer semantic errors were produced in translation than in naming in both languages. This effect was significant at the group level as well as for most individual participants and it occurred despite the fact that more errors overall were produced in translation than in naming. These results are inconsistent with the claims of Hernandez et al (2010) as they clearly support the hypothesis that translation may take place, at least in part, via direct lexical connections between languages with reduced semantic mediation. In addition, the effect did not interact with cognateness. In other words, there were more semantic errors in naming than in translation for both cognates and non-cognate items. This does not support the hypothesis of a greater strength of direct lexical connections for cognates than non-cognates. There was a numerical trend for more semantic errors in translating cognates than non-cognates overall, though this may be due to uncontrolled factors, such as the semantic density of the items and their relation to the target. Moreover, the number of cognate and non-cognate word sets differed, which may have resulted in greater variability.

5.5.1. Semantic mediation in translation: general discussion

In general, there was a clear effect of task on the incidence of semantic errors, suggesting that the involvement of the semantic system in translation is reduced in comparison to naming for these participants. We also observed significantly more 'no response' errors, and fewer language intrusions in translation, possibly indicating that participants are making no response errors in an attempt to avoid repetition of the stimulus. Green (1998) suggests that if translation can occur via a direct lexical route, then in successful translation the stimulus lexical representation must remain active until its translation has been activated, at which point it must be inhibited in order to enable production in the target language. In our participants, then the greater inaccuracy in translation than naming, and increase in 'no response' errors may result from an inability to suppress the stimulus word.

These results partly replicate the findings of Hernandez et al (2010) who also observed fewer semantic errors in translation than in naming, but in L1 to L2 translation only in JFF, a participant with Alzheimer's disease and a semantic deficit. In addition, JFF's accuracy on naming was much lower than translation (42% and 31% correct in Catalan and Spanish naming, respectively, and 68% correct in Spanish-

Catalan translation, and 56% correct in Catalan-Spanish translation). Much of the increased accuracy in translation was for cognate words. In contrast, our participants showed comparable accuracy in the two tasks or were more accurate in naming than in translation. It is unclear at this stage what factors may explain the discrepancy between their results and those of our participants. Our study has the advantage of including eight participants who presented with a consistent pattern of performance.

Thus, our study contradicts the conclusion of Hernandez et al (2010) that there are no functional direct links between the lexical representations of each language. We have seen in the Introduction that their claim that a lexical-semantic deficit should entirely preserve translation appears to be too strong for a number of reasons. In addition, our data is difficult to interpret without positing that translation requires less conceptual involvement than naming, consistent with the existence of functional direct lexical links across languages

One hypothesis is that direct lexical links do exist in both directions of translation in neurologically healthy bilinguals, but as conceptual access becomes more automatic with increased fluency, conceptual mediation occurs more automatically in translation. How is language processing different in language impaired participants, such as bilingual speakers with aphasia? In impaired language, for many aphasic participants the connections between the conceptual level and the lexical level are weakened or are less reliable. Therefore, in impaired translation, the direct links may be required to supplement or support the damaged conceptual route. This is similar to the use of phoneme-grapheme conversion (PGC) and grapheme-phoneme-conversion (GPC) in reading or spelling, which are not normally used in unimpaired language processing except in the case of new words or non-words. However, many participants with dysgraphia or dyslexia do utilise the PGC/GPC routes when whole word mappings are damaged.

Furthermore, the majority of studies investigating translation have used tasks with orthographic input and phonological output. This is arguably a less direct route than was used in the current study- phonological input to phonological output.

5.5.2. Considerations for future study

The present study investigated the incidence of semantic errors in naming versus translation tasks in Welsh-English bilingual participants with aphasia. Comparisons were made at the group and the individual level. Future investigations could include examination of reaction times in order to support the findings from error type analysis. Previous studies with neurologically healthy participants have observed differences in response times between forward and backward translation (e.g. Kroll & Stewart, 1994; Sholl, Sankaranarayanan & Kroll, 1995) indicating differing levels of conceptual involvement depending on translation direction. Our participants were balanced bilinguals, however it would be interesting to study the relative involvement of semantics in translation in less balanced bilinguals. We also observed a numerical trend for more semantic errors in cognate translation than for non-cognates overall at the group level. However, this may be due to factors that we did not control for, such as the density of the semantic neighbourhood of the target words. Future investigations could control for this factor, and could also match for numbers of cognate and non-cognate stimuli to allow for comparable power in the two conditions at the participant level.

A further focus could be on the effect of concreteness on the involvement of the semantic system in translation, as measured by response times and error types. Concrete translation equivalents are hypothesised to overlap more strongly in terms of meaning than abstract words (Tokowicz & Kroll, 2003, cited in Kroll & Tokowicz, 2005). De Groot & Poot (1997) observed faster translation for concrete than abstract words which they interpreted as indicating conceptual involvement in both directions of translation. However, Hristova & Janyan (2008) observed faster L2-L1 translation for abstract than concrete words in Bulgarian-English bilingual participants. The authors suggest that semantic involvement is lower for abstract words due to the lower number of conceptual features they share across languages. Combining error types and reaction times in analysis of concrete and abstract word translation in bilingual participants with aphasia could help further unravel the extent of the involvement of the semantic system in translation.

5.5.3 Conclusions

This study contributes to the on-going debate about the existence and functionality of direct lexical links in bilingual speakers. We demonstrated that fewer semantic errors were produced in translation than in naming of the same words in a group of 8 Welsh-English bilingual participants with aphasia. Thus, our results support the hypothesis of a lesser involvement of the semantic route in translation than in naming and of the existence of an additional route to translation via direct lexical links between translation equivalents in the two languages which appears to remain at least partly functional even in highly proficient bilinguals

CHAPTER 6: BILINGUAL ANOMIA TREATMENT: GENERALISATION ACROSS LANGUAGES AND TASKS

CHAPTER 6: BILINGUAL ANOMIA TREATMENT: GENERALISATION ACROSS LANGUAGES AND TASKS

6.1. Abstract

The present study aimed to investigate the conditions under which naming treatment in one language can result in cross-linguistic generalisation to an untreated language and to untreated tasks. Current models predict that cross-language generalisation of treatment effects should be stronger for cognates than non-cognates due to stronger co-activation of cognates across languages during lexical access. In addition, we predicted that treating phonological lexical access in naming should generalise to untreated tasks that also rely on this process (reading aloud and translation). To test these hypotheses, we utilised an errorless treatment method to investigate the effectiveness of decreasing sentence and phonological cueing treatment in English with a Welsh-English bilingual speaker with anomia. As predicted, treatment effects in English generalised to the Welsh translations of treated words occurred but for cognate words only. In addition, we observed generalisation of the naming treatment to the untreated tasks of reading aloud and translation.

The greater improvement for cognates than non-cognates supports models that posit a stronger co-activation of cognates in bilingual lexical access. This is the first study to demonstrate generalisation to untreated cognates implementing errorless sentence cueing treatment in bilingual anomia and to extend the investigation to untreated tasks.

6.2. Introduction

The first goal of this study was to investigate the effect of cognateness on cross-language generalisation of treatment effects in a bilingual individual with severe bilingual anomia. The effect of cognateness on generalisation of treatment effects was measured in order to investigate the ways in which the two languages of bilingual speakers interact. The second goal was to extend the scope of most investigations into treatment generalisation by examining the transfer of picture naming ability to word translation and reading aloud in both the treated and untreated languages. The purpose of this was to investigate whether picture naming treatment results in improvement to other lexical tasks as a result of activation of the phonological output lexicon (Raymer, Thompson, Jacobs & Le Grand, 1993).

This study brings together several treatment elements that have not previously been investigated together: errorless treatment in bilingual aphasia, using combined sentence, phonological and orthographic cues, and the generalisation of these treatment effects within and across language. The effectiveness of phonological cueing is well-documented in the aphasia literature (e.g. Hickin, Best, Herbert, Howard & Osborne, 2002; Wambaugh, Linebaugh, Doyle, Martinez & Kalinyak-Fliszar, 2001) and though sentence completion cues have been found to be effective, studies investigating their use are relatively few (e.g. Linebaugh, Shisler & Lehner, 2005; Weidner & Jinks, 1983).

6.2.1. Models of bilingual naming

The majority of the world's population is bilingual (De Bot, 1992, Grosjean, 1992). However, bilingual models of lexical processing are less well developed than those addressing monolingual language processing. Patterns of ability across languages and different word types contribute to our understanding of the nature of lexical interaction between languages in multilingual speakers (Paradis, 2004). The nature of the bilingual lexicon has been the subject of extensive investigation. In general, bilingual speakers are thought to access a single semantic store common to both languages (e.g. Kroll & Stewart, 1994). Furthermore, it is generally assumed that representations at the lexical level are separated by language (e.g. Kroll & Stewart, 1994, Potter, So Von Eckhardt & Feldman, 1984).

In general, it is assumed that the lexical representations of both languages of a bilingual are activated during naming, and the process by which bilingual speakers are able to inhibit the non-target language is a matter of continuing debate (e.g. Costa, Miozzo & Caramazza, 1999; Costa & Caramazza, 1999; Green, 1998).

Thus, bilingual speakers are hypothesised to activate the phonological representations of target words in both languages. (e.g. Duyck, 2005; Jared & Kroll, 2001). This co-activation has also been observed for cognate words (e.g. Costa, Caramazza, & Sebastien-Galles, 2000), translation equivalents that share similar phonology (e.g. English 'cat' & Welsh 'cath'). Cognate words have been found to benefit from an advantage in processing in several lexical tasks (e.g. Costa et al, 2000, Costa, Santesteban & Caño, 2005; Kroll & Stewart, 1994; Lalor & Kirsner, 2001). Costa et al (2000) proposed that cognate words receive activation due to co-activation at the lexical level from conceptual level, and also receive extra activation due to bi-directional feedback from the phonological level. An alternative explanation is that cognate words are more strongly inter-linked at the lexical level than non-cognates (e.g. Gerard & Scarborough, 1989; Lalor & Kirsner, 2001).

6.2.2. Bilingual Anomia

Anomia, or an impairment of word-finding, is one of the most common communication impairments following stroke. In bilingual speakers the two languages are typically affected (Paradis, 2004), though the specific nature and severity of the deficit can vary across languages as a consequence of variables such as pre-morbid ability and frequency of language use (Fabbro, 2001). This means that predictions for language recovery following stroke, and for treatment success, can be challenging. Naming impairments in bilingual anomia can also be affected by pathological language mixing or switching, in which the participant often makes cross-language intrusion errors in naming tasks (Ansaldo, Saidi & Ruiz, 2010; Kohnert, 2004).

An important area of investigation in the anomia literature is the impact of cognateness on lexical tasks. Several studies have observed a cognate advantage in participants with aphasia across different tasks (Detry, Pillon & de Partz, 2005; Lalor & Kirsner, 2001; Verreyt, de Letter, Hemelsoet, Santens & Duyck, 2013). Roberts & Deslauriers (1999) observed a significant advantage for cognates over non-cognates in a picture-naming task in both languages for a group of 15 bilingual aphasic participants. However, other studies have not observed a cognate advantage in bilingual aphasia. Tiwari & Krishnan (2015) report on a bilingual aphasic participant with a specific deficit in naming cognates in only one of his languages, and

Siyambalapitya, Chenery & Copland (2013) observed a non-cognate advantage for cross-language priming in a bilingual Italian-English participant with aphasia. Chapter 4 of this thesis also presents naming and translation data from a group of Welsh-English bilingual aphasic participants which revealed a highly variable cognate advantage in both tasks. The nature of the cognate advantage in impaired bilingual language processing therefore requires further investigation.

6.2.3. Bilingual aphasia treatment

Treatment of naming impairments in bilingual aphasia has been proven to be effective with several different treatment types and a number of different languages. The majority of studies have used semantic-based treatments (e.g. Goral, Rosas, Conner, Maul & Obler, 2012; Kiran, Sandberg, Gray, Ascenso & Kester, 2013; Kohnert, 2004, Kurland & Falcon, 2011). Of particular relevance to this study are investigations that have implemented phonological cueing (e.g Abutalebi, Della Rosa, Tettamenti, Green & Cappa, 2009; Galvez & Hinckley, 2003). No studies have investigated sentence cueing in bilingual aphasia, though it has been found to be effective in monolingual participants with aphasia (e.g. Linebaugh, Shisler & Lehner, 2005; Pease & Goodglass, 1978; Thompson, Kearns & Edmonds, 2006; Weidner & Jinks, 1983).

6.2.4. Cross-language generalisation of treatment effects

When a word is activated in one language, its corresponding lexical representation is also activated in the other language, which could lead to cross-language generalisation of treatment in bilingual aphasia (e.g. Costa & Caramazza, 1999; Green, 1998). This could mean that translations of treated items are easier to access following treatment, with the result that cross-language transfer of treatment effect would take place, given sufficiently preserved semantic and lexical representations. Though the investigation of treatment effects in bilingual aphasia is by no means as comprehensive as that of monolingual aphasia, a number of studies report improvements following treatment. In general, there tends to be improvement to treated items in the target language (e.g. Goral, et al, 2012; Kohnert, 2004; Kurland & Falcon 2011), with mixed findings of generalisation of improvement in lexical retrieval to the non-target language (e.g. Goral et al, 2012; Kiran & Edmonds, 2004; Kiran et al 2013; Miertsch, Meisel & Isel, 2009). Conflicting results could be due to a number of factors including differing control protocols and types of lexical item investigated.

The current study focuses on the effect of cognateness on cross-language generalisation. Only a few treatment studies have compared cross-language generalisation in cognates and non-cognates. Kohnert (2004) investigated cross-language generalisation following treatment for one Spanish-English bilingual participant, and observed generalisation for cognate items only. Similar results are reported by Goral et al (2012) who conducted a mixed treatment design with a single participant JM, in Spanish and English. JM also spoke Catalan, French and German. All 5 languages were assessed pre- and post- treatment. Improvement to treated items was only seen following treatment in English, and no cross-language generalisation to any language occurred following treatment. However, following treatment in each language, cognates were produced correctly more often than non-cognates in the untreated languages. Assessment of naming in each language took place once only at baseline and post-test, therefore any observed changes may have been the result of fluctuating performance across time (Kiran et al, 2013). Hughes, Roberts & Tainturier (2012) also observed greater improvement for cognates than non-cognates in a Welsh-English bilingual participant with aphasia following treatment in both languages. Cross-language generalisation to untreated translations was also greater for cognate items. Control testing was rigorous, with 3 assessments in each language at baseline and post-test.

In contrast, Kurland & Falcon (2011) report the opposite pattern following intensive semantic naming treatment with a Spanish-English bilingual, with greater generalisation for non-cognates than cognates. However, the authors present no statistical analysis of treatment effects, therefore the results must be treated with caution. Further investigation of cross-language generalisation of treatment effects to cognate translations is therefore necessary.

6.2.5. Generalisation to untreated tasks: translation and reading

In monolingual aphasia, several studies have investigated generalisation of naming treatment to untreated tasks that also involve word production, such as reading aloud. Raymer et al (1993) observed generalisation of treatment effects to word reading in three of four aphasic participants, following phonological cueing treatment. They also observed generalisation to written naming in two participants. In contrast, Greenwood, Grassly, Hickin & Best (2010) observed no change to untreated control tasks, including word reading, in a single case study with an aphasic participant. However, pre-treatment scores were very close to ceiling, which would have reduced the scope for generalisation (Best, Howard, Bruce & Gatehouse, 1997).

As discussed in Chapters 3 and 4 of the present thesis, several studies have investigated naming and translation in neurologically unimpaired bilingual participants, with the aim of exploring lexical links between languages in bilingual speakers. However, very few studies have been made of translation ability in neurologically impaired bilingual speakers (see Detry, Pillon & de Partz, 2005; Goral, Levy, Obler & Cohen, 2006; Hernandez et al, 2010), and the relationship between naming and translation in anomia. Only one study has investigated generalisation of naming to translation ability following treatment. Ansaldo, Saidi & Ruiz (2010) investigated improvement to naming and translation following a model-based intervention with a Spanish-English bilingual participant with aphasia. EL was more accurate at translation than naming at baseline, but presented with pathological language switching. The treatment, Switch-Back Through Translation, was designed to exploit EL's preserved mechanism for suppressing the input language during translation, in order to minimise switching during naming. The treatment was conducted in Spanish and resulted in improved naming in Spanish, and also in improved translation from English to Spanish (Ansaldo et al, 2010). The present study investigates generalisation not only to naming in the untreated language, but also to translation and reading aloud of the same items, in both languages.

6.2.6. Aims, rationale and hypothesis

This study presents a decreasing sentence completion and phonological cueing treatment that was administered to LM, a Welsh-English bilingual woman with anomia, using a picture-naming task. The treatment was carried out in English, with the aim of investigating the effects of treatment on treated items, and on within-language generalisation to untreated items, and cross-language generalisation to Welsh. Both cognate and non-cognate words were treated, in order to investigate the effect of cognateness on direct treatment effects, and cross-language generalisation of those effects. The specific research questions being addressed in this treatment study can be summarised as follows:

1) Does cross-language generalisation occur following naming treatment using a decreasing sentence completion and phonological cueing task?

2) Is cross-language generalisation stronger for cognate than non-cognate words?

3) Does improvement in naming generalise to improvement in the ability to read aloud and translate the same items?

The present study was a replication of a previous study investigating cross-language generalisation of treatment effects in Welsh-English bilingual anomia, presented above (Hughes et al, 2012). The previous treatment design was adapted to investigate the impact of errorless treatment with a sentence completion and phonological cueing design on treatment outcome. It was hypothesised that errorless cueing would be more effective in bilingual anomia than progressive cueing, as the translation equivalent for cognate words would not be erroneously cued. There are currently no studies which have investigated the effect of errorless treatment with bilingual participants with aphasia. One aspect of bilingual treatment effects is the contrast between cognate and non-cognate words on naming success following therapy (e.g. Goral , Rosas, Conner, Maul & Obler 201; Kohnert, 2004; Kurland & Falcon, 2011). This contrast is relatively understudied in the aphasia treatment literature, and merits further investigation, due to the clinical and theoretical implications of cross-language transfer being affected by lexical features. Hughes et al (2012) investigated the effects of phonological cueing treatment with a Welsh-English bilingual patient, comparing the effect of cognateness cross-language generalisation of treatment effects. The participant, HBL, made many translation errors during the treatment. For example if the Welsh target word was 'coeden' she would name it as 'tree'. For non-cognate words, which share few if any common phonemes, the initial phonological cue would immediately highlight to HBL that she had made an error and cue the target word in the target language. However, many of the cognate word pairs shared several phonemes, especially word-initially, e.g. 'carped'-'carpet'. This meant that following production of the incorrect translation of the target, HBL would then receive progressive cues that would reinforce her error, with the target only diverging from its translation equivalent towards the end of the word. Errorless or decreasing cueing therapy would therefore be of benefit in circumstances such as this, potentially reducing the possibility that the aphasic patients will be erroneously cued by the therapist with the translation equivalent of the target, and therefore learn their own cross-language intrusion errors (Abel, Schultz, Radermacher, Willmes & Huber, 2005; Fillingham, Sage & Lambon-Ralph, 2006; Middleton & Schwartz, 2013). HBL did in fact demonstrate a greater improvement on cognate than non-cognate words, however this effect may have been stronger if errors had been limited.

Improvement was predicted to occur for naming treated items in the treated language. Cross-language generalisation of naming effects was also predicted to occur for the treated items. This generalisation was predicted to be greater for cognate items due to their receiving extra activation from phonology in addition to semantic activation. Cross-task generalisation was also predicted to occur, with improvement to naming and translation of treated items due to the shared lexical processes involved across tasks. No improvement was predicted to occur for control items in either language.

6.3. METHOD

6.3.1. Case report

LM was 49 years old and 5 years post onset at the beginning of the treatment study. She is a Welsh-English bilingual. She was educated to secondary school level and was formerly employed in retail but retired at age 44 due to the stroke. LM received speech and language therapy following the stroke, but has since been discharged and had received no speech and language therapy in the year prior to the treatment study. LM was referred by a speech and language therapist, and selected for participation in the treatment study based on her performance on a battery of language and cognitive assessments, which revealed a severe language impairment. Ethical approval for the study was granted by Bangor University, and ethical procedure followed Bangor University protocol. NHS ethical approval was also granted by the North Wales Research Ethics Committee (REC reference: 10/WNo01/67). Following referral, spoken and written information was provided to LM about the study, and written consent to participate was obtained, prior to any testing or intervention taking place.

Medical and Neuropsychological Details

In 2010, LM suffered a large ischaemic stroke in the territory of the left middle cerebral artery. See Figure 6.1 for MRI scan and details of the damaged cortical areas.

LM's vision is intact with normal eye movement, no visual ataxia, or visual extinction. LM was right handed prior to the stroke, but due to a right-sided hemiplegia now only has use of her left hand. The hemiplegia also affects her locomotion but she is able to walk unassisted for short distances.

LM's nonverbal intelligence was assessed using the Raven's progressive coloured matrices (Raven & Court, 1998); she scored 30/36 which, according to a small standardized study conducted in the 1950's, is equivalent to the mean score of unimpaired participants aged 60-65 (study cited in Raven & Court, 1998). On the BCoS (Humphreys, Bickerton, Samson & Riddoch, 2012), LM scored at normal levels for the rule finding and concept switching task, and she was also unimpaired on the gesture recognition and imitation subtests.

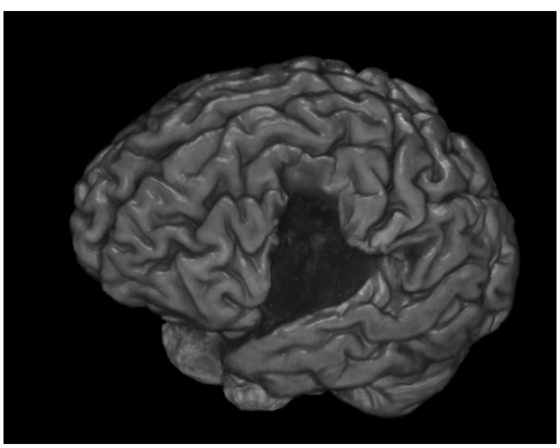


Fig 6.1: MRI scan, 2014. LH ischaemic stroke involving segments of L inf. and middle frontal gyri, pars opercularis of Broca's area & ventral parts of precentral & postcentral gyri

Language background

LM has always lived in North Wales, an area where a large part of the population is bilingual. Before the stroke, LM reports having native-like fluency in both English and Welsh (self-report). Welsh is her L1, and she spoke mainly Welsh while growing up. She began formally acquiring English at approximately age 7 in school; however, due to the bilingual nature of the North Wales environment, she would have been exposed to English before this from the media and non-Welsh speakers in the community. LM's use of English and Welsh became more balanced as an adult, though prior to the stroke she spoke Welsh approximately 75% of the time (based on self-report and language background questionnaire; see Appendix I for details). Welsh was the language used at home, and she was exposed to English through the media, some written communication, and when conversing with monolingual English friends and work colleagues. Since the stroke, LM's spoken output is predominantly in Welsh, though she is able to comprehend both languages. She is currently exposed to English predominantly via the media (magazines, radio and television).

Language skills

Immediately following the stroke LM's expressive language was severely impaired, but comprehension appeared generally intact. At the time of the present investigation, LM's comprehension in conversation is adequate, and her speech is generally clearly articulated. However, her spoken output is severely reduced with severe word finding difficulties. LM's output is typically at the single word level, supported by many filler words such as 'neis' (nice), 'yum-yum'. She produces several automatic words and phrases, which she repeats frequently during conversation in order to communicate her ideas and intentions. She is also able to produce accurate gestural representations of target words in both confrontation naming and conversation. In this way she is able to communicate reasonably effectively with a Welsh speaking conversation partner.

The results of an extensive assessment of LM's language skills are presented in Tables 6.1 and 6.2. English and Welsh tests were always administered in separate sessions, and by a native speaker. LM's nonverbal comprehension is generally preserved at the level of single object relations. At the single word level, her spoken comprehension is mildly impaired in English and Welsh, more so for low-imageability words [$\chi(1)=5.45$, $p<.05$]. She is more impaired in more challenging tests of receptive vocabulary. At the sentence level LM is impaired in auditory sentence-picture matching in both English and Welsh, though the impairment is greater in English. This was assessed with PALPA 55 (Kay, Lesser & Coltheart, 2009) administered in English and also adapted into Welsh.

LM has a moderate to severe repetition difficulty for real words at the single word level, and makes predominantly no response errors, and neologisms, e.g. THING-'fink'. She did not demonstrate an effect of frequency in repetition ability in English. In Welsh and English word repetition, she demonstrates an inconsistent length effect (English: 1 syll:6/8; 2 syll: 3/8; 3 syll:5/8. Welsh: 1 syll 8/18; 2 syll: 2/14; 3 syll: 0/4). She is at floor at repeating non-words in both languages. She is unable to repeat sentences. LM is able to identify same minimal pairs in words and non-words with no difficulty. However, she demonstrates a mild impairment at discriminating differing word minimal pairs (28/36) and a moderate impairment at discriminating differing non-word minimal pairs (22/36)

Table 6.1: Spoken language assessment (impaired scores in bold)

Process	Task	Score
Non-verbal semantics	3 picture PPT*	50/52
	Kissing and Dancing Test (picture version)***	**44/52**
Single word comprehension		
	Spoken word-pic matching PALPA** 47	
English		39/40
English	PALPA** 49 auditory synonym judgment	**Highly imageable: 21/30; low imageable: 12/30**
English	PPT* spoken word, 2 pictures	**46/52**
English	BPVS	**100/168**
Welsh	Translation of PALPA** 48	35/38
Welsh	Prawf Geirfa Cymraeg****	**69/111**
Sentence comprehension		
English	PALPA** 55	**30/60**
English	PALPA** 58 auditory comp of locative relations	**12/24**
Welsh	Adapted from PALPA** 55	**41/60**
Phonological perception		
English	PALPA**1 Word minimal pair discrimination	Same:36/36**; Different: 28/36**
English	PALPA**1 Non-word minimal pair discrimination	Same: 35/36; **Different: 22/36**
Single word repetition		
English	PALPA**9	**26/80**
Welsh	In-house task	**10/36**
Pseudo-word repetition		
English	PALPA**9	**1/80**
Welsh	In-house task	**2/36**
Sentence repetition		
English	PALPA** 12	**Unable to complete**

Welsh	Adapted from PALPA** 12	**Unable to complete**
Picture naming: Nouns		
English	Object and Action naming battery*****	**0/50**
	With phonological cue	**32/50**
Welsh	Adapted from above	**8/50**
	With progressive phonological cues	**29/50**
Picture naming: Verbs		
English	Object and Action naming battery*****	**0/30**
	With progressive phonological cues	**7/30**
Welsh	Adapted from above	**1/30**
	With progressive phonological cue	**3/30**
Translation (nouns)		
Welsh-English	In-house test	**1/75**
English-Welsh	in-house test	**2/77**

* PPT (Howard & Patterson, 1992)
** PALPA (Psycholinguistic Assessment of Language Processing in Aphasia) (Kay, Lesser & Coltheart, 2009)
*** Kissing and Dancing Test (Bak & Hodges, 2003)
****Prawf Geirfa Cymraeg (Mueller Gathercole, Thomas & Hughes, 2008)
***** Object and Action naming battery (Druks, 2000)

Table 6.2: Written language assessment

Process	**Task**	**Score**
Single word comprehension		
English	Written word-pic matching PALPA** 48	**30/40**
English	Kissing and Dancing Test word version***	**33/52**
English	PPT* 3 written words	**41/52**
English	PALPA** 50 written synonym judgments	**36/60 (highly imageable: 23/30; low imageable: 13/30)**
English	PALPA **51 Word Semantic Association	**6/30**
English	PALPA** 24 Visual lexical decision with illegal nonwords	Words: 30/30**; Nonwords: 29/30**
English	PALPA** 25 Visual lexical decision	**Words: 46/60; Nonwords: 37/60**
English	PALPA** 27 Visual lexical decision	**Reg. words: 13/15; Irreg. words: 13/15; Pseudohomophones: 8/15; Nonwords: 7/15**
Welsh	Translation of PALPA 48**	35/38
Welsh	Adapted from Kissing and Dancing Test*** word version	**28/47**

Sentence comprehension		
English	PALPA** 56	**Unable to complete**
Welsh	Adapted from PALPA** 55 spoken sentence comp	**Unable to complete**
Reading aloud		
English	In-house test	**Nouns 11/60; Verbs 6/60**
Welsh	In-house test	**Nouns 16/60; Verbs: 2/60**
Non-word reading		
English/Welsh	In-house test	Unable to complete

* PPT (Howard & Patterson, 1992)
** PALPA (Psycholinguistic Assessment of Language Processing in Aphasia) (Kay, Lesser & Coltheart, 2009)
*** Kissing and Dancing Test (Bak & Hodges, 2003)

Written comprehension (Table 6.2) is moderately impaired at the word level in both languages, but LM is severely impaired at reading aloud, and has a similar profile across languages. She demonstrates better noun than verb reading in both languages. She predominantly makes 'no response' errors in both languages, though she also makes semantic errors (e.g. DRINK- milk), orthographic errors (e.g. MONKEY- 'money'), translation errors, (e.g. PYSGOD- fish'), and circumlocutions in both languages, which indicate that although she is unable to verbally produce a response for many words, she can often access the meaning of the word she is attempting to read. Analysis of lexical features indicates that LM has a word length effect in reading aloud Welsh nouns ($t(58)=2.65$, $p<.05$), though no other word groups showed this effect. LM did not demonstrate an effect of frequency in reading aloud in either language with nouns or verbs.

Informal assessment of non-word reading indicates that she is unable to do so (no data available). LM's error patterns, combined with the imageability effect in written synonym judgements ($\chi^2(1)= 6.94$, $p<.05$), suggest that she presents with a deficit pattern indicative of 'deep dyslexia'.

LM has a severe anomia in Welsh and English, and is impaired in naming at the single word level in both languages, see Table 6.1 for details. Welsh is more preserved than English. She responds well to phonological cues, and these are especially effective for nouns. While she cannot always respond correctly to initial phoneme cues, progressive cues are effective in eliciting correct responses (see Table 6.1).

Table 6.3 below presents the results of further assessments of LM's picture naming and word translation ability, aimed at examining the effects of word frequency and cognateness on performance. A naming and translation test in Welsh and English was developed in-house, and normed on 35 age matched Welsh-English bilingual control participants. This assessment is discussed in Chapter 3 of this thesis. The assessments were matched across languages for lexical features including phoneme length, word frequency and cognateness (values taken from Kucera & Francis (1967) for English and from Ellis, O'Dochartaigh, Hicks, Morgan & Laporte (2001) for Welsh).

Table 6.3: The effect of frequency and cognateness on naming and translation in Welsh and English (% accuracy).

	English (N=75)		Welsh (N=77)	
	Naming	Translation	Naming	Translation
High frequency	5.8	0	15.4	2.5
Cognate	0	0	25	8.3
Non-cognate	8	0	11.1	0
Low Frequency	0	2.08	10.5	0
Cognate	0	0	21.4	0
Non-cognate	0	4.1	4	0

English: K-F, Kucera &Francis (1967); **Welsh**: CEG, Ellis, O'Dochartaigh, Hicks, Morgan & Laporte (2001).

During separate sessions for each language and tasks LM completed a confrontation naming task (pictures presented one at a time on PowerPoint slides). She also completed a translation task using the same items. The words were spoken by a bilingual native speaker of Welsh and English.

LM is at floor in her translation ability as can be seen in Table 6.2, therefore effects of length, frequency and cognateness cannot be analysed statistically. However, it can be noted that her performance is slightly better in Welsh naming than in English naming [$\chi^2(1)=6.55$, p<05], with a trend in Welsh naming towards greater accuracy for high frequency than low frequency items($\chi^2(1)=1.04$, $p=.244$) and for cognate than non-cognate items($\chi^2(1)=2.14$, $p=.132$), though neither of these trends were statistically significant. In addition, of the items LM produced correctly in the Welsh picture naming task, nine were in the 'short' category (4 phonemes or fewer), and only two in the 'long' category (5 phonemes or more)($\chi^2(1)=5.41$, $p<.05$). The two items she named correctly in the English picture naming task were also categorised as 'short' (with 2 and 3 phonemes respectively), as were all items translated correctly in both translation tasks. Therefore it is possible to tentatively conclude that LM demonstrates a length effect in naming and translation.

Error types

Table 6.4 presents a summary of the types of errors that LM made in response to the naming and translation tasks presented above. These error types are representative of her responses with other word lists. In both languages, LM produces 'no response' errors most frequently, especially in translation tasks. She also makes semantic errors, circumlocutions, language intrusions, phonological errors and neologisms though these are more common when naming. In addition, LM often produces accurate gestures or mimics an action related to the target. For example, for 'shave' she clearly mimics the act of shaving, and for 'book' she will hold her hand in an 'open book' gesture. These error types and the fact that she gestures to convey ideas, and has intact nonverbal semantics, indicate that LM is generally able to access the conceptual representation, but not the phonological information, for many of the items she attempts to name.

Table 6.4: LM's error types in Welsh and English picture naming and word translation tasks. All responses taken from LM's initial response on presentation of stimulus.

	English		Welsh	
	naming	translation	naming	Translation
	N (% of total errors)	N (% of total errors)	N (% of total errors)	N (% of total errors)
All errors N(%)	**73 (97.3)**	**74 (98.6)**	**66 (85.7)**	**75 (97.4)**
No response	46 (63)	70 (94.5)	49 (74.2)	73 (97.3)
Semantic	14 (19.17) *(jacket->dress)*	2(2.7)	10 (15.15) *Eira (snow)->glaw (rain)*	N/A
Language Intrusion	9 (12.3) *Window-> ffenest*	1(1.3)	1 (1.52) *(Sanau->socks)*	N/A
Other	4 (5.4)	1(1.3)	6 (9.09)	3 (4)

The locus of LM's word production deficit

LM's profile of accuracy and error types across tasks indicate that she has co-occurring deficits at several levels of the naming process. LM demonstrates no difficulty with tests of non-verbal semantics. In addition, she is able to use gesture in naming even when unable to find the name of the item she wants to say, which indicates that her conceptual-semantic representations are intact. LM can often retrieve words when given phonological cues. LM's preserved semantic processing, combined with a severe expressive naming impairment at the single word level indicates an impairment accessing phonological lexical units from conceptual representations. This is further supported by the fact that she makes semantic errors and circumlocutions in naming. Naming of nouns and verbs is severely impaired in both languages, though she responds better to cues for nouns than verbs.

Furthermore, the fact that LM produces phonologically related responses, including neologisms, indicates an additional impairment of post-lexical processing. A length effect is usually attributed to deficits in post-lexical phonological encoding procedures, e.g. at the level of the phonological output buffer (Nickels, 2001). The fact that she is more impaired at non-word than word repetition supports this hypothesis. This combination of impairments at several levels of the naming process results in a severe naming deficit at the single-word level, often resulting in 'no response' errors.

LM also presents with severe impairments in reading aloud and translation. These can also be explained by the deficit in accessing lexical phonology from semantics, as demonstrated by the fact that she makes semantic and translation errors in reading. Note that because LM cannot read non-words at all, it is likely that she reads words lexically rather than using grapheme phoneme conversion. Translation is further affected by her mild receptive impairment at the single word level, indicating an impairment of both comprehension and phonological processing.

6.3.2. Treatment Intervention Study

Design and Predictions

This was a single-case study with multiple baselines in which picture naming performance was assessed at baseline and post-test for four stimulus sets. Performance was assessed both in terms of picture naming accuracy and in terms of the number of phonological cues required to successfully retrieve words following inability to spontaneously name a target. A reduction in the number of cues would indicate partial improvement in accessing phonological representations. There were two English sets aimed at measuring treatment effects: Set 1, a treated set, and Set 2, an untreated control set. In addition, there were two Welsh sets, aimed at assessing cross-linguistic generalisation of treatment effects. Set 3 consisted of translations of treated Set 1, and Set 4 comprised translations of untreated control Set 2. Set 1 was presented during all treatment sessions, in addition to baseline and post-test sessions. All other sets were seen only at baseline and post-test. All sets included 50% cognates and 50% non-cognates, of which half of each were nouns and half were verbs (see details below).

It was predicted that LM's picture naming performance would improve on the treated set of items (Set 1) but not in the untreated English control items (Set 2). Improved naming of the treated set as compared to the untreated control sets would indicate item specific effects of treatment.

In terms of cross-linguistic generalisation, it was expected that the translations of the treated items would show improvement. This generalisation was predicted to be greater for cognate words. No improvement was expected for the unrelated control items in either language, as LM was in a chronic stage of recovery from aphasia, therefore no spontaneous improvement was likely. This was also demonstrated in background testing.

Generalisation to untreated tasks (reading, translation) was also measured for the same items as in naming, both in the treated language (English) and in the untreated language (Welsh). As the three tasks require accessing the phonological lexicon, we predicted that any treatment or generalisation effects observed in naming would also affect translation and reading. Translation ability in both directions was measured, though a greater improvement is hypothesised for translation into the language of treatment (English), i.e. translation from Welsh into English. Thus, we predicted that any treatment related task generalisation would be strongest for Set 1 items (treated words) but might also be observed for Set 3 items (translation of treated words), particularly for cognates.

LM's error types before and after treatment were measured in order to identify changes to functional communication as a result of therapy. Although translation errors, i.e. the target word in the incorrect language, are labelled as incorrect, in terms of functional communication naming a target word in the non-target language could be deemed more useful in a bilingual context than producing a 'no response' or semantic error.

Timeline

Baseline testing took place over a period of 3 weeks prior to treatment. English and Welsh items were presented in separate sessions. All stimulus sets were presented three times for picture naming at baseline. During the 3rd baseline session for each language, following an unsuccessful naming attempt, LM was provided with progressive phonological cues and the number of cues required to successfully retrieve each word was noted. Following treatment, post-testing also took place over three weeks, with 3 post-test measurements of picture naming ability, beginning in the week immediately following the end of treatment. Again, in the 3rd post-test session phonological cues were given in the case of incorrect responses. LM's translation (in both directions) and reading aloud of all stimuli were assessed once at baseline and again at post-test, in further, separate sessions, immediately following the end of naming assessment. The treatment phase included 4 sessions per week. Treatment was to continue until ceiling had been reached or until LM demonstrated no improvement over 4 consecutive sessions. LM reached a plateau after 16 sessions (i.e., 4 weeks). Mid way through treatment LM's naming was assessed once in English and Welsh in order to monitor her progress. These results are not reported here.

In each treatment session the treated set was cycled through twice, and LM was cued twice per cycle for each word, therefore she made 4 naming attempts per word during each session. Each session lasted approximately one hour.

All baseline and post-test assessment sessions and the treatment sessions were administered and analysed by the same individual, namely the candidate.

Stimuli

Stimuli for the present study were selected by identifying items named incorrectly by LM in background assessments, as well as a selection of items she could name correctly, so that baseline naming would not be at floor. The items were randomly distributed into two sets across each language (see Table 6.5); in English, a treated set and an untreated control set; in Welsh, translations of the treated set and of the untreated control set. The treated set included 48 high frequency, highly imageable, items, 24 nouns and 24 verbs. Half of the words in each set were cognates, which were defined as translation equivalent word pairs sharing at least 70% phonemes (e.g. ‘orange’ and ‘oren’). No cognate items had 100% phonological overlap across languages in order to ensure that it was always clear which language was being produced. The sets were matched for word class, cognateness, and frequency (English- Kucera and Francis, 1967; Welsh- CEG Cronfa Electroneg o Gymraeg, Ellis et al, 2001). See Appendix J for word lists. One way Anova confirmed the sets did not differ significantly in frequency, F (1,3) = 1.24, p=.296. There was a significant difference in word length (in phonemes) between the English and Welsh sets, F (1,3) =19.2, p<.01. As is typical, the Welsh words were longer on average than the English words (by a little over one phoneme on average). However, there was no difference between the translations of the treated and control sets in terms of length. As LM tends to be more accurate on Welsh naming than English this was not considered to be problematic. Due to LM’s somewhat greater accuracy in Welsh than in English, and the restrictions necessitated by the need to include translation and cognate words, sets could not be matched closely on LM’s pre-treatment performance levels. However, the sets were constructed to ensure similar baseline levels within language. In each set, LM was able to name some of the items before treatment, although there was significant room for improvement in each set.

Table 6.5: Lexical characteristics of the stimulus sets (means and standard deviations)

Word Set	N	Word length (phonemes)	Frequency Log 10
English treated Words (all)	48	3.95 [1.15]	1.73 [0.49]
Cognate verbs	12	3.41 [0.66]	1.74 [0.28]
Non-cognate verbs	12	3.16 [0.83]	1.86 [0.47]
Cognate nouns	12	4.08 [0.9]	1.46 [0.57]
Non-cognate nouns	12	3.5 [1]	1.96 [0.36]
English Untreated Controls (All)	48	3.56 [0.98]	1.76 [0.48]
Cognate verbs	12	3.8 [0.86]	1.31 [0.39]
Non-cognate verbs	12	3.58 [0.99]	1.99 [0.31]
Non-cognate nouns	12	2.72 [0.49]	1.59 [0.46]
Cognate nouns	12	4.25 [0.49]	2.05 [0.39]
Welsh translations of English treated (All)	48	4.81 [1.11]	1.58 [0.54]
Cognate verbs	12	5.33 [1.15]	1.35 [0.36]
Non-cognate verbs	12	4.75 [1.05]	2.01 [0.61]
Cognate nouns	12	4.41 [0.9]	1.33 [0.58
Non-cognate nouns	12	4.66 [1.3]	1.99 [0.34]
Welsh translations of untreated controls (All)	48	4.94 [0.95]	1.58 [0.73]
Cognate verbs	12	5.5 [0.86]	0.76 [0.68]
Non-cognate verbs	12	5.16 [0.83]	1.98 [0.34]
Cognate nouns	12	4.5 [1]	1.4 [0.47]
Non-cognate nouns	12	4.72 [1.07]	2.12[0.50]

All picture stimuli were presented as full colour images on individual A4 paper sheets. The pictures used to represent each target word were the same at all assessment points (baseline, treatment and post-test). During the initial 8 treatment sessions the pictures were presented in the same order. However, as it was felt that LM was becoming able to predict the next target item, during the final 8 sessions presentation order was randomised. In assessment sessions, item presentation was randomised across all sets of the same language (i.e. Sets 1, and

2, vs. Sets 3 and 4). Each language was assessed during separate sessions in order to inhibit language mixing.

6.3.3. Treatment protocol

The treatment used was a sentence completion and phonological cueing type treatment, targeting several levels of the naming process, including conceptual representations and the phonological output lexicon. Decreasing cues were given to aid LM's naming. This was chosen based on LM's positive response to phonological and sentence completion cues, revealed in background naming assessment. Furthermore, two different treatment types were administered, in order to compare the effects of targeting treatment at different levels of the naming process. These are outlined below.

During the treatment phase, LM was visited at her home for 4 x weekly sessions. The treatment set was treated with semantically meaningful sentence completion cues, combined with phonological cues. The phonological cues were 'vanishing' or 'decreasing', in order to minimise reinforcement of errors; they initially consisted of the whole word to be repeated, decreasing phoneme by phoneme as a function of LM's response to each prompt.

During treatment, LM was shown a picture and immediately given a sentence completion and phonological cue. In the initial sessions the phonological cue consisted of the whole word. LM was then asked to repeat the word or complete it following the cue. Following LM's response, the researcher either repeated the target name (following a correct response), or following an erroneous response, modelled the correct word for LM to repeat. LM's attention was again drawn to the picture, and she was given the sentence completion and relevant phonological cue and asked to repeat or complete the target picture name. For half of the items, LM was provided with an additional orthographic cue, which she was required to copy following the first sentence completion and phonological cue. When LM required the full spoken name of the word as a phonological cue, then the whole written name was provided for copying. As the length of the phonological cues decreased, so did the orthographic cues. For example (see Figure 6.2), if the participant was able to produce the target word "window" accurately following the phonological cue 'wind', then the orthographic cue (when provided) would be shown as in 6. 2 below, with the relevant letters hidden.

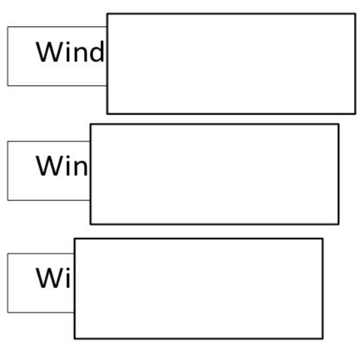


Figure 6.2: decreasing orthographic cues

LM would then attempt to copy the part of the word shown, and then recall the remainder from memory. If she was unable or made an error, the next letter was immediately shown until she had produced the written word accurately.

Regardless of LM's response, the same level of cue was given for each item during the subsequent treatment session in order to consolidate the learning effects. If she had responded correctly to a given item for two consecutive sessions, the length of the cue would be reduced by one phoneme at the following session. For example, the cue for the word "window" would first be 'when it's hot you open the **window'** , then 'when it's hot you open the **wind__',** and so on, removing one phoneme at a time until only the sentence and mouth-shape of the first phoneme was provided.

This process was continued until the participant no longer required a phonological cue at all to produce the word accurately, at which point she received a sentence completion cue only. Following two consecutive sessions of accurate retrieval of the target with a sentence cue only, the participant was prompted to retrieve the target word upon viewing the picture stimulus only. However, in order to maintain the errorless nature of the treatment method, if the participant was unable to retrieve the target word within 5 seconds of picture presentation, the sentence completion cue was again provided, and a note of the participant's response made. Each sentence completion and phonological cue was presented twice during each cycle of treatment. The cueing level was reviewed for each word individually following each session, therefore LM required a whole word cue for some items for several consecutive sessions, whereas she improved more quickly with other words and was able to respond to the sentence cue only within a short time frame.

6.4. RESULTS

6.4.1. Scoring and analysis

The analyses below evaluate treatment and generalisation effects by comparing performance (number of correct initial responses; number of cues required to elicit a correct response) before and after treatment. The significance of change in naming performance at different time points (baseline vs. post-test) was tested using the WEST (Weighted Statistics) method advocated in Howard, Best & Nickels (2015). For naming accuracy, we used the WEST-COL statistic that allows for comparisons by items between pre- and post-test in cases where there is no significant change between different baseline measurements, as was the case in the present study (see below). This method essentially compares the differences of scores, weighted as appropriate by the number of observation points (e.g. 3 baselines vs. 3 post-tests) in each condition against the null hypothesis of a zero difference, using a paired samples t-test. In addition, paired samples t-tests were used to compare the number of cues required at baseline and post-test. Across-task generalisation was assessed by comparing accuracy at baseline and post-test using the WEST-COL statistic. One-tailed p-values are reported for those comparisons where we had a priori predictions as to the direction of the possible difference between pre- and post-test (i.e. for naming treated items, translations of treated items, and reading and translation of treated items and their translations). Two-tail p-values are reported for other contrasts, or when the observed difference was in the opposite direction to what was predicted. Effect sizes are calculated using Pearson's correlation coefficient, *r*.

In general, no systematic differences were observed between nouns and verbs so for simplicity they have been presented in a combined format (see Appendix K for a full breakdown). We will however present data from nouns and verbs separately when there are different patterns of improvement across word class.

Similarly, the two treatment types generally resulted in similar treatment outcomes (as measured by independent t-test) therefore all results presented below represent both treated sets together, except where this is explicitly stated in the case of different patterns of improvement across treated sets.

The distribution of error types was also compared between baseline and post-testing using Chi-square analysis (only significant results are reported).

6.4.2. Baseline performance

Figure 6.3 shows LM's naming accuracy across all word sets over the three assessment sessions. As can be seen from the graph, the baselines were very stable overall. There was an upward trend across sessions for the Welsh translations of the treated items (from 6/48 to 8/48 between baselines 1 and 3) but this change was not significant (M=-0.13, SE=0.069), $t(23)$ =1 .81, p=.08. Although there is some variation, accuracy is very low on all sets; thus there is potential for statistically significant improvement post-treatment on all sets. Reading and translation ability was assessed once at baseline in each language, see Table 6.6 for details. LM's reading ability was better than translation, in both languages, but she had very low accuracy across all sets for both tasks.

Table 6.6: LM's % baseline accuracy on reading aloud and translating all word sets

	English		**Welsh**	
	Reading	Translation	Reading	Translation
Control Set	16.6	0	6.25	20.8
Treated Set	14.5	8.3	18.75	20.8

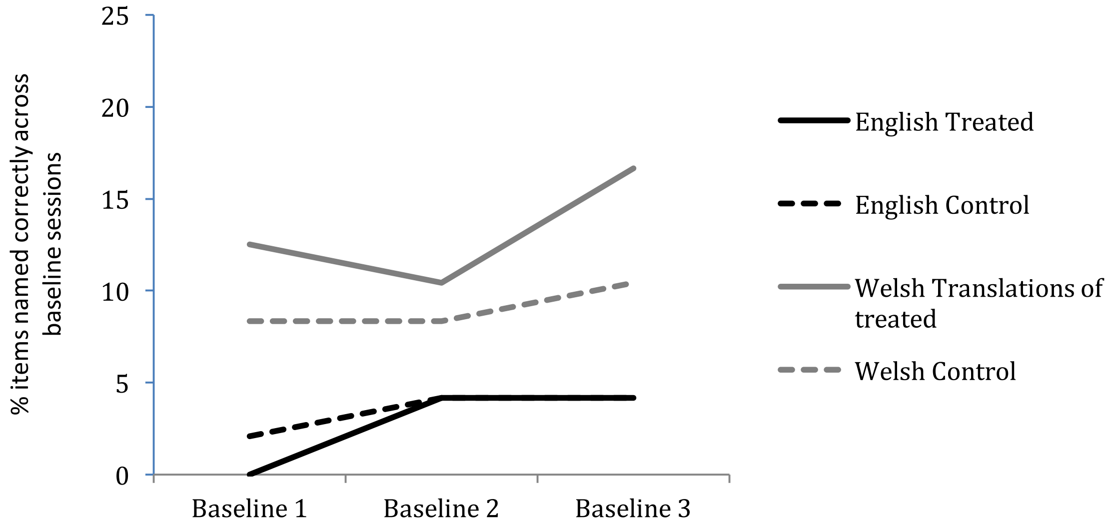


Figure 6.3: LM's % naming accuracy across baseline sessions

6.4.3. Treatment effects within language

Figure 6.4 presents naming accuracy pre and post-treatment across treated and control word sets (change in accuracy across all words sets can be seen in Appendix K). As predicted, there was a main effect of treatment; treated words improved, from an average of 6.9% at baseline to 27.1% at post-test, $t(47)=3.24$, p<.01, 1-tailed. This represents a medium sized effect, $r=.43$. There was no difference in the improvement observed for cognate and non-cognate items: cognates improved by 20% and non-cognates improved by 19.4% (t (47)=.386, p=.701).

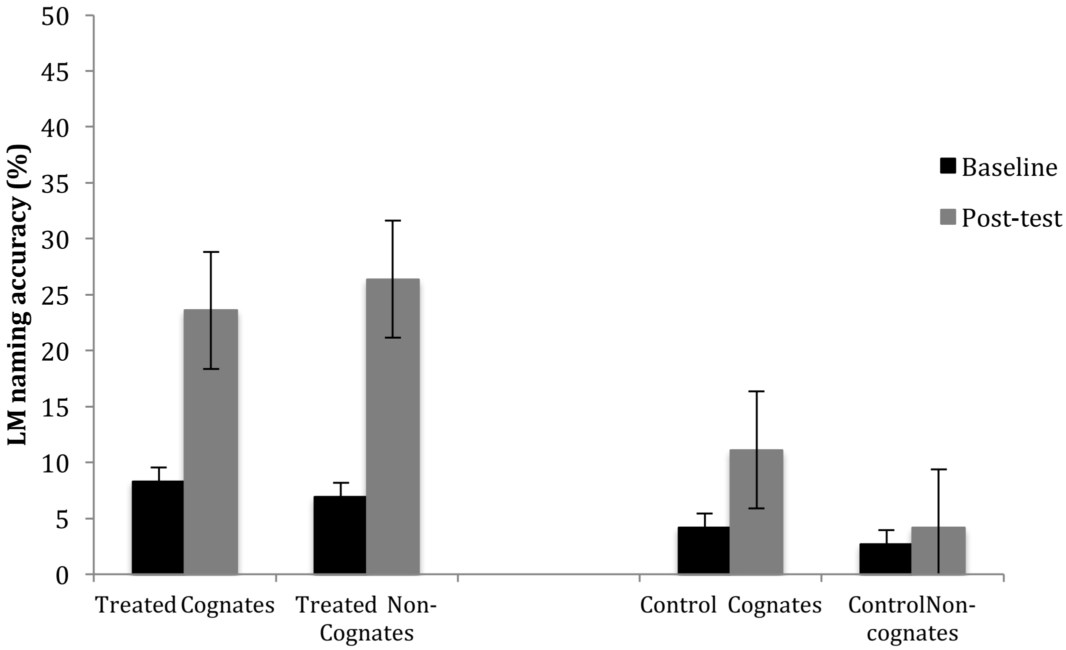


Figure 6.4: LM's mean naming accuracy and SE on all English items for the three baseline and three post-test sessions.

The number of cues required for LM to successfully produce the picture names was also measured in baseline 3 and post-test 3 (see Figure 6.5). The number of cues was measured in number of phonemes ranging from 0 (correct without cue) to the total number of phonemes in a given word. As predicted, there was a significant reduction in the number of cues required to name treated words pre- vs. post-treatment, and this was true for both cognate items (Pre: M= 2.5, SE = 0.27; Post: M=1.62, SE=0.26, t (23)=2.36, p<.01; medium sized effect, r=.32) and for non-cognates (Pre: M=2.2, SE=0.37; Post: M=1.5, SE =023, t (23)=2.02, p<.05; medium sized effect, r=.28).

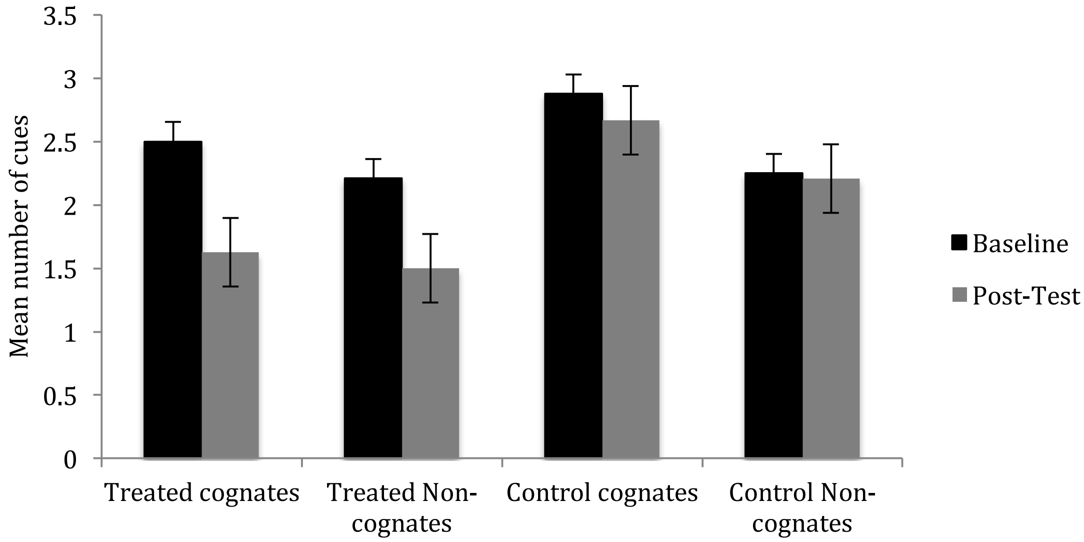


Figure 6.5: Mean number of cues (and SE) required for successful word retrieval at baseline and post-test (English word sets)

We next present the analyses for the untreated control words, seen only at baseline and post-test. As predicted, there was no significant change in naming accuracy for these items (t (47)=1.16 p=0.24, 2-tailed). There was also no change in the number of cues required for successful retrieval of control items between baseline (M=2.56, SE=0.26) and post-test (M=2.43, SE=0.25), t(47)=1.01, p=.313). This confirms the improvements reported above are treatment related and specific to treated words.

6.4.4. Cross-linguistic generalisation effects

In this section we examine performance across time points for words in the untreated Welsh sets as a function of their relationship with the word sets in English (cognate and non-cognate translations of treated items; untreated unrelated controls; see Figure 6.6).

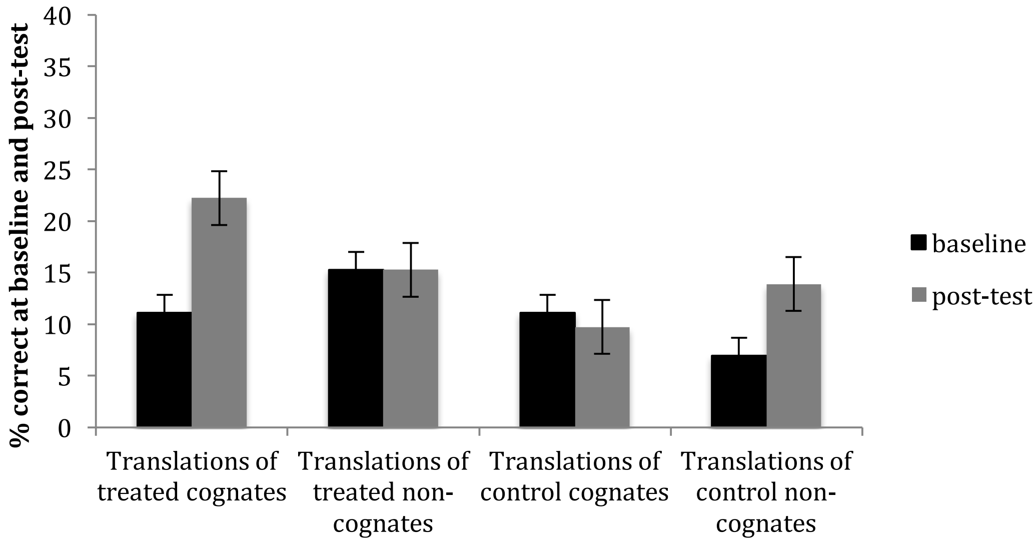


Figure 6.6: LM's mean naming accuracy and SE on all Welsh items for the three baseline and three post-test sessions.

As predicted, cognate translations of treated items did show some improvement after treatment. This change approached significance (t(23)=1.55, p=0.06, 1-tailed) and represents a medium sized effect, r=0.3. There was no change in performance on non-cognate translations of treated items (t(23)=0, p=1).

There was an overall decrease in the number of cues required to name Welsh translations of English treated items [t(47)=2.19, p<.05, r=.3] as can be seen in Figure 6.7. When word sets were separated by cognateness the effect only reached significance for cognates (Cognates: M=2.92, SE=0.39 at baseline vs. M=2.29, SE=0.37 at post-test, t(23)=1.73, p<.05, 1 tailed, r=.33; Non-cognates: M=3.04, SE=0.39 at baseline vs. M=2.71, SE=0.33 at post-test, t(23)=1.31, p=0.1, 1 tailed, r=.26). Thus, cognate translations of treated items improved both in terms of overall accuracy and in terms of the number of cues required.

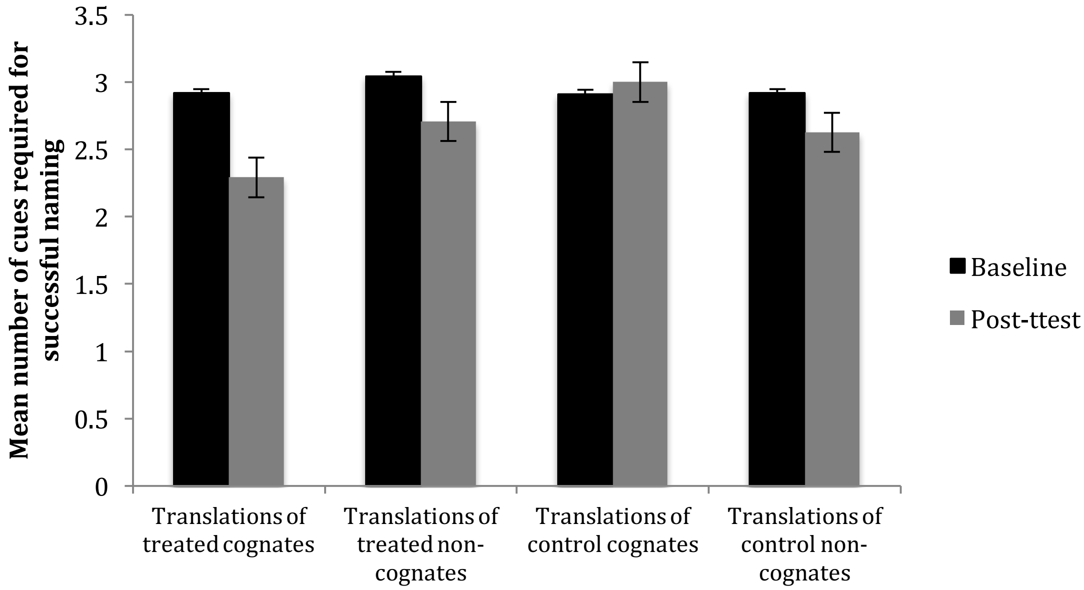


Figure 6.7: Mean number of cues (and SE) required for successful word retrieval at baseline and post-test (Welsh word sets)

We next present the analyses for the translations of the untreated control words, seen only at baseline and post-test. As predicted, there was no change in naming performance between baseline and post-test ($t(47)=0.97$, $p=0.16$, 2 tailed) and no change in the number of cues required for successful retrieval at baseline: $M=2.91$, $SE=0.28$ vs. $M=3$, $SE=0.29$ at post-test, [$t(47)=0.97$, $p=.59$]. This was true for both cognates ($t(23)=0.27$, $p=0.78$) and non-cognates ($t(23)=1.15$, $p=0.25$).

6.4.5. Generalisation to untreated tasks

In this section we examine LM's performance on translation and reading aloud of the same items used to assess naming. The results are split by language, first to establish within-language effects to untreated tasks, and second to establish cross-language generalisation to the untreated language.

Task generalisation within language

Figure 6.8 presents the change in number of items named, read aloud and translated correctly in English following treatment. Translation from Welsh to English of cognate treated items did improve between baseline and post-test although the effect is only marginally significant ($t(23)=1.44$ $p=0.08$ 1-tailed, $r=.28$). However, there was no change in the translation from Welsh to English of non-cognate treated items ($t(23)=1$, $p=0.34$, 2-tailed). As predicted, there was no change on translating the control items ($t(47)=1$, $p=0.32$, 2-tailed).

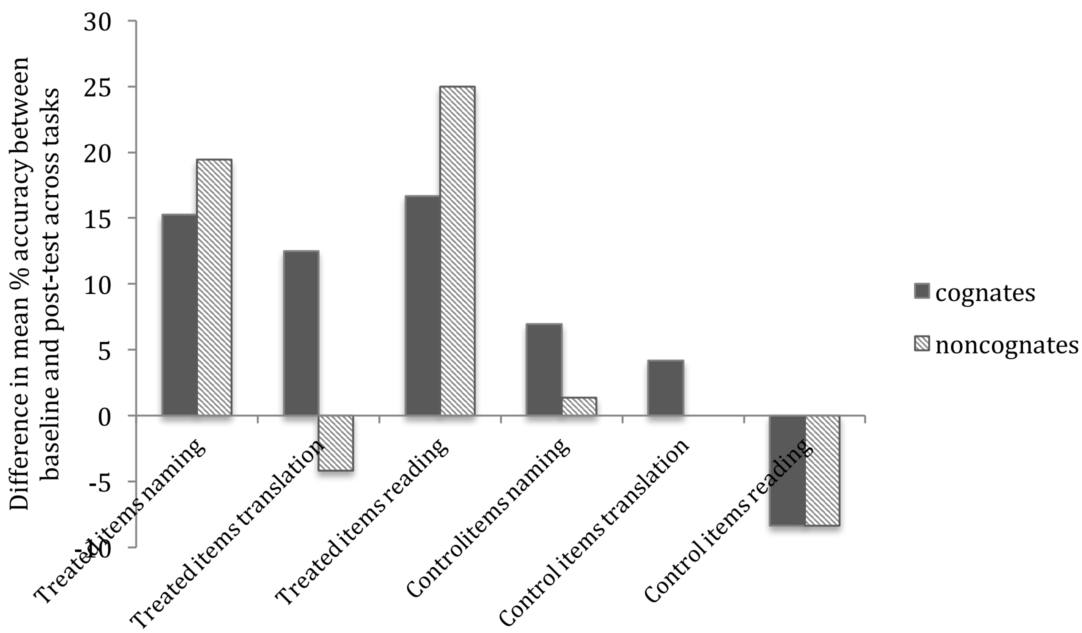


Figure 6.8: Difference between post-test and pre-test in mean percent accuracy in naming, translation and reading of the English word sets.

LM demonstrated significant improvement on reading aloud treated items overall [$t(47)=3.13$, $p<.05$, 1 tailed, $r=.41$]. When analysed in terms of cognateness, this improvement was significant for cognate treated words [$t(23)=2.04$, $p<.05$, 1-tailed, $r=.39$], and for non-cognate words [$t(23)=2.31$, $p<.05$, 1-tailed, $r=.43$]. However, there was no improvement in the reading of control items; instead a slight decrease was observed although this was not significant ($t(23)= 1.43$, $p=.159$)

Task generalisation across language

Figure 6.9 compares the % change in LM's accuracy in naming, translating and reading aloud in Welsh before and after treatment. As predicted, LM improved significantly on translating treated items into Welsh [$t(47)=1.97$, $p<.05$, 1-tailed, $r=.27$]. Cognates and non-cognates improved at an equal rate. There was no change on translating control items into Welsh ($t(47)=1.41$, $p=0.16$).

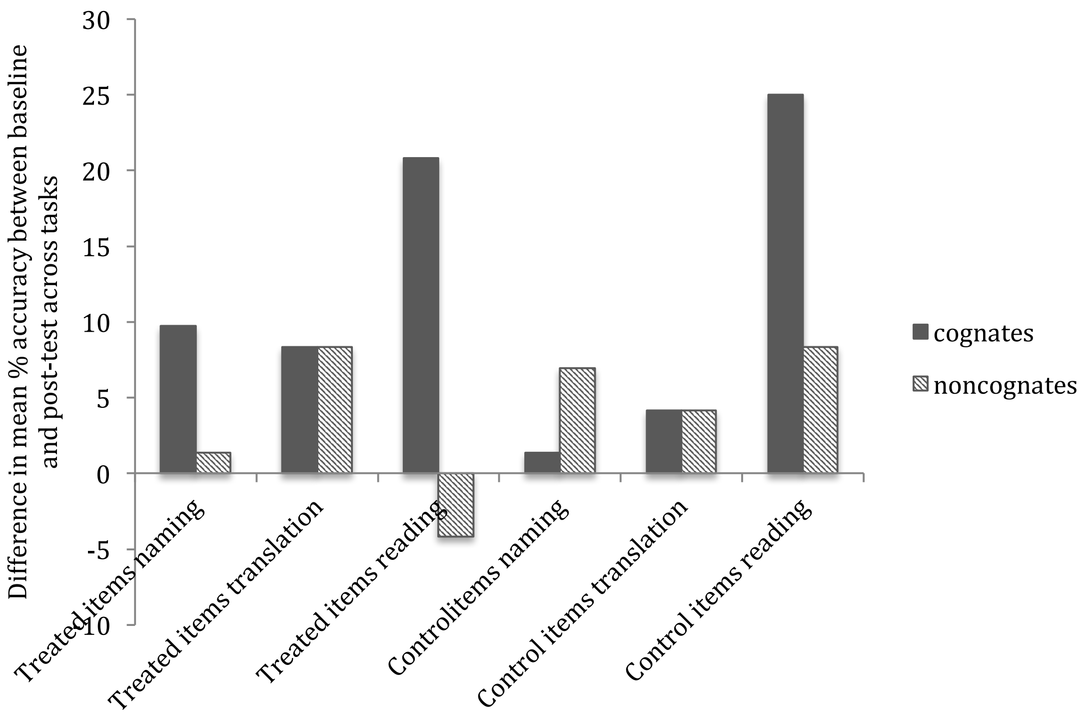


Figure 6.9: Difference between post-test and pre-test in mean percent accuracy in naming, translation and reading of the Welsh word sets

LM improved on reading aloud the Welsh words that are cognates of the English treated words [$t(23)=2.46$, $p<0.01$, 1-tailed, $r=.45$], but did not improve with non-cognates.

Furthermore, LM also improved in her reading aloud of cognate control words, that is of cognate translations of untreated items the translations of the untreated control cognate nouns showed significant improvement between baseline and post-test ($t(23)=2.76$, $p<.01$, $r=.49$). No other sets of control words demonstrated significant improvement. In other words, LM improved in her reading of all Welsh cognate words, whether or not they corresponded to English treated items.

Change in error types following treatment in the naming task

Change in error types was measured between baseline and post-test (see Figure 6.10). These analyses included LM's responses from baseline sessions 1 and 2 in each language, and post-test 1 and 2 in each language. The third baseline and post-test sessions were not included as in these sessions LM was given progressive phonological cues when she was unable to spontaneously produce a correct response, and she tended to produce more 'no response' errors during these sessions in anticipation of being cued. All changes are reported as a proportion of total number of errors.

As can been seen in Figure 6.10, the type of errors that were made after treatment remained relatively stable overall compared to baseline. The only change that reached significance was an increase in the proportion of language intrusion errors for Welsh cognate translations of the treated items ($\chi^2(1)=7.21$, $p<.05$), which was accompanied by a reduction of no response errors for the same word category ($\chi^2(1)=5.82$ $p<.05$), No other changes were significant.

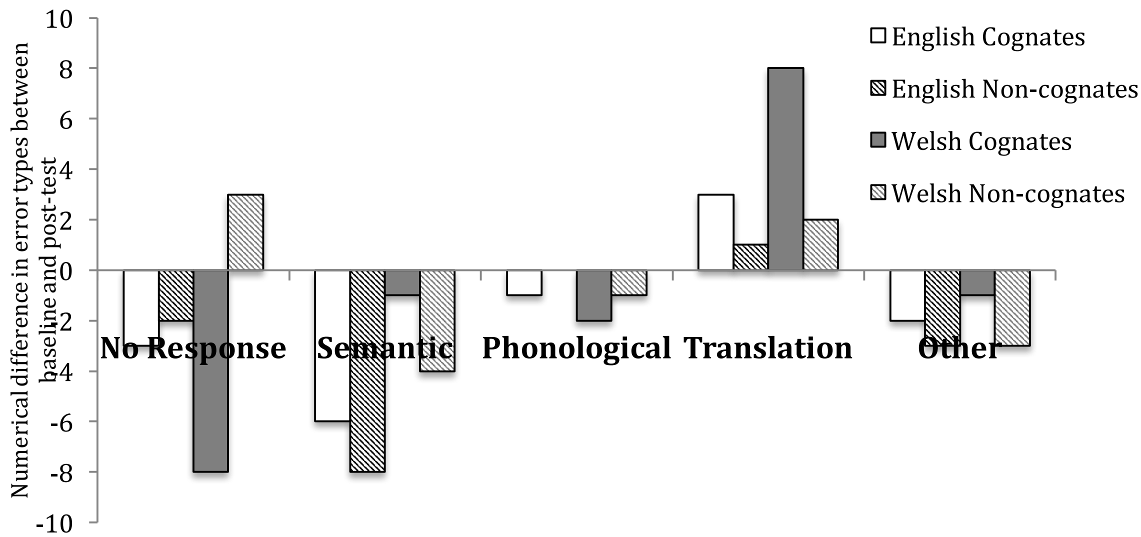


Figure 6.10: Change between baseline and post-test in incidence of error types in English and Welsh naming treated items

As for control items, there was a reduction in the proportion of semantic errors in English between baseline (17.2%) and post-test (4.39%), ($\chi^2(1)=7.78$, $p<.01$) that was accompanied by a proportional increase in 'no response' errors ($\chi^2(1)=9.79$, $p<.01$). There were no other significant changes in error types for control items in either language.

6.5. DISCUSSION

The present study investigated the outcome of a sentence and phonological cueing treatment with LM, a Welsh-English bilingual aphasic participant. Generalisation of treatment effects was measured, both within and across language, to naming of untreated items and also to translation and reading aloud of the treated and control items. The number of cues required for successful lexical retrieval was also measured before and after treatment, as a further indicator of treatment success.

6.5.1. Within language gains

As predicted, the treatment resulted in gains to treated items in the treated language (from an average of 6.9% correct at baseline to 27.1% at post-test), with similar patterns of improvement across cognates and non-cognates. There was also a significant decrease in the number of phonological cues required to elicit a correct response, between baseline and post-test. There was no corresponding improvement to untreated items. This finding suggests that the decreasing cueing treatment was effective, and that any improvement was not as a result of generalised spontaneous improvement.

6.5.2. Cross-language gains

We investigated LM's naming of all items in the untreated language, and predicted that cross-language generalisation would be greater for the cognate translations of the treated items. Generally, this prediction was upheld, as improvement on naming cognate translations of treated words approached significance (from an average of 11.1% at baseline to 22.2% at post-test). The number of cues required for successful naming decreased significantly for translations of cognates only. There was no improvement to naming translations of untreated control items.

As LM's within language treatment gains were quite small, the limited improvement for cognates is in line with the predictions and replicates the pattern reported for patient HBL in Hughes et al (2012).

6.5.3. Generalisation to untreated tasks

We also examined generalisation to untreated tasks, as a further indicator of treatment outcome. We predicted improvement in translation and reading aloud of the treated items, with a further prediction of a cognate advantage in the untreated language that would parallel the pattern of improvement observed in naming.

The results did not entirely conform to some of our specific predictions but overall the translation and the reading tasks did improve after treatment, both within and between languages. More specifically, LM's translation performance improved within language for treated cognates and between language for both cognates and non-cognate translation of treated items. Thus, the more specific prediction that generalisation across task and languages would be stronger for cognate than for non-cognate items was not upheld. As for reading aloud, improvement was observed for all treated items within language. Thus, the naming treatment improved both the naming and the reading aloud of the same words, as predicted since reading and naming both require access of the phonological output lexicon. Between language, there was an improvement in the reading of cognate translations, as predicted, although this improvement was also observed in the control cognates, that is cognate translations of untreated English words, which was not expected. It is worth noting that words treated with and without orthographic cues improved similarly, meaning the improvement in reading aloud was not related to LM being shown the word form. In addition, when LM was successful in reading aloud, she tended to respond quickly, with no indication that she was trying to decode the words using grapheme-phoneme conversion. This combined with the presence of semantic errors (see Appendix L for full details) indicates that she was attempting to read lexically using a whole word approach.

LM's reading and translation were assessed once only at baseline and post-test, compared to three times for naming in both languages. As LM's ability shows some variation across sessions, repeated testing may have revealed more consistent and predictable effects of generalisation to these tasks

6.5.4. Error patterns

We measured changes in LM's error types in naming following treatment. For the English treated items, there were no significant changes in error types. For the Welsh translations of the treated items, only one significant change occurred, which was an increase in the number of translation errors for cognate items. There was no change in the number of translation errors for non-cognates, that is of cases in which she produced the treated word itself rather than its Welsh equivalent. Although these non target language responses were recorded as incorrect, in the context of a Welsh-English bilingual environment, producing the translation of a target cognate word is more functionally communicative than any other error type (Roberts & Deslauriers, 1999) and from a clinical standpoint this would reflect a successful treatment outcome. If both correct answers and language intrusions are considered as communicative answers, the improvement is quite substantial for cognate words, going from 15% at baseline to 40% at post-test ($\chi^2(1)=6.38$, $p=0.006$).

6.5.5. Contributions & Implications of the present study

The present study was a replication of a previous study investigating cross-language generalisation of treatment effects in Welsh-English bilingual anomia. The previous treatment design was adapted to investigate the impact of errorless treatment with a sentence completion and phonological cueing design on treatment outcome. It was hypothesized that errorless cueing would be more effective in bilingual anomia than progressive cues, as the translation equivalent for cognate words would not be erroneously cued.

The findings from the present study replicate those of the previous study with HBL, in that treated items in the treated language improved. Cross-language generalisation was greater for cognate translations than non-cognates, as has been found in previous studies (e.g. Kohnert, 2004). As far as can be concluded by comparing two different patients, the errorless cueing treatment was not more effective than traditional cueing treatment in improving naming in the treated or untreated languages.

6.5.6. Limitations

Patients differ in their response to treatment for reasons that are not yet fully understood. Although the present study investigated a treatment design that incorporated more cueing elements than the previous study with HBL and many other treatment studies, relearning was limited.

Although LM demonstrated significant improvement on naming the treated items in the treated language, these gains were quite small, and she did not reach ceiling on the treated set of words. As a result, cross-language generalisation to naming in Welsh was also limited. The severity of LM's impairment was probably a factor in this result; her lexical processing is severely impaired at several levels of the naming process, which means that for successful activation to take place (i.e. for normal flow of information between levels) the treatment may have to target several areas of weakness at once.

An alternative explanation for the limited results may be the number of items targeted in treatment. Forty-eight words were treated in total, which is possibly too many for a patient with a deficit as severe as LM's. Had we treated fewer words she would have had more naming opportunities in each session for consolidation. Concentrating on fewer items may have allowed LM to come closer to reaching ceiling on accuracy. Fillingham et al (2006) compared the number of naming attempts across two treatment studies and found that increased naming attempts resulted in an increase in the number of items learnt during treatment. However, Laganaro, Di Pietro & Schnider (2006) compared the size of treatment set in a group study with 8 aphasic patients and found that gains were greater following treatment with a larger word set. The authors concluded that treatment outcome depends more on the number of items treated than the number of repetitions per item. In a meta-analysis of anomia therapy, Snell, Sage & Lambon-Ralph (2010) also investigated the effect of number of words treated on therapy outcome, and found that most patients improved more on treated items when treated with larger word sets, and that severity of aphasia did not interact with set size. These contradictory findings may be the result of differing treatment types, or a reflection of individual differences. Further investigation could include a comparison of individual participants' responses to different treatment set sizes.

A second consideration was the semantic information provided in the sentence cues. Each word was cued with a semantically constrained sentence cue, e.g. 'you get milk from a… COW'. The same cue was provided each time, with no variation across sessions. Each word was cued up to 4 times per session, with the same sentence cue. While this, combined with the phonological information provided in the phonological cue, meant that different levels of representation were being cued, only very limited semantic information was activated for each item over the course of treatment. A more interesting treatment design, and one that may have resulted in stronger semantic activation, would have been to provide different semantic cues within and between sessions, in order to increase the amount of semantic information activated for each target word, and to promote generalisation to different semantic contexts. In addition, this may have led to greater cross-linguistic generalisation, especially for non-cognate items, as it may have strengthened lexical-semantic representations in both languages. Studies with monolingual participants have found that treatment focusing on semantic information results in within-language generalisation to semantically related control items (e.g. Kiran & Thompson, 2003). Such treatment is hypothesised to increase the activation level of target items, and that of semantically related items. In bilingual speakers, both languages are thought to access a common semantic representation for each phonological representation (e.g. Kroll & Stewart, 1994) and that phonological representations in both languages are activated during naming (e.g. Costa et al, 1999; Costa & Caramazza, 1999; Green, 1998). As a result, treating items in one language can often result in improved access to their translation equivalents (e.g. Edmonds & Kiran, 2006).

6.5.7. Considerations for future study

In terms of the effect of language dominance on treatment outcomes, LM was a balanced bilingual prior to her stroke, but post-morbidly her vocabulary and naming ability are significantly better in Welsh, as evidenced by background naming assessments and baseline testing. The current study resulted in modest cross-language generalisation of treatment effects to Welsh cognate items, in line with a small but significant improvement in naming English treated items. Treating LM's naming impairment in her L1 Welsh may result in greater improvement to treated items, with a corresponding improvement to English translations of treated items.

A further area for consideration may be to incorporate a translation task in treatment as well as in assessment of treatment outcomes, alongside picture naming- as a further way to strengthen lexical connections. Translation has been used in treatment with a bilingual patient with a deficit of pathological language switching (Ansaldo et al, 2010) with resulting improvement to naming and translation in the treated language. Therefore, incorporating cross-language lexical connections as well as conceptual-lexical links into treatment may result not only in improvement to treated items but also in greater cross-language transfer of treatment effects.

6.5.8. Conclusions

The present study replicates the findings of a previous study investigating cross-language generalisation of treatment effects in Welsh-English bilingual anomia (Hughes et al, in preparation). The previous treatment design was adapted to investigate the impact of errorless treatment with a sentence completion and phonological cueing design on treatment outcome. The present treatment resulted in significant gains to treated items and greater cross-language gains for cognates than non-cognates.

There was also a significant reduction in the number of cues required for successful naming following treatment, indicating an increase in lexical activation levels for items not successfully named at post-test. Furthermore, there was a significant improvement to an untreated task, reading, in both languages, indicating that the activation of the phonological output lexicon in naming generalised to improvement in reading aloud. The fact that only cognate words improved in either language lends further support to the hypothesis that cognate items may benefit more from treatment due to co-activation of lexical representations during naming. As far as can be concluded by comparing two different patients, the errorless cueing treatment was not more effective than traditional cueing treatment in improving naming in the treated or untreated languages. However, LM did not appear to become frustrated by the repeated attempts at naming, as can often be the case in progressive cueing, which may have implications for patient motivation.

In conclusion, the present study supports the hypothesis that cross-language treatment generalisation can occur following treatment in bilingual anomia, particularly for cognate items. Furthermore, our findings generally support the assumptions of models of bilingual lexical processing models (e.g. Kroll & Stewart, 1994; Costa & Caramazza, 1999), regarding language co-activation at different levels of the naming process (semantic, lexical, phonological). The greater generalisation for cognate words also supports a hypothesis of stronger co-activation across languages for words with similar form as well as meaning. This co-activation may be as a result of feedback from the phonological level (e.g. Costa et al, 2000) or take place via direct links at the lexical level (e.g. Kroll & Stewart, 1994).

CHAPTER 7: GENERAL DISCUSSION

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7.1 Summary of main findings

The main aim of this thesis was to compare the effect of cognate status on lexical processing across picture naming and translation tasks with Welsh-English bilingual healthy and language-impaired participants in order to explore the processes that underlie lexical processing of cognates and non-cognates in bilingual speakers.

The results from these experiments revealed a robust cognate advantage in healthy bilinguals, which were stronger in translation than in naming. In aphasic participants, we observed a consistent cognate advantage for naming in the weaker language, but this was less consistent for naming in the stronger language, or in translation tasks. In these same tasks, the aphasic participants made fewer semantic errors when translating than when naming the same items. Finally, the treatment study of a case of bilingual anomia resulted in cross-linguistic generalisation for cognates, as well as cross-task generalisation from naming to translation and reading aloud.

7.2. A working model of bilingual lexical retrieval in naming and translation

The results of the experiments reported here contribute to the evidence supporting models of interactive bilingual lexical processing.

We have utilised two models in order to make predictions for bilingual lexical processing in this thesis. We have used Costa et al's 2005 model of bilingual lexical processing in order to make predictions for a cognate facilitation effect in unimpaired and impaired bilingual lexical retrieval, and for cross-language generalisation of treatment effects in bilingual aphasia. We have used the Revised Hierarchical Model (Kroll & Stewart, 1994) to make predictions about the processes involved in translation. Costa's model provides an account of the cognate facilitation effect in naming, but does not account for translation processes. Conversely, while the RHM provides an account for both naming and translation, and the routes used for both tasks, it does not specify the role of cognateness (see Figure 7.1 below for a representation of the models, and see Chapter 1 for a full account of the predictions of both). In order to interpret our findings, we have made a preliminary attempt to integrate the two models in order to provide a full account of naming and translation processes in bilinguals.

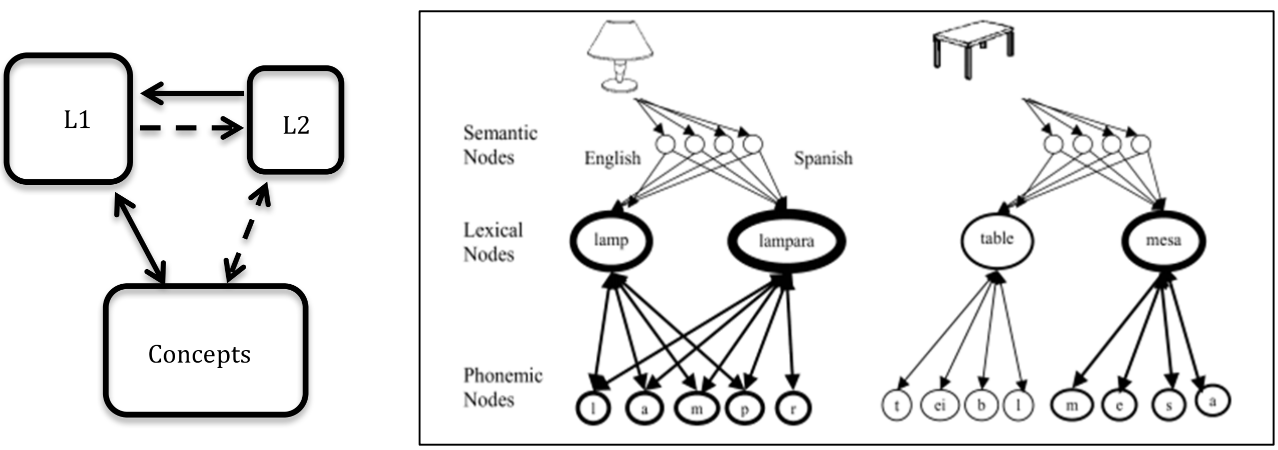

Figure 7.1: Left: Kroll & Stewart's Revised Hierarchical Model (1994); Right: Illustration of the cognate facilitation effect (from Costa et al, 2005)

The predictions of the model vary according to the nature of the task, e.g. picture naming versus translation, and the type of stimulus that is being processed, e.g. cognate versus non-cognate words. Note that this integrated model assumes balanced proficiency in the two languages, in accordance with the characteristics of our bilingual participants. Predictions may vary with differing proficiency levels, which is a subject for future investigations. As depicted in Figures 7.2 and 7.3 below, the representations are 'weighted' in order to indicate the strength of activation hypothesised to occur during processing; the thicker the line, the stronger the hypothesised activation. One difference between this model and that of Costa is the existence of direct lexical connections between languages. These are not necessary to account for cognate facilitation effects in naming, but have been postulated by several authors (e.g. De Groot et al, 1994; Kroll & Stewart, 1994) and will be a focus of our account of translation in comparison to naming, in which these direct lexical connections result in increased co-activation across languages. Below are some predictions for how this model would behave in the context of the tasks and lexical stimuli presented in this thesis, followed by an analysis of how the model accounts for the results we have obtained.

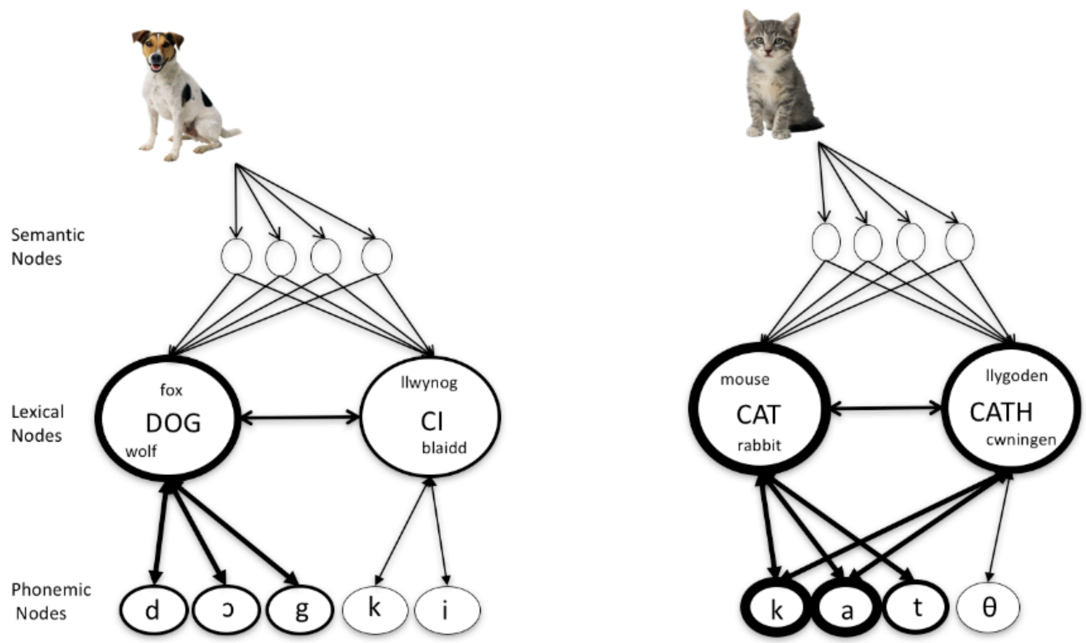

Figure 7.2: Schematic illustrating picture naming of non-cognate words (Left) and cognate words (Right), in English. Line thickness indicates the relative degree of activation as a function of task and word type; based on the model of Costa et al (2005)

Figure 7.2 illustrates how non-cognate and cognate words would be processed in a picture naming task in English.

In the case of non-cognate picture naming represented in Figure 7.2 (Left), presentation of the picture results in activation of semantic features of the target word, which leads to activation of semantic competitors at the lexical level (e.g. activation of the semantic features of 'dog' would also result in the activation of semantic competitors such as 'wolf, fox' etc) (Costa et al, 2001). This is represented by the smaller text of competitors in the lexical nodes of each language. As is assumed by several models of bilingual lexical processing (e.g. Colomé, 2001; Costa et al, 2000) lexical representations in both languages are activated during a naming task in only one language, however (as represented by the stronger lines around the circle at the lexical level) the target language is more activated than the non-target language. Following lexical activation, the phonological representations in each language are activated, which then feed back to the lexical level. As there are no shared phonological features between the English target word ("dog") and its Welsh translation equivalent *("ci")*, the activation of the phonological features in Welsh does not result in further activation of the target word's phonological features.

Picture naming of cognate words in English is illustrated in the right hand panel of Figure 7.2. Following lexical activation, the phonological representations in each language are activated to some degree, which then feed back to the lexical level. In this case, there are shared phonological features between the target word in English("cat") and its translation in Welsh *("cath")*, and this is represented by thick bi-directional lines connecting phonological features, as well as stronger activation of the shared phonological features themselves. Here therefore, the activation of the phonological features in Welsh provides activation of the target word's phonological features in English. This should result in easier, faster naming of cognate words. This is consistent with our results in healthy bilinguals in Chapter 3 of this thesis, in which we observed faster naming of cognates than non-cognates in both older and younger bilingual participants, with no corresponding cognate advantage for monolingual English participants.

In aphasic bilingual participants, discussed in Chapter 4, we observed a cognate advantage at the group level in Welsh picture naming only, which for 7 of 8 participants was less accurate than English picture-naming. The lack of a cognate effect in English may be due to the fact that post-stroke these participants were more impaired in Welsh, which would lead to reduced feedback from Welsh phonology to the lexical level in English. Stronger cognate effects in the non-dominant language have also been observed in healthy bilinguals (e.g. Gollan et al, 2007; Rosselli et al, 2012) and in aphasic participants (e.g. Roberts & Deslauriers, 1999).

This model can also be used to describe the findings of the treatment study presented in Chapter 6. We observed cross-language generalisation of treatment effects to the untreated language for cognate words, as well as generalisation to the untreated tasks of translation and reading aloud. According to this model we would expect cross language generalisation due to covert activation of the non-target language during treatment and the direct lexical links between languages. We also observed generalisation to translation and to reading aloud for both cognate and non-cognate words in English, but we observed improvement in reading aloud of Welsh cognates only, supporting the hypothesis of increased cross-language activation for cognate words. Assuming the same phonological representations are accessed in naming, translation and reading, every time a word is accessed during treatment, there should be feedback to both L1 and L2 lexical representations for cognate words, as hypothesised by this model, and to a lesser extent for non-cognate words.

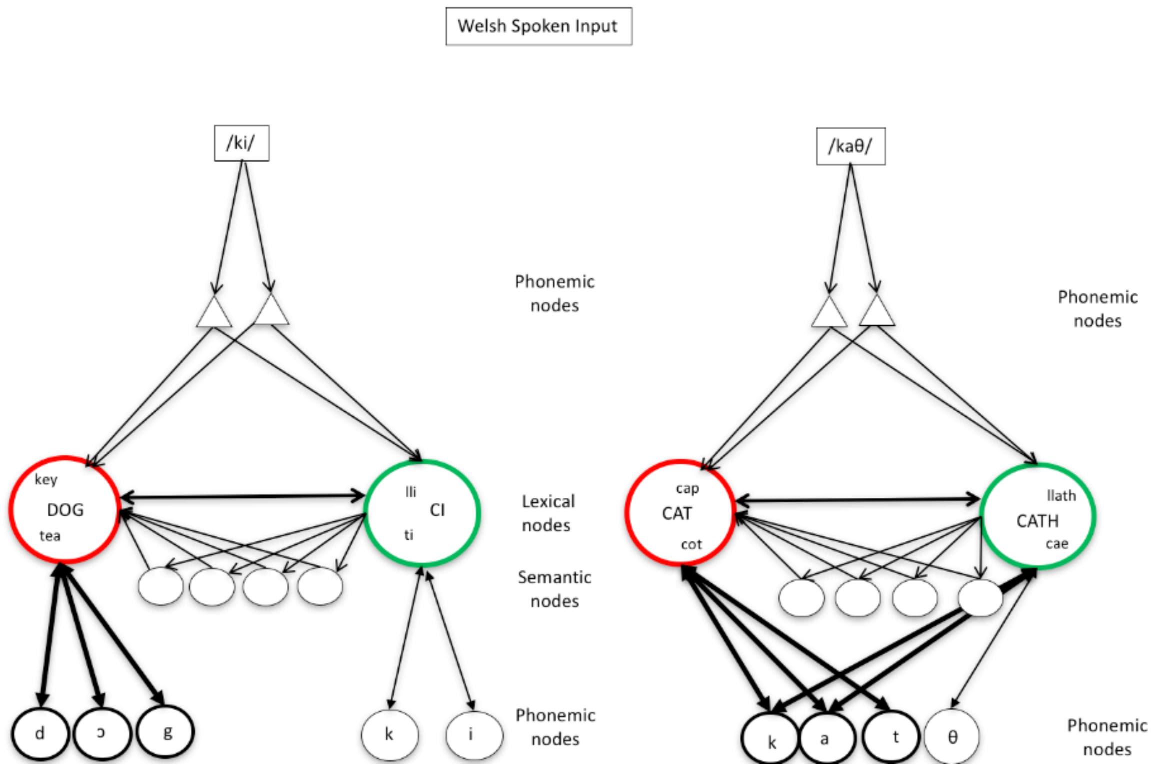

Figure 7.3: Schematic illustrating translation of non-cognate words (L) and cognate words (R) from Welsh to English. Line thickness indicates the relative degree of activation as a function of task and word type. The green & red circles denote order of activation: namely that the green circle of the lexical node in the input language is process first, before the red circle of the lexical node in the target language.

Translation of non-cognate and cognate words from Welsh to English is illustrated in Figure 7.3. There are three key differences between picture naming and translation tasks. First, the initial activation of lexical representations will be phonologically driven in translation but semantic in naming. Second, semantic mediation is not strictly necessary in the case of translation but obviously is in the case of naming(e.g. Kroll & Stewart, 1994; De Groot et al, 1994). Third, translation must involve the activation of the two languages, at least sequentially within a trial; it is in some ways similar to a language-switching task (Green, 1998). Naming could in principle be achieved without any language co-activation (although most evidence shows that co-activation does occur to some extent, e.g. Marian & Spivey, 2003).

We propose that translation takes place via two main routes: semantic and lexical (i.e., via direct connections between translation equivalents). This is in line with models such as the one of Kroll and collaborators. In addition, it can readily explain why our bilingual participants with aphasia produced very few semantic errors in translation as compared to naming. If, following the phonological activation of the stimulus word, translation strictly took place via a semantic route, then one might expect a similar pattern of performance as in naming (given normal or close to normal phonological processing, as in 7/8 of our participants). Our proposal can also explain why cognateness effects appear to be stronger in translation than in naming in neurologically healthy participants. First, in the case of translation, the presentation of a cognate word in one language will lead to a direct co-activation of the translation equivalent in the other language. In other words, hearing "cath" will also directly activate "cat" (as well as other neighbours in each language, e.g., llath, cap) due to their high phonemic overlap, leading to a pre-activation of the target response. This cognate advantage would be further boosted by feedback from output phonology (as in naming) and from a stronger activation of the direct connections between lexical representations in each language. In the case of non-cognates, the words phonologically activated by the input in each language would bear no semantic relationship, e.g., hearing "ci" in Welsh would activate words such as "key" or "me" in English, which would in turn lead to the activation of different semantic features, at least in initial stages of processing, and thus lead to competing rather than converging responses, a phenomenon that would not occur in picture naming. This would explain why cognateness effects were stronger in translation than in naming in our experiments.

Other aspects of the results are more difficult to interpret within the proposed framework. On the one hand, this is due to the fact that fine grained predictions partly depend on further specifying some aspects of the model. In particular, one issue is whether word comprehension and word production rely on common or on distinct lexical representations. This is a question that has not yet received any clear answer in the monolingual literature. For simplicity, we have used only one level of lexical representations in our figures, but we are not strongly committed to this view. This issue is relevant in the current context as proposing input representations raises the question of the level(s) at which languages interact in translation and at which translation takes place: input to input? Output to output? Input in Language A with output in Language B? All of the above? Is it necessary to postulate that translation would involve the inhibition of the stimulus language to allow target production in the other language? On the other hand, patient performance is likely to vary as a function of the specific nature of their deficit(s) and by their severity in each language and even more so as a task involves multiple processes. Although our patients all show a deficit in lexical retrieval, this is still a fairly broad characterisation of their deficits. What is clear is that translation is a more complex task than naming which requires fine-tuning of the relative activation of the two languages involved. This may partly explain why most of our aphasic participants were more impaired in translation than in naming and why cognateness did not have a consistent effect in this task. For example, the cognateness advantage may be offset by an increased competition between the two languages in some cases.

In sum, the main findings of the experiments reported here support a model of bilingual processing that posits interactive language non-specific activation within and across languages, as well as direct links between languages at the lexical level.

7.3 Main Contributions

We have examined the effect of cognateness on naming and translation using a within-subjects design, using the same stimuli across picture naming and translation tasks and across neurologically healthy monolingual and bilingual, and impaired bilingual participant groups, in an attempt to clarify the nature of the processes that underlie bilingual word production. The use of the same stimuli across tasks allows us to directly compare performance in naming versus translation. This was seldom done before (however see Kroll & stewart, 1994), which may explain some of the inconsistencies in the results of prior studies. In addition, the comparison of monolingual and bilingual participant groups allows us to investigate how bilingualism shapes lexical processing, and to confirm that lexical effects such as that of cognateness are indeed the result of being bilingual and not a feature of the task, such as inappropriate matching of cognates and non-cognates.

Furthermore, this is the first study to compare the incidence of semantic errors in picture naming vs. translation in bilingual participants with aphasia. This allowed us to study the existence and functionality of direct links between languages at the lexical level, in impaired language processing. This study represents a valid contribution to models of bilingual lexical processing, providing evidence for reduced semantic involvement in translation, and thus points to the functional existence of direct lexical links between languages.

Finally, this research includes the first investigation of the efficacy of errorless treatment in bilingual aphasia. We upheld a high standard of experimental control, including multiple baselines and post-tests, with word sets carefully selected and matched across sets in order to enable a comparison of treatment effects both within treated word sets and with untreated sets. We ensured the use of appropriate statistical analysis for multiple baseline single-case treatment studies, which is a significant contribution to the currently sparse field of research investigating rehabilitation of cognate words in bilingual aphasia. The contribution of the study to the question of how cognateness impacts treatment outcomes in bilingual aphasia therapy has both theoretical implications for models of bilingual lexical processing (e.g. Costa et al, 2005; Kroll & Stewart, 1994) and clinical implications for the provision of treatment in bilingual aphasia. A further innovative contribution is that we also investigated generalisation of treatment effects to untreated tasks; namely reading aloud and translation of the same items in Welsh and English, providing evidence of shared underlying lexical processes across tasks.

7.4 Future Perspectives

In our studies, participants were fully proficient in both their languages, or had been before brain damage in the case of the aphasic participants. An avenue for future research would be to examine how variations in language dominance might modulate the main effects that we have reported. We believe that the working model that we have presented could be used to generate more specific predictions about the possible interactions between task, cognateness and language dominance in normal or impaired performance and could also provide a guide to treatment studies (e.g. Goral, Levy & Kastl, 2010). Generally speaking, one would expect stronger cognate effects in the weaker language.

In addition, future research could investigate the relationship between concreteness and cognateness. This could strengthen our claims about the relative use of direct connections between lexical representations vs. semantically mediated processing as a function of task demands. First, an effect of concreteness would indicate semantic mediation and we would predict that such an effect would be reduced in translation.

Finally, one focus of the present thesis concerned treatment generalisation in bilingual aphasia. To date, very few treatment studies have investigated the impact of cognateness on treatment outcomes using well-controlled experimental protocols. Our study makes an important contribution to this area of investigation, but a number of questions remain to be answered. For example, how would the cognate advantage in treatment apply to different anomic participants, or to participants with more complex deficits? Could treatment outcomes relate to the severity of the deficit and how? Could they also relate to the specific languages treated? What would be the best way to promote the generalisation of treatment effects across task and situations? One possible would be to combine different tasks in the treatment itself, such as treating translation alongside picture naming as a further way to strengthen lexical connections. Translation has been used in treatment with a bilingual patient with a deficit of pathological language switching (Ansaldo et al, 2010) with resulting improvement to naming and translation in the treated language. Therefore, incorporating cross-language lexical connections as well as conceptual lexical links into treatment may result not only in improvement to treated items but also to greater cross-language transfer of treatment effects, and greater understanding of the mechanisms underlying bilingual lexical processing.

7.5. Concluding remarks

The research presented in this thesis demonstrates successful application of cognitive models and methods of bilingual language processing to the investigations of lexical processing in neurologically healthy and aphasic Welsh-English bilingual speakers. Overall, this study elucidated the role of cognate status in bilingual word production, and contributes to a better characterization of the processes involved in naming and translation.

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APPENDICES

APPENDIX A: Control Participants Consent & Debrief forms

APPENDIX B: Control Participant Language & Medical Background Questionnaires

APPENDIX C: Naming and translation assessment items

APPENDIX D: Test administration instructions to participants

APPENDIX E: Final task word lists with accuracy and reaction times across tasks

APPENDIX F: Participant consent form: Anomia Study

APPENDIX G: Aphasic participant accuracy on naming and translation task: all items

APPENDIX H: Participant error types in naming and translation

APPENDIX I: LM Language Background Questionnaire

APPENDIX J: LM treatment study word lists

APPENDIX K: LM accuracy: all word groups (baseline and post-test)

APPENDIX L: LM reading aloud error type frequency (% of total errors at baseline)