Language assessment and therapy for verb-production impairments in multilingual aphasia

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Abstract

Aphasia is an acquired language disorder induced by a focal damage to the brain, most commonly caused by a stroke. For all speakers with aphasia word retrieval is difficult, and in particular verbs are challenging. At the same time verbs play a crucial role in communication. Hence, verb retrieval impairments potentially have profound implications on everyday interaction. In multilingual speakers with aphasia, the different languages can be differently affected. Thus, assessment and treatment may be even more challenging than with monolingual speakers.

The dissertation, which is the first one on multilingual aphasia in Norway, investigates assessment, clinical practice and treatment, with a focus on cross-linguistic transfer and inhibition of the untreated languages. The results are analysed in light of different models of multilingual language processing.

The dissertation shows the importance of assessing all the languages of multilingual speakers with aphasia and of complementing formal assessments with functional assessment tools. It contributes new knowledge on the impact of verb-production treatments for speakers with different aphasia types. The dissertation shows that treatment in one language has positive effects, not only in the treated language, but also in the other, untreated language(s) of the speaker. Importantly, treatment in one language does not harm the other language(s). Furthermore, treatments focusing on production of verbs in sentence contexts result in improvement in discourse production. Finally, the dissertation shows that treatment gains are attainable when treatment is provided in a non-native language of both the client and the clinician.

The results corroborate theories on the nature of the verb and its role in sentence production, and provide evidence for a shared conceptual network of the languages in multilingual speakers. With its clinical focus and firm theoretical basis, the dissertation has inter- and multidisciplinary relevance.

Sammendrag

Afasi er språkvansker forårsaket av en ervervet skade i hjernen, oftest som følge av hjerneslag. For personer med afasi er gjenkalling av ord vanskelig, og verb er spesielt vanskelige. Samtidig har verb en avgjørende rolle i kommunikasjon. Dermed kan vansker med verb ha store konsekvenser for hverdagen til personen med afasi og hans eller hennes pårørende. Når en flerspråklig person får afasi, kan de ulike språkene påvirkes i forskjellig grad. Derfor er kartlegging og undervisning enda mer utfordrende enn for enspråklige med afasi.

Avhandlingen, som er den første om afasi og flerspråklighet i Norge, undersøker kartlegging, klinisk praksis og undervisning for flerspråklige personer med afasi, med et hovedfokus på generalisering mellom språk, og på å undersøke mulig forverring av utrente språk. Resultatene er analysert i lys av ulike modeller for flerspråklig prosessering av språk.

Avhandlingen understreker betydningen av å kartlegge alle språkene til flerspråklige personer med afasi og nytten ved å bruke både formelle og funksjonelle kartleggingsverktøy. Den bidrar med ny kunnskap om tiltak for bedring av verbproduksjon for personer med ulike typer afasi. Avhandlingen viser at undervisning på ett språk har positiv effekt, ikke bare på det trente språket, men også på andre, utrente språk til personen med afasi. Ikke minst viser den at undervisning på ett språk ikke skader andre, utrente språk. Videre belyser den at undervisning for bedring av verbproduksjon på setningsnivå resulterer i bedret diskursproduksjon. Til slutt viser avhandlingen at språklig rehabilitering er mulig også når undervisningen foregår på et felles andrespråk for klienten og logopeden.

Resultatene underbygger teorier om verb og verbets betydning for setningsproduksjon. Avhandlingen støtter modeller om felles språklige nettverk for de ulike språkene til en flerspråklig person. Kombinasjonen av klinisk praksis og et solid teoretisk fundament gjør avhandlingen relevant på tvers av ulike fagdisipliner.

‘The Babel fish is small, yellow, leech-like, and probably the oddest thing in the Universe. […] The practical upshot of all this is that if you stick a Babel fish in your ear you can instantly understand anything said to you in any form of language.’ (*The Hitchhiker's Guide to the Galaxy*; Adams, 1979, p. 42)

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List of papers

This dissertation is based on the following papers, which are referred to in the text by their Roman numerals.

Paper I: Knoph (2011). Language assessment of a Farsi–Norwegian bilingual speaker with aphasia. *Clinical Linguistics & Phonetics, 25*(6-7), 530–539.

Paper II: Knoph (2013). Language intervention in Arabic–English bilingual aphasia: A case study *Aphasiology, 27*(12), 1440–1458.

Paper III: Knoph, Lind, and Simonsen (in press). Semantic Feature Analysis targeting verbs in a quadrilingual speaker with aphasia. *Aphasiology*, doi: 10.1080/02687038.2015.1049583.

Paper IV: Knoph, Simonsen, and Lind (submitted). Verb production treatment in sentence contexts in fluent and nonfluent multilingual aphasia. *Bilingualism: Language and Cognition*, Manuscript ID: BLC-15-RA--0061.

1 General introduction

This dissertation presents a clinical linguistic study on language assessment and therapy for verb production impairments in multilingual aphasia. *Clinical linguistics* is 'the application of linguistic science to the study of communication disability, as encountered in clinical situations' (Crystal, 1981, p. 1). Ball and Kent argue that the definition should also cover 'either applying linguistic/phonetic analytic techniques to clinical problems, or showing how clinical data contribute to theoretical issues in linguistics/phonetics' (1987, p. 2). This dissertation adopts both approaches.

1.1 Background

Aphasia is an acquired language disorder induced by a focal damage to the brain, most commonly caused by stroke (Lesser, 1989). Individuals with aphasia have problems with language comprehension and language production to varying degrees (cf. Chapter 2 for a definition of aphasia). One of the core symptoms of aphasia is word-retrieval impairments, or anomia. Especially verb retrieval is challenging for individuals with aphasia (e.g. Berndt, Haendiges, & Wozniak, 1997; Mätzig, Druks, Masterson, & Vigliocco, 2009). Verbs play an essential role in sentence production and therefore also in communication. Hence, difficulties in verb retrieval can potentially pose great challenges for speakers with aphasia, and for their communication partners. As with monolinguals with aphasia, verb production has been found to be more demanding than noun production for multilingual[1] speakers with aphasia (Ansaldo, Ghazi Saidi, & Ruiz, 2010; Faroqi-Shah & Waked, 2010; Kambanaros & van Steenbrugge, 2006). Since verbs are crucial for communication, and at the same time difficult to retrieve for many speakers with aphasia, verb-retrieval treatments were targeted for the purpose of this dissertation.

More than half the world's population is multilingual (De Groot & Kroll, 1997; Grosjean, 2008), and together with an increasing number of people with aphasia, the number of multilingual speakers with aphasia is increasing (Paradis, 1998b, 2001a; Roberts & Kiran,

[1] As we yet do not know if there are structural difference between bilinguals and multilinguals, for instance in their symptoms and their prognosis in case of aphasia (Roberts & Kiran, 2007), throughout this dissertation the terms bilingual and multilingual will be used somewhat interchangeably. By not separating these two groups, the use of the cumbersome term *bi- and/or multilinguals* is avoided. (Cf. 2.2 for a discussion and definition of bilingualism and multilingualism.)

2007). When a multilingual speaker acquires aphasia, the different languages can be affected in different ways, thus diagnosis and treatment[2] planning may be an even greater challenge than with monolingual speakers. Despite the increasing amount of multilingual speakers with aphasia, research in language assessment and language production within this group is a relatively new field. There are still many unanswered questions, and research is needed both for clinical and for theoretical reasons (cf. 2.3 for more about multilingual aphasia).

A core feature of linguistic aphasiology is that aphasic phenomena should be related to models of normal language structure and normal language processing (Caplan, 1987). In some instances, findings about normal language structure are applied to understand aphasic language. In other instances however, discoveries about aphasic language processing have led to new theories of normal language processing (see Nickels, Kohnen, & Biedermann, 2010). Following the definition of clinical linguistics stated above, one aim of aphasia research in multilingual speakers is that the insights gleaned about language representation and breakdown in these speakers may provide deeper insights into language processing in multilingual speakers in general (Croft, Marshall, Pring & Hardwick, 2011) (cf. Chapter 3 and 6.8).

An important issue raised in the research literature is the question of cross-linguistic[3] therapy transfer. This refers to the possible therapy gains following treatment in one language on another, untreated language. Over the last decades there has been an increasing number of studies of cross-linguistic transfer (Faroqi-Shah, Frymark, Mullen, & Wang, 2010; Miller Amberber, 2011). They have shown equivocal results. It is therefore evident that more research is needed (cf. 2.7.1 on cross-linguistic transfer in multilingual aphasia). Another question raised concerns possible inhibition of the untreated language(s). Both of these issues have clinical as well as theoretical consequences. Clinically, cross-linguistic therapy transfer is desirable, given that treatment in one language may have a positive impact on untreated languages. Inhibition, on the other hand, is an undesired result of language treatment. Linguistically, both therapy transfer across languages and inhibition of untreated languages may shed light on the structures and functioning of the bilingual language system. If therapy in one language does affect a multilingual speaker's untreated language(s), either in a positive

[2] The terms treatment, therapy and rehabilitation will be used interchangeably in the dissertation. In the present project, they refer to the speech and language therapy provided to the speakers with aphasia.

[3] The term cross-language transfer is also used in the dissertation.

or in a negative manner, the languages must have (partially) shared networks (Goral, 2012) (cf. 6.8).

1.2 The purpose of the project

The dissertation is based on an overarching project (henceforth referred to as the *project*), consisting of three separate studies: *study 1*, *study 2* and *study 3* (cf. 4.1 for a thorough presentation of the studies). The three studies in the project all have single-subject[4] designs, including five participants[5] in total. The studies use different approaches and methodologies to address the different research questions. What the studies share is that they adopt an impairment-based approach. Study 1 includes a bilingual Farsi-Norwegian speaker with aphasia, and describes the assessment of both languages. It addresses the importance of conducting a proper assessment of both languages of the bilingual, and discusses the applicability of the *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987) in this context. In addition to possible cross-linguistic effects and inhibition of the untreated language, study 2 addresses the clinical work with a bilingual Arabic-English speaker with nonfluent aphasia, and discusses the use of a mutual L2 of the client and the speech and language therapist (SLT) as a *lingua franca* in the work with bilingual clients. Study 3 includes three multilingual speakers with fluent and nonfluent aphasia. It investigates the impact of *Semantic Feature Analysis* (SFA) specifically, and the combination of SFA and *communication-based treatment* to improve naming of trained and untrained verbs, semantics and syntax, and narrative production in the treated and untreated languages of each speaker. The issues of cross-linguistic transfer and inhibition of untreated languages are also explored.

The project has both clinical and theoretical purposes. Since research in multilingual aphasia is a relatively new field nationally and internationally, the scope of the project is broad. It covers assessment, clinical practice and verb-production treatment for multilingual speakers with aphasia, with a focus on cross-language transfer and inhibition of untreated languages. To ensure the ecological validity of the project so that the results may be transferable to clinical practice, the studies have to be clinically applicable and client compliant, with a sound balance between assessment and treatment. Theoretically, the overall

[4] The terms *single-subject* and *single-case* will be used interchangeably in the dissertation (cf. 4.4).

[5] The individuals who participated in the study will be referred to as *subjects*, since they are subjects in this research protocol and it is also the term of the design (single-subject design) or as *participants*, since they all agreed to participate in the study. In addition, the terms *client* and *multilingual speaker with aphasia* may also be used.

aim is to examine the extent to which different models of multilingual language processing are suitable for describing language recovery in multilingual speakers with aphasia.

This project aims to address the following research questions:

1. **Assessment tools**: How can standardised and unstandardised assessment (e.g. narrative production) tools give us deeper insight into the language impairment and the rehabilitation process of multilingual speakers with aphasia? (papers I, III, IV, cf. 6.1)

2. **Cross-linguistic transfer and inhibition**: Is it possible to achieve cross-linguistic treatment transfer from a late learned non-native language to earlier acquired languages in the rehabilitation of language impairments in multilingual aphasia, and does this treatment lead to inhibition of earlier-acquired languages? (papers II, III, IV, cf. 6.3 and 6.4)

3. **Treatment across aphasia types**: Do verb-production therapies (e.g. Semantic Feature Analysis and communication-based treatment) constitute effective treatment methods for the multilingual participants across different aphasia types? (papers II, III, IV, cf. 6.2, 6.5 and 6.11)

4. **Languages for treatment**: Can the provision of therapy in a mutual, non-native language of both the client and the speech and language therapist constitute an effective intervention? (paper II, cf. 6.7)

5. **Models of language processing**: How can data from this project enlighten different psycholinguistic models of multilingual language processing? (papers II, III, IV, cf. 6.8)

1.3 Outline of the dissertation

The dissertation consists of four papers written for scientific publication and a synopsis that summarises and compiles the scientific investigations and conclusions presented in the papers. The synopsis consists of five chapters in addition to the present introduction. In Chapter 2, key terms, such as aphasia, multilingualism and treatment are presented and discussed, and relevant previous research on cross-linguistic effects and verb-retrieval

treatment for multilingual speakers with aphasia is presented. The overall theoretical approach of the project is presented together with relevant models of language production in Chapter 3. Chapter 4 presents the methods and materials of the project. To make the research transparent and to enable replication of the studies the above chapter also presents the data collection process and the treatment procedures. Furthermore, the same chapter discusses aspects of reliability, validity and ethical considerations regarding the project. Chapter 5 contains summaries of the four papers, as well as a discussion of some methodological challenges. Chapter 6 presents answers to the research questions and discusses the theoretical, methodological, and clinical implications of the findings.

The four papers contribute to one or several of the research questions in 1.2. The papers illuminate different aspects of assessment, rehabilitation, cross-linguistic transfer and inhibition of the untreated languages of multilingual speakers with aphasia (cf. Chapter 5, and the papers themselves).

2 Key terms and previous research

Key terms in the present project will be presented in this chapter. Firstly, aphasia (cf. 2.1), bilingualism and multilingualism (cf. 2.2), will be defined in general, prior to a presentation of multilingual aphasia, specifically (cf. 2.3). Furthermore, verb production in aphasia (cf. 2.4) and issues of assessment of multilingual speakers with aphasia (cf. 2.5) will be discussed. Treatment will be presented in 2.6. Finally, this chapter will review relevant previous verb-treatment studies involving multilingual speakers with aphasia (cf. 2.7).

2.1 Aphasia

2.1.1 Definition

Aphasia is an acquired language impairment caused by a focal damage to the brain. In research and clinical practice various definitions of the term aphasia are found, and this dissertation will adopt a linguistic, rather than for instance a functional definition: '[Aphasia is] a complex of persisting language disorders, acquired after focal lesions to brains which previously had a mature language system' (Lesser, 1989, p. 3). Aphasia is most commonly induced by stroke, but also by other aetiologies, like traumatic brain injury and tumours or other diseases in parts of the brain on which language seems to be critically dependent (Lesser & Milroy, 1993). Most commonly, this is in the left hemisphere, the dominant hemisphere for language in most speakers.

The definition adopted limits the notion of aphasia in several ways. Primarily it states that aphasia is *complex*. It is a multimodal language disorder, characterised by an impairment of any or all language modalities (i.e. auditory comprehension, oral language production, reading and writing). It is a central language disorder, and therefore excludes articulation disorders like apraxia of speech and dysarthria. In addition, as aphasia is *persisting* according to the definition, it excludes temporary language disorders, and temporary language disturbances caused for instance by a transient ischemic attack (TIA). Aphasia is not congenital; it is an *acquired* disorder in individuals with a *mature* language system. This excludes language disorders in children (e.g. specific language impairment and child aphasia). Lastly and according to this definition, aphasia is a result of a *focal* lesion to the brain, rather than a result of diffuse damages, often found in for instance dementia.

As pointed out above, aphasia is usually caused by stroke, that is, infarct or haemorrhage, also referred to as a cerebrovascular accident (CVA) (Hallowell & Chapey,

2008). Annually there are about 15.000 strokes in Norway. About 25–30 percent of all strokes lead to aphasia as a result of the damage to the brain. From the numbers presented above, one can estimate that more than 5000 adults acquire aphasia every year in Norway (Corneliussen, Haaland-Johansen, Knoph, Lind, & Qvenild, 2006), and with the growing numbers of strokes, the number is expected to increase (Waaler, 1999).

Many individual and sociocultural factors are important in the clinical work with speakers with aphasia. However, it is beyond the scope of this dissertation to consider all these. This dissertation focuses mainly on the linguistic aspects of speaking two or more languages when the aphasia occurs.

2.1.2 Fluent and nonfluent aphasia

For the purpose of this dissertation, two aphasia types will be distinguished: fluent and nonfluent aphasia. This distinction is commonly used, both in clinical practice and in aphasia research (Hallowell & Chapey, 2008; Reinvang & Engvik, 1980).

Speakers are regarded as *fluent* when they are able to speak fluently, with normal or faster than normal speech rate in spontaneous speech, with normal prosody and without long periods of silence. Speakers with fluent aphasia will have word-finding difficulties, probably due to lexical-semantic problems. Many speakers with fluent aphasia have impairments in auditory comprehension and/or challenges in the repetition of words, phrases, or sentences spoken by others. Their speech is easy and fluent, but there may be difficulties related to the output of language as well, such as paraphasias and neologisms and an excessive amount of so called 'empty speech', where little information is conveyed (Bastiaanse, 2011; Edwards, 2005; Hallowell & Chapey, 2008). Aphasia syndromes that are associated with fluent speech, according to the Boston classification (Tesak & Code, 2008), include Wernicke's aphasia, conduction aphasia and anomic aphasia.

Speakers with *nonfluent aphasia*, on the other hand, are apt to having a reduced speech- and phrase rate and usually impaired prosody. Some of these speakers will have difficulties in articulation and as with fluent aphasia; speakers with nonfluent aphasia may have problems with repetition. Moreover, the oral language production is characterised by agrammatic speech with hesitations and pauses, and for many speakers, an overuse of stereotypes. In many cases there is relatively good auditory comprehension, even if the auditory comprehension often is more impaired than earlier assumed (Code, 1989; Hallowell & Chapey, 2008; Menn, O'Connor, Obler, & Holland, 1995). Aphasia syndromes that are

characterised with nonfluent speech are Broca's aphasia, transcortical motor aphasia and global aphasia (Tesak & Code, 2008).

2.2 Multilingualism

2.2.1 Definitions

Multilingualism has become the rule, rather than the exception around the world. Multilingualism is widespread also in Norway, and it is increasing. There is not one clear definition of bilingualism. The term has different meanings depending on the context it is used in (Grosjean, 2013). Some researchers emphasise language use, rather than fluency, in their definition of bilingualism or multilingualism, among them Grosjean (2013). He suggests a wide definition of the term when he posits that bilingualism is the use of two or more languages (or dialects) in everyday life. This dissertation adopts this broad definition. Thus, this definition includes people with a range of levels of knowledge of a second – or third, fourth, etc. – language. Even if researchers do not completely agree on the definition of the term bilingual, most researchers agree that bilinguals usually do not have equal competence in their first language (L1) and their subsequent language(s) (L2, L3, etc.). Moreover, bilinguals often have unequal language proficiency in the different language modalities, for instance many do not read or write one (or more) of their languages (Grosjean, 2013). Following this, anyone who uses their languages at a relatively proficient level, in their everyday lives will be regarded as multilinguals in this dissertation, regardless of the age the L2 (or L3 and L4) was acquired, how the languages were acquired, or whether they have reading and/or writing skills in all of their languages or not. Bilingual speakers are usually divided into two subgroups, often referred to as simultaneous and sequential bilinguals (Centeno, 2007). The term simultaneous or early bilingual acquisition is generally used when the child is exposed to two (or more) languages at the same time in childhood, or from a very early age. Concerning sequential, successive or consecutive bilinguals, these are usually adults, or older children acquiring L2 as second language learners.

2.2.2 Language fluency and language use

How bilingual speakers perform linguistically in each of their languages depends on different variables. For instance, when and how the languages are learned, how frequent and in which settings the bilingual person uses his or her languages may play a role in how the languages are organised in the brain. These factors often affect the discourse of bilingual speakers and

may therefore be relevant for the language impairments in multilingual aphasia. The linguistic history of a multilingual speaker can be very complex, as a result of different events in life. Languages that were acquired at school may not be in use later in life. In the case of moving to another country, a new language is learned and may cause a loss of proficiency of previously well-known languages, even the L1 (Schmid, 2011; Schmid & Jarvis, 2014). So-called 'wax and wane' of languages is very common in multilingual speakers.

Moreover, multilinguals use their languages in different domains of their life, and with different people. This phenomenon is known as the *complementarity principle*, and refers to the fact that different aspects of life require different languages. Grosjean (2010, p. 29) argues that the different needs and uses of the languages of multilinguals result in unequal language fluency, and it is also the reason why the language proficiency often is domain specific. The variation of the language use, together with the complementarity principle demonstrates the importance of being familiar with the language history of multilinguals and their patterns of use (Grosjean, 2013). The diversity in language history is important in assessment and treatment of multilingual speakers with aphasia (cf. 2.5 and 2.7). In Chapter 3 a usage-based approach will be presented, and within this theory it is argued that language use can affect how the languages are structured in the mind (cf. 3.1) (Bybee, 2010).

2.2.3 Proportion of multilinguals in Norway

There is naturally no register of multilingual speakers in Norway (or in any country, probably), but to get an impression of the number of people that are assumed to have another native language than Norwegian in Norway, the Statistics Norway's web pages are consulted. There are primarily three large groups of individuals who are assumed to have another L1 than Norwegian, namely the refugees, the immigrants coming to Norway, and a proportion of the Sámi population.

At the start of 2015 the total population of Norway was almost 5 166 000. 3.4 percent of the total population consisted of persons with a refugee background (Statistics Norway, 2013). This group is assumed to have another L1 than Norwegian. Furthermore, 15.6 percent of the total population are immigrants and Norwegian-born to immigrant parents (Statistics Norway, 2015). The bilingual status of this second group is more uncertain, since it includes both immigrants, and children born to immigrants. Many in this second subgroup will probably grow up with both their parent's language(s), as well as Norwegian. In Norway, there is an indigenous population, namely the Sámi. They live in Norway, Sweden, Finland

and Russia. There is no overall registration of the Sámi population. Therefore, it is not certain how many Sámi there are today. However, Statistics Norway estimates that there are close to 40.000 Sámi in Norway (2012), although not all of them speak Sámi. In addition to the above-mentioned groups, there are bimodal bilinguals (with Norwegian sign language as L1 or L2), and many Norwegian speakers of more than one dialect. Furthermore, many people learn another language than their native language during school education, or due to moving with the family as a child, studying or working abroad, or in many other ways.

2.3 Aphasia in multilingual speakers

The growing number of multilingual speakers combined with a growing number of strokes lead to an increasing number of multilingual speakers with aphasia (Ansaldo & Ghazi Saidi, 2014; Paradis, 2001a; Roberts & Kiran, 2007).

2.3.1 Patterns of impairment and recovery

Several studies have shown that symptoms of aphasia can vary across the different languages of a multilingual speaker (Fabbro, 2001; Menn et al., 1995; Paradis, 2001b). When multilingual speakers acquire aphasia, the most common outcome is that the different languages are impaired in the same manner and to the same degree, relative to the premorbid (i.e. prior to the stroke) level of proficiency (i.e. *parallel impairment*), however this is not always the case (Paradis, 2004). While the majority regain access to both/all their languages approximately at the same time and in the same manner, others may regain access to only one of the languages. This is referred to as *non-parallel recovery*. Which language is predicted to be less impaired or best recovered is uncertain. While this may vary, many factors have been proposed to predict which language will be best rehabilitated. In 1881 Ribot proposed, as a consequence of his theory on regression, that the *native* language should generally be recovered first or better when bilingual speakers suffer from aphasia (Code, 2013; Paradis, 2001a). Pitres, on the other hand, pointed out in 1895 that the native language was usually also the most familiar to the patient, and when this is not the case, patients should recover the most recently learned and most *familiar* language before or better than their native language (Code, 2013; Paradis, 2001a). There is still no consensus in the field, but the age of acquisition, the patterns of language use, the aphasia type and the brain area of impairment have been suggested as possible explanations for non-parallel recovery.

Given the complementary principle and the fact that multilinguals often have different premorbid proficiency levels of the languages, a thorough investigation of the multilingual speaker's languages is crucial for the purpose of giving a proper diagnosis. Furthermore, since multilinguals usually have different proficiency levels in the different language modalities, and since aphasia can affect the modalities differentially, classifications of impairment or recovery patterns should be done separately for each modality (for more on the different patterns, cf. Roberts, 2008). The patterns of impairment and recovery are compatible with different models or hypotheses of inhibition (cf. 3.3.1 on selection and inhibition). It is suggested that the inhibition of languages manifests differently in the different patterns, such as an equal degree of inhibition for each of the languages in parallel recovery and a stronger inhibition of one of the languages in differential recovery (Paradis, 2004).

2.4 Verb production in aphasia

Verbs have a pivotal communicative role in language production (de Diego Balaguer et al., 2006), and difficulties in verb retrieval may thus lead to problems with daily communication. There is ample evidence that action naming and verb production are more difficult than object naming and noun production for people with aphasia. There has been some debate about the distribution of this difficulty across aphasia types. While some have suggested that verb-retrieval difficulties primarily apply to speakers with nonfluent aphasia (Faroqi-Shah, 2012; Links, Hurkmans, & Bastiaanse, 2010; Mätzig et al., 2009; Webster & Whitworth, 2012), others have found verb deficits in fluent aphasia as well (Berndt et al., 1997; Luzzatti et al., 2002). Mätzig and colleagues (2009) reported that close to 80 percent of the speakers with aphasia in their review (of a total of 63 individuals) demonstrated verb deficits. Almost 60 percent of these individuals presented a nonfluent aphasia and about 33 percent presented fluent aphasia. In contrast, around 22 percent of the individuals demonstrated noun deficits, and this group consisted only of speakers with a fluent type of aphasia.

One reason for the relatively larger problems in retrieving verbs than nouns may be that verbs in general are more complex than nouns, with more complex semantic representations (Masterson, Druks, & Gallienne, 2008). Nouns are categorised hierarchically in several levels where members of a category share a large numbers of features. For instance, the subordinate words mammals, fish, and birds will share semantic features that are related to the superordinate word animal. In contrast to the deep hierarchical organisation of nouns, the semantic organisation of verbs is less hierarchical, that is, comparatively shallower (ibid.).

Furthermore, verbs determine the number and types of arguments in the sentence, whereas concrete nouns do not have an argument structure, and they are apt to behaving grammatically similarly to each other (Mätzig et al., 2009). Verbs that have more than one argument tend to be more difficult to produce for speakers with aphasia than single argument verbs (Kim & Thompson, 2000; Thompson, 2003). Moreover, verbs are less imageable than nouns, and since imageability has shown to affect performance in word and picture naming (Bird, Howard, & Franklin, 2003), the lower imageability of verbs may affect their retrieval in speakers with aphasia. Consequently, verbs in sentences impose greater processing demands than nouns in sentences (Vigliocco, Vinson, Druks, Barber, & Cappa, 2011).

2.5 Assessment of multilingual aphasia

Assessment is defined by Murray and Coppens (2013, p. 67) as 'the quantitative and the qualitative data gathering process for the purpose of circumscribing an individual's communicative function and activity limitations, understanding his or her participation restriction, and devising appropriate rehabilitation objectives'. Additionally for multilingual speakers, one aim of assessment is to discover the preserved and impaired communication abilities, in either language (Ansaldo, Marcotte, Scherer, & Raboyeau, 2008). An individual selection of assessment tools and approaches are usually made where the previous and the current levels of functioning, as well as the aims and needs of the individual with aphasia are taken into account. Language assessment of speakers with aphasia can be formal (with standardised and norm-referenced tests) or informal (e.g. creating and manipulating stimuli to make clinical decisions, as well as gathering premorbid language information), and often the two approaches are combined.

The great diversity in multilingual speakers with aphasia poses challenges in assessment. Taking into account the differences in language acquisition and language use, and the diversity in how aphasia may affect the languages differently, it is obvious that one has to assess all the languages of multilingual speakers with aphasia to obtain a valid impression of the linguistic consequences of aphasia in each case. However, this has rarely been the case, neither in Norway (Knoph, 2003) or in other countries (Paradis, 2004). There is therefore a need for an appropriate tool to assess all the languages of a multilingual speaker. Most tools are developed for monolinguals and may thus not be applicable to multilingual speakers. Tests are culturally dependent with regard to both context and illustrations. Even the procedure of testing in itself is culturally dependent (Paradis, 2004). Thus, a mere translation

of a tool is not sufficient. Stimuli may be inappropriate and linguistic constructions may have different levels of difficulty in the translated version. Further, some constructions may even be non-existent. To be able to compare the person's performance in the two languages, the assessment tools must be equivalent on subtest level and on item level. In addition to standardised testing, the elicitation and examination of narrative production in each of the languages of multilingual speakers with aphasia is an approach that can provide information of the languages of the speaker (Roberts & Kiran, 2007). Issues like word-finding difficulties and code-switching amongst others, may be investigated and compared (cf. 4.3 for the measures used in this project).

For consideration, and in addition to the already presented linguistic factors are other non-linguistic factors that are unique for multilingual speakers with aphasia. In addition to the background information that is normally collected when working with people with aphasia (e.g. educational, medical, occupational, social factors, etc.), it is imperative to start with an assessment of the premorbid language history of the multilingual speaker. This refers to how and when the languages were acquired, and domains and frequency of language use. This is important, to detect premorbid language dominance and mastery, and the amount of use of the different language modalities (cf. 2.2.2). This can be done as a self-report by the bilingual speaker him/herself, and/or with assistance of significant others (Centeno & Ansaldo, 2013; Paradis & Libben, 1987; Roberts, 2008; Roberts & Kiran, 2007).

An important aspect of working with multilingual speakers is the use of interpreters as it often happens that the clinician and the multilingual speaker with aphasia do not share all the languages. The use of interpreters may influence the results of an assessment. In this context, there are several aspects to consider. The interpreter needs information about aphasia and instructions on how to facilitate good communication with individuals with aphasia; this is in line with the suggestions from the American Speech-Language-Hearing Association (2004). It is not unusual for interpreters inadvertently to change test stimuli or fail to convey the client's responses (Roberts, 2008). Since the SLT does not speak the language under consideration, the above may happen without his/her awareness. The interpreter therefore needs training in the use of the assessment tools (cf. 4.3.5 about the use of interpreters in this project).

2.6 Aphasia rehabilitation

According to Howard and Hatfield (1987), therapy is a single or limited application of a technique that is extensive, spread over days, weeks or months. An individual may be

provided therapy on specific words, and the aim is to improve unassisted word retrieval after the therapy period has ended. Aphasia rehabilitation often focuses on restoring language and communication abilities.

In the last few decades, two general categories of aphasia rehabilitation have emerged, namely the medical *impairment-based* approach that focuses on restoring impaired language and the *consequences-focused*, which has a focus on the consequences of the language impairment (Thompson & Worrall, 2008; Worrall, Papathanasiou, & Sherratt, 2013). A primary principle of the first approach is that aphasia has damaged the access to the normal language system, and the aim of therapy is to retrieve access to the language. In this approach, therapy is provided directly towards the individual with aphasia. Generalisation and transfer of the treated language skills to functional communication is the main goal of this approach. A primary focus of the second approach is increased participation in society and on reducing the effects of aphasia in daily living, with indirect treatment. There is evidence that impairment-based therapy can have an effect on the conversations of speakers with aphasia (Carragher, Conroy, Sage, & Wilkinson, 2012), therefore an impairment-based approach was selected for the purpose of this project (cf. 4.4 for procedures).

The Norwegian Directorate of Health (Helsedirektoratet, 2010) recommends that treatment is provided in an intensive manner, in line with findings of the importance of the intensity of language therapy in aphasia rehabilitation (Bhogal, Teasell, & Speechley, 2003; Kelly, Brady, & Enderby, 2010). Following these recommendations, the treatments in study 3 were provided in a highly intensive manner.

2.7 Previous research on therapy studies in multilingual aphasia

Language rehabilitation of bilingual speakers with aphasia has gotten more attention internationally the last decade. However, in Norway this is so far an unexplored field. Nationally, the vast majority of research on aphasia is linguistic studies of monolingual speakers[6]. With the exception of the doctoral thesis of Kirmess (2011), there are very few Norwegian aphasia rehabilitation studies. Until now, there have been no Norwegian studies on multilingual aphasia, nor studies on multilingual aphasia rehabilitation.

[6] (e.g. Becker, 2009; Lind, 2002a, 2002b, 2005, 2007; Lind, Moen, & Simonsen, 2007a, 2007b; Moen, 1985, 2006, 2007; Simonsen & Lind, 2002; Uri, 1992, 1997)

2.7.1 Cross-linguistic transfer and inhibition

The main goal of providing treatment for multilingual speakers with aphasia is to facilitate communication abilities in all the languages needed for participation in meaningful life activities. There is no consensus as to which of the languages to choose for treatment – or if treatment should be provided in both (or all) languages simultaneously. For some multilingual speakers with aphasia treatment of both languages may be preferred, due to the possibility of utilising both languages. However, for others this may lead to unwanted code-switching (Faroqi-Shah et al., 2010).

An overarching goal of aphasia treatment is obviously the direct treatment effect, in addition to the generalisation to untreated conditions, tasks, or stimuli. For multilingual speakers, treatment generalisation, or cross-linguistic transfer, to untreated languages is an additional goal of treatment. Since the early 2000s there has been an increased amount of studies of cross-linguistic transfer in multilingual aphasia (see reviews by Ansaldo & Ghazi Saidi, 2014; Faroqi-Shah et al., 2010; Kohnert, 2009; Miller Amberber, 2011). They have shown equivocal results, which serve as a rationale for further research. Some studies have reported cross-linguistic transfer, either from the treated L1 to an untreated L2 (e.g. Ansaldo et al., 2010; Croft et al., 2011; Edmonds & Kiran, 2006; Gil & Goral, 2004) or from a treated (weaker) L2 to an untreated L1 (e.g. Faroqi & Chengappa, 1996; Kiran & Edmonds, 2004; Kiran & Roberts, 2010; Miertsch, Meisel, & Isel, 2009). Yet other studies have failed to achieve cross-linguistic transfer for some of the participants (e.g. Croft et al., 2011; Kiran & Roberts, 2010). Hence, cross-linguistic transfer is possible, but it is challenging to determine which factors influence whether treatment gains will transfer to untreated languages, and in which direction this may happen. Several explanations have been posed, among them structural overlap between languages, treatment provided in the language of the environment, language proficiency and inhibition of the untreated languages (Ansaldo & Ghazi Saidi, 2014; Faroqi-Shah et al., 2010; Fredman, 1975; Goral, Rosas, Conner, Maul, & Obler, 2012; Kohnert, 2009). A discussion of the above follows further below.

Many studies agree that cognates, that is, words that have identical or very similar form and meaning in two languages seem to have a privileged position in bilingual language processing (e.g. De Groot & Van Hell, 2005; Dijkstra, 2005). The so-called *cognate advantage* seems to be valid not only for neurologically healthy bilingual speakers (Kroll, Dussias, Bice, & Perrotti, 2015), but also for bilingual speakers with aphasia. Roberts and Deslauriers (1999) found that cognates are named more correctly in both languages than non-

cognates, and Kohnert (2004) found better generalisation of the cognates, compared to non-cognates. Cognates are however not investigated in the present project.

While some suggest that structural differences between languages may play a role regarding cross-linguistic transfer (e.g. Goral, Levy, & Kastl, 2010), Ansaldo and Ghazi Saidi (2014) found no evidence of this in their review. On the contrary, a range of studies have shown that treatment effects can transfer across languages, regardless of what language family they belong to within the Indo-European family of languages (Croft et al., 2011; Goral et al., 2010; Kiran & Iakupova, 2011; Kohnert, 2004; Miertsch et al., 2009). Furthermore, there has been published a growing number of studies examining whether some treatment methods are better for enhancing cross-language therapy transfer than others. Semantic treatment is preferred to phonological treatment to enhance the possibility of cross-linguistic transfer (e.g. Abutalebi, Rosa, Tettamanti, Green, & Cappa, 2009; Croft et al., 2011). This preference is supported by earlier treatment studies in monolingual aphasia that were based on models of lexical-semantic processing (Wisenburn & Mahoney, 2009). To some extent, successful generalisation to untrained semantically related items has been reported by Kiran and Thompson (2003). The possible advantage of semantic treatment may be explained by that the different languages of multilingual speakers influence one another (Kroll et al., 2015). Several bilingual language models propose that bilinguals have a shared semantic/conceptual system (e.g. de Bot, 2004; Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994; Pavlenko, 2009) (cf. 3.3.2 for models of multilingual language processing). It is therefore assumed that semantic treatment in one language will benefit untreated languages, through the shared networks. Additionally, treating the language of the environment has been suggested to enhance cross-language transfer (Fredman, 1975; Goral et al., 2012). Finally, research has shown that both pre- and postmorbid proficiency may affect the possibility of transfer. Treatment in a premorbidly weaker language may benefit the untreated, stronger language (e.g. Edmonds & Kiran, 2004, 2006; Kiran & Iakupova, 2011), whereas treatment in a stronger language post-stroke has shown to be beneficial for cross-linguistic transfer (Croft et al., 2011; Goral, 2012).

Inhibition of untreated languages is in this dissertation defined as a negatively affected performance in one language, following treatment in another. Both reviews of Faroqi-Shah et al. (2010) and Kohnert (2009) concluded that treatment in one language does not harm the untreated languages. However, Goral and colleagues (Goral, 2012; Goral, Naghibolhosseini, & Conner, 2013) found inhibition (i.e. negative effects) of the stronger language when

treatment was provided in a postmorbidly weaker language, at least in the short term. Since harming untreated languages is a highly unwanted outcome, this poses for further research.

2.7.2 Verb-treatment studies in multilingual aphasia

A vast number of studies have found that verbs are more difficult to produce than nouns for multilingual speakers with aphasia, corroborating studies in monolingual aphasia (cf. 2.4) (Ansaldo et al., 2010; Faroqi-Shah & Waked, 2010; Hernández, Costa, Sebastián-Gallés, Juncadella, & Reñé, 2007; Kambanaros & van Steenbrugge, 2006; Poncelet, Majerus, Raman, Warginaire, & Weekes, 2007; Weekes & Raman, 2008). Naming of actions can be improved by various treatments for verb retrieval, but generalisation to untrained items is a challenge in monolingual aphasia (see reviews by Conroy, Sage, & Lambon Ralph, 2006; and Webster & Whitworth, 2012). Regardless of this, previous studies examining the effectiveness of therapy concern for the most production of nouns, and not verbs, both in monolingual (Links et al., 2010) and in multilingual aphasia (Croft et al., 2011). Several studies have examined the naming of actions and objects in multilingual individuals with aphasia (e.g. Hernández et al., 2007; Kambanaros, 2008, 2010; Kambanaros & van Steenbrugge, 2006; Miozzo, Costa, Hernández, & Rapp, 2010; Weekes & Raman, 2008), however the number of studies focusing on verb-retrieval treatment is scarce. More research in this field is therefore required.

As described above, some studies have found that treatment provided in the L1 of the multilingual speaker with aphasia is beneficial for cross-linguistic transfer. Ansaldo et al. (2010) and Goral et al. (2012) provided treatment in the L1 of the participants. A Spanish-English bilingual speaker with nonfluent aphasia participated in the Ansaldo et al. (2010) study. Verb and noun production treatment was provided in Spanish (L1), which was also the language of the environment. Two different treatment protocols were used interchangeably, to increase activation of target semantic features. Significant improvements in naming of trained nouns and verbs, as well as a generalisation to untrained verbs were found in the treated language. No significant transfer to the untreated language (English) was found. The authors suggested that cross-linguistic effects of therapy may be limited to cognates, and since no cognates were included in the therapy list, no cross-linguistic transfer was found. Goral et al. (2012) provided treatment for noun and verb retrieval and examined cross-linguistic transfer in a quadrilingual speaker (Spanish, German, French, and English) with nonfluent aphasia. He was treated in his strongest language, Spanish (L1), as well as his weakest language, English (L4), which was also the language of the environment. In general, treatment in English (L4)

led to improvements in the treated language and to cross-linguistic transfer to the untreated languages. Following treatment in Spanish on the other hand, there were only small changes in naming of objects and actions in Spanish, and a limited degree of generalisation to the untreated languages. The authors suggest that treating the language of the environment, which was also his weakest language (English), may have contributed to the findings.

Bastiaanse and colleagues (Bastiaanse, Hurkmans, & Links, 2006; Links et al., 2010) have proposed that verbs should not be treated in isolation, but rather in sentence contexts. In several studies in monolingual aphasia this has shown to improve sentence production (e.g. Bastiaanse, Hurkmans, et al., 2006; Edwards & Tucker, 2006; Webster, Morris, & Franklin, 2005). The improvement is explained by the fact that in this form of treatment, the verb is paired with nouns, and in addition, the speaker is exposed to argument and syntactic structure.

A limited number of studies have treated verbs in sentence contexts in multilingual speakers with aphasia. In contradiction to the above-mentioned studies where the treatment was provided in the L1, Goral and colleagues treated a trilingual speaker (Hebrew, English, and French) with nonfluent aphasia in his L2 (English) (Altman, Goral, & Levy, 2012; Goral et al., 2010). Verbs were not targeted specifically in these studies, but the overall focus of the treatment on language production in sentence and discourse contexts, makes them relevant for this dissertation. Altman et al. (2012) reported improvements to varying degrees in narrative structure and sentence grammaticality in all the languages, including the L1 (Hebrew). Goral et al. (2010) also found positive changes in the treated language, as well as in the untreated L3 (French). In contradiction to Altman et al. (2012) however, little transfer was found to the untreated L1 (Hebrew). The absence of generalisation to the L1 was explained by ceiling level performance in this language, as well as a possible differential representation and processing of the treated L2 (English) and the untreated L1 due to structural differences between the two languages. Consequently, the authors propose that the first-acquired language may have a different mental representation from the other languages.

A comparable pattern showing lack of transfer to the untreated L1 was reported by Miertsch et al. (2009). They provided treatment in the L3 (French) of a trilingual speaker (German, English, and French) with fluent aphasia of the Wernicke type. The treatment focused on word finding of verbs and nouns, exercises with prepositions, semantic-conceptual relationships between words, and word finding in a discourse context. In line with the findings of Goral et al. (2010), the participant showed significant gains in the treated language (French), as well as cross-linguistic transfer to the untreated L2 (English), but not to the

untreated L1 (German). The findings were interpreted as a result of the participant's close-to-ceiling level performance in the L1. Furthermore, the authors point out that the duration of the treatment (23 sessions over 3.5 weeks) may not have been extensive enough to induce significant improvements in a language with an already stable linguistic performance.

The limited number of verb-retrieval studies in sentence contexts in multilingual aphasia and the equivocal results of cross-linguistic transfer in general warrant for more research. Hence, verb retrieval in sentence contexts is the focus of this project.

3 Theoretical framework

Linguistic theories are needed to explain different aspects of aphasia, and research in aphasia may contribute to linguistic theories and models of language processing. Since the 1990's there has been a great increase in the interest of linguistic analyses of multilingualism (Leikin, Schwartz, & Tobin, 2012, p. 1). During the same period, the interest in the usage-based framework has also grown (Backus, 2012). Within this approach, language use and generalised cognitive processes are argued to be accountable for the structure and knowledge of language(s).

Many of the symptoms characteristic of aphasic speech, like omission of words, anomia, and morphosyntactic deficits are also observed among speakers with for instance Down syndrome and children with Specific Language Impairments, as well as neurologically healthy speakers under specific conditions, for example under stress or extreme fatigue, albeit not to the same extent as in aphasia (Bates & Goodman, 1997; Dick et al., 2001). These symptoms of language impairment are thus not specific for aphasia. Aphasic phenomena should therefore, as posed in Chapter 1, be seen in relation to normal language processing and hence be explained by models of normal language processing (Caplan, 1987).

Traditional models of language postulate distinct processing components with different modules; for instance, they view lexicon and grammar as separate entities. Each of these modules presumably process language-specific information and have separate neural representations (Fodor, 1983; Pinker & Ullman, 2002; Ullman, 2001). Language deficits in speakers with aphasia, especially the distinction between Wernicke's and Broca's aphasia, have served as evidence for such domain-specific models. The predominance of grammatical impairments in speakers with Broca's aphasia and lexical-semantic deficits in speakers with Wernicke's aphasia have been explained as selective impairment of the different modules following a stroke (Pinker & Ullman, 2002). Contrasting this view, a range of studies provide evidence against the modular organisation of language (e.g. Aydelott, Kutas, & Fedemeier, 2005; Bates, 1994, 1999; see review by Bates & Goodman, 1997; Dick et al., 2001). They argue that all speakers with aphasia with grammatical deficits also experience anomia (i.e. word-finding difficulties), and reversely: speakers with lexical impairments also display limitations in at least some aspect of grammatical processing (receptive, expressive, or both) (ibid.). It is suggested that instead of separate modules of the different linguistic levels, with one module for lexicon and one for grammar, they rather constitute one large, structured network (Bybee, 2010).

This chapter will present the usage-based approach (cf. 3.1), followed by a description of some general models of speech production (cf. 3.2), and lastly, relevant models of multilingual language processing (cf. 3.3).

3.1 Usage-based theory

3.1.1 General assumptions in cognitive linguistics

The theoretical framework adopted in the dissertation is the *usage-based approach*. In this view, an individual's language changes with use (Bybee, 2001). This means that throughout life the way we use our language combined with our experiences, will change the way language is organised and processed in our brains. The brain's plasticity seems to underpin this notion (Dąbrowska, 2004; Elman, 1999). There is also compelling evidence that the languages of multilingual speakers affect one another, in both directions (i.e. the L1 will affect the L2, and the other way around) (Kroll et al., 2015). Furthermore, there are no brain regions that are used for language processing only. The areas that are involved in language processing are also involved in processes that language shares with other domains, like memory, attention and motor planning, amongst others (Dick et al., 2001) (cf. 3.1.2). Assuming that language is not a separate module in the brain, it is recommendable to make use of what is already known about the mind when studying language (Taylor, 2002).

Cognitive linguistics falls within the usage-based approach, and three hypotheses that guide the cognitive linguistics approach to language are presented as general assumptions of language, namely *1)* language is not an autonomous cognitive faculty, *2)* grammar is conceptualisation and *3)* knowledge of language emerges from language use (Croft & Cruse, 2004, p. 1). The first of these hypotheses emerged as a response to the view of language as an innate, autonomous faculty, organised separately from the non-linguistic cognitive capacities, as presented by generative grammar. Concerning the second hypothesis, meaning is not identified with concepts; hence the choice of the more dynamic term, *conceptualisation*. Conceptualisation is defined to encompass any angle of mental experience and it includes both novel and established conceptions, as well as sensory, motor and emotive experiences. It is further a perception of the physical, linguistic, social and cultural context, and also conceptions that develop and unfold through processing time are included (Langacker, 2008, p. 30). The basis of the third hypothesis is that language categories and structures in semantics, syntax, morphology and phonology are built up from our specific language use in

an abstraction process where schemas are created. Bybee (2001, p. 5) states that the way language is used affects the way it is represented cognitively, and thus the way it is structured.

3.1.2 Domain-general processes

An important consequence of adopting the usage-based approach is that there is no clear distinction between *knowledge* of language and *use* of language (i.e. *competence* and *performance*, in generative terms); knowledge of language is knowledge of how language is used (Evans, Bergen, & Zinken, 2007). All our experiences and the way we use our language will affect how language is processed. According to usage-based theory the processes that underlie language structure are not specific to language; they are applicable in several cognitive domains, and are *domain-general* processes (as opposed to domain-specific, e.g. Ullman, 2001). Domain-general abilities are hence used also outside of language – they are what we in general refer to as cognition. Recent research has found that the use of two or more languages has consequences for domain-general cognitive functions. One example is that bilingualism is found to enhance the efficiency with which some executive processes are carried out, even for nonverbal tasks (Bialystok, Craik, & Ryan, 2006). It appears that bilinguals to a larger extent than monolinguals are able to ignore irrelevant information, switch between tasks, and resolve conflicting cognitive alternatives. Furthermore, several studies have found that bilingualism seems to offer some protection against pathological decline, particularly in delaying the onset of dementia (e.g. Bialystok, Craik, & Fredman, 2007; Freedman et al., 2014), also when the L2 is acquired in adulthood (Bak, Nissan, Allerhand, & Deary, 2014). This advantage may be attributed to the continuous practice of selective activation and inhibition of the two languages, and switching between them (Bialystok et al., 2006). These enhanced inhibition abilities have been found in unbalanced bilinguals especially, as they to a larger extent than balanced bilinguals have to suppress the non-target language (Goral, Campanelli, & Spiro, 2015). The inhibitory control of the non-target languages of multilingual speakers is an example of domain-general functions (e.g. Green, 1986) (cf. 3.3.1), and applies therefore not only to language tasks, but to any complex selection situation (Bialystok et al., 2006). It should be noted however, that there is some controversy with regards to the so-called multilingual advantage, and an advantage is not always found (e.g. Hilchey & Klein, 2011; Klein, 2015; see Valian, 2015 for a discussion).

Domain-general abilities relevant for the dissertation, are categorisation, chunking, rich memory, analogy, the ability to make inferences, and cross-modal association (Bybee,

2010, p. 7). *Categorisation* interacts with the others and is thus the most pervading of these abilities. It refers to the similarity or identity matching that occurs when words and phrases are recognised and matched to stored representations, forming schemas (i.e. general patterns at different levels of abstraction) (cf. 3.1.4). The categories coming out of this process are the basis of the linguistic system, whether they are words, phrases, or larger stretches of speech – or even small entities as phonemes and morphemes (Bybee, 2010, p. 7). These stretches – or *chunks* – can be small sentences or regular expressions. *Rich memory* is the storage of the details of experience with language. This includes phonetic detail for words and phrases, together with contexts of use, meaning, and inferences associated with utterances. Categorisation is the process that maps these rich memories onto already existing representations. *Analogy* relates to the process where a speaker uses a novel item in a construction and when new utterances are created on basis of already known utterances. For this to happen, categorisation is required (Bybee, 2010, p. 8). The final relevant domain-general ability mentioned by Bybee is the ability to make *cross-modal associations* that provide the link between meaning and form, in words, phrases and constructions. This is also relevant for models of bilingual language processing (cf. 3.3.2).

3.1.3 Storage and processing

In Bybee's usage-based theory the phonological shape of all words and frequent phrases known by the speaker are stored in memory together with their meaning (semantics) and their contexts of use. These contexts can be both linguistic and non-linguistic (Bybee, 2001, p. 29). In her view, this storage is not a simple list, but rather involves a *network* of connections between related items that makes this storage more efficient (ibid.). As phonologically and semantically similar words are categorised and stored in relation to one another, the activation of a word in the storage activates – or spreads to – other, semantically or phonologically related words (Figure 1).

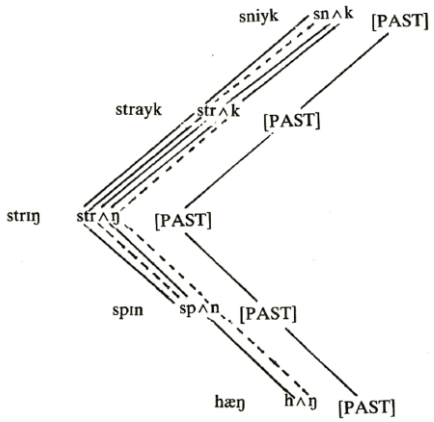

Figure 1. Diagram of connections in the lexicon. Reprinted from Bybee (1985, p. 130).

This is in line with the *spreading activation theory* proposed by Collins and Loftus (1975) (cf. also Dell et al.'s (1997) model presented in 3.2). A concept can be represented as a node in the network, and different properties of the concept are symbolised as two-way links between a given node and other concept nodes. When a person is trying to name the concept DOG, other words denoting related concepts, like FUR, BARK, CAT, STICK will also get activated (Dell, 1986). According to Collins and Loftus (1975) this conceptual network is organised along lines of semantic similarity, whereas the names of the concepts in the network are stored in a lexical network. This lexical network is argued to be organised along links of phonemic similarity, so that when a word is activated, it also activates words that start with the same phonemes/phoneme combinations. Each of the name nodes in the lexical network is assumed to have connections to concepts in the semantic networks (Collins & Loftus, 1975). When activation of a word or a phrase occurs, presumably the spreading of activation continues and extends.

3.1.4 Frequency effects

As already mentioned, a principle of the usage-based theory is that experience affects representations (Bybee, 2001). The way and the number of times we produce and perceive words and phrases will affect their representation in our memory. From this, it follows that frequency is of great importance in this theory. High-frequency words and phrases have stronger representations and will thus be more easily accessed than low-frequency words and phrases (Bybee, 2001). Usage-based approaches distinguish *token* frequency from *type*

frequency, where the first refers to how often specific words or phrases occur, whereas type frequency counts the number of different lexical items a certain pattern or construction is applicable to. These schemas, are patterns in the lexicon, and their productivity is affected by the number of items that belong to them (Bybee, 2001, p. 6). For instance, a schema that ranges over several different verbs will be more productive than a schema that ranges over fewer verbs. This means that they are more likely to be used to produce novel constructions – words and sentences.

Psycholinguistic studies have shown that token frequency is a critical variable affecting performance (along with other variables, such as imageability, word regularity, etc.) in naming. Neurologically healthy speakers name high-frequency words faster than low-frequency words (e.g. Jescheniak & Levelt, 1994; Levelt, Roelofs, & Meyer, 1999). Also in studies with people with aphasia, it is found that many speakers with aphasia have easier access to high-frequency words (Kittredge, Dell, Verkuilen, & Schwartz, 2004; Whitworth, Webster, & Howard, 2014). This lexical strength may change as the words or phrases are used in different contexts. The usage-based theory is therefore a dynamic one, and hence corresponds with some of the models of bilingual language processing that are described in 3.3.2.

Summing up, mental representations of language are not specific to linguistic knowledge, but are domain-general. A consequence of this view is that mental representations are based on categorisations of actual perceived tokens. Every time a speaker uses a new word or a string of words, this is stored. Further, every time the word is accessed, its cognitive representation is strengthened. A model of how words are categorised is the *exemplar model*. Here, tokens, or words, are categorised and matched to similar tokens that have already been stored as exemplars. An exemplar is explained as 'built up from a set of tokens that are considered by the organism to be the same on some dimension' (Bybee, 2010, p. 19). Stored exemplars of words or strings of words are organised into categories. This categorisation is based on phonetic and semantic similarities and schemas are formed over exemplars in the category based on these similarities. For example, when new tokens are experienced, they are mapped onto the already existing exemplars and thereby strengthening them. The meanings and contextual information are also stored with these exemplars. The speaker stores an abstract summary of description – a *prototype* – based on the tokens that are experienced. An assumption is that speakers build a prototype of a category where the central members belonging to this category share more features than more peripheral members (Bybee, 2001;

2010, p. 18). This prototype effect in the storage of language has been demonstrated to be pervasive. According to Bybee (2010, p. 19), both the prototype effect and the exemplar model are evidence of rich memory storage.

3.2 Models of speech production

There are many models of language production, and they all have in common that they assume that our search for words is semantically driven. It is presumed that when attempting to activate one word, a set of semantically related words gets activated as well, and thus the system needs to choose the appropriate item among a number of alternatives (Hall, 2011). A further assumption is that the semantic features specified by the speaker will generally point to a single node that matches the semantic intent of the speaker (ibid.). The production system then has to select one of the activated nodes for use. The more activated the non-target nodes get, that is, the stronger the competition between the nodes, the longer the time it will take to select and produce a target word (cf. 3.3.1).

A very influential model has been Levelt's model of speech production, *A blueprint for the speaker* (Levelt, 1989, 2001; Levelt et al., 1999) (Figure 2).

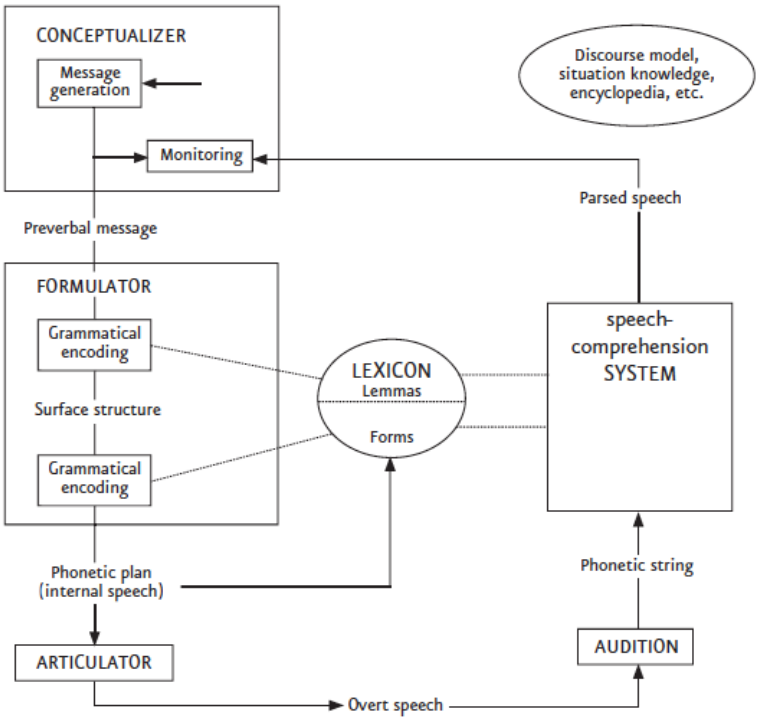

Figure 2. A blueprint for the speaker. Reprinted from Levelt (1989, p. 9).

Levelt's model proposes that activation flows in one direction, top-down. In the *conceptualiser*, the message is conceived preverbally. The intention of producing a meaningful utterance to convey the intended message involves the activation of lexical concepts[7]. Each lexical concept is linked to other concept nodes through the semantic network, and the activation of one lexical concept thus spreads to all semantically related concepts (Levelt, 1999; Levelt et al., 1999; Roelofs, 1992). Lexical access comprises two dominant steps: lemma retrieval and word-form encoding. Each lexical concept is linked to a lemma, and the lemma contains links to both the syntactic and the semantic properties of a word (Levelt, 1989)[8]. The lexical selection occurs when a word is retrieved from the mental lexicon, for the lexical concept to be expressed. The active lexical concept spreads activation to 'its' lemma node, and the highest activated lemma is selected. This occurs in the *formulator*. At the time a lemma is selected, its syntax becomes available for further grammatical encoding. The next level of lexical access is the *phonological access* level, where the mapping from the lemma to the phonological word form takes place (Dell et al., 1997; Levelt et al., 1999). At this level, the message is first phonologically encoded, and thus, prepared in terms of its syllabification and prosody. Thereafter, it is phonetically planned before its articulatory program is prepared in the *articulator*. The seriality of this model does not allow for direct feedback from word forms to lemmas. However, the model includes a self-monitoring device for the speaker to control what s/he is saying. This happens not only at the level of overt speech, but the monitoring is also applied to the internal speech (Levelt et al., 1999).

Even if it is argued that this model is the most complete and sophisticated theory of lexical access in language production (Dell, Ferreira, & Bock, 1999), it has been criticised for its one-way flow, with no feedback from the later stages of processing to the earlier ones (e.g. Ferrand, 1999; O'Seaghdha, 1999). The seriality between the lexical and the phonological stages is not compatible with findings from research on 'tip-of-the tongue'-states, for instance, where evidence for simultaneous activation at the semantic and the motor areas has

[7] Concepts are described as 'bundle of semantic/conceptual features' by de Bot (2004, p. 24). The term is expanded by Jarvis (2009, p. 100) and he refers to *concepts* as reflecting 'the level of thought and experiential knowledge'. The concepts are comprised of different kinds of mental images and image schemas, and the knowledge is organised into structured categories of thought and meaning, whereas semantic representations consist of the mental links that map lemmas to concepts and lemmas to other lemmas.

[8] According to Aronoff (2007) psycholinguists use the term *lemma* for the abstract lexical entry, and the term *lexeme* for the phonological or grammatical word. This might cause confusion, because according to classical linguists, the term *lexeme* refers to the abstract entry of the word.

been found (Resnik, Bradbury, Barnes, & Leff, 2014). However, Hall (2011, p. 2) argues that even if the original model assumed strict seriality, a feed-forward activation is now widely accepted.

Another relevant model is Dell et al.'s connectionist model, that is developed from spreading activation theory, that was mentioned in 3.1.1 (Dell et al., 1997) (Figure 3). Rather than the seriality of Levelt's model, this model combines a two-step notion with an interactive activation mechanism. It therefore allows connections between semantic, lexical, and phonological representations to run not only top-down, but also bottom-up. This way, activation at phonological levels of the production system feeds back to the semantic level, and these activated semantic representations, in turn, reinforce activation of nodes at the phonological level (Dell et al., 1997). In order to link this model to bilingual language production, it is assumed that for the correct lemma to associate with the right lexical concept (often referred to as *binding*) it must be ensured that the intended lexical item is the most active at the moment of selection (Green, 1998). The interactive activation of this model, where the structures are not predetermined, but are shaped by the feedback, makes it well fitted with usage-based theory (Bybee, 2001).

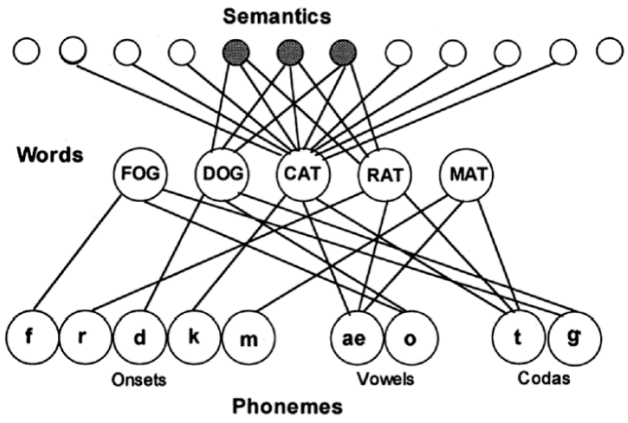

Figure 3. Dell et al.'s Connectionist model. Reprinted from Dell et al. (1997, p. 805).

3.3 Models of language storage and processing in multilinguals

In the past 25 years interest in the psycholinguistic studies of bilingualism has had an exceptional upsurge (Grosjean & Li, 2013), and the quest to model how bilinguals process and store various languages has been of special interest. There are several models of bilingual language organisation, of how the different languages are stored, and of how bilinguals

manage to select or inhibit the activation of words in one of the languages when producing an utterance in the other language.

There is compelling evidence for parallel activation of all the languages of a multilingual speaker when s/he is producing words in one of the languages (e.g. Brysbaert & Duyck, 2010; de Bot, 1992; Dijkstra, 2005; Green, 1998; Kroll, Bobb, & Wodniecka, 2006; Kroll et al., 2015; Kroll, Van Hell, Tokowicz, & Green, 2010; Marian & Spivey, 2003; Spivey & Marian, 1999; Van Hell & Dijkstra, 2002). This is the case, not only when the speaker is using a weaker L2 or L3 (and so on), but also when s/he is using the L1 (e.g. Dijkstra, 2005; Kroll et al., 2006; Marian & Spivey, 2003; Spivey & Marian, 1999; Van Hell & Dijkstra, 2002). Current models of multilingual language processing agree that a multilingual speaker has a shared conceptual system for both/all languages, even though of course phonological and morphosyntactic forms differ across the languages. However, the models differ in their views on how the two (or more) lexica are organised and how multilingual speakers are able to keep the language systems separate, and what prevents them from uncritically mixing languages (e.g. de Bot, 2004; Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994; Pavlenko, 2009).

3.3.1 Selection and inhibition

Since all the languages of multilingual speakers are active during language processing, explanations to how the speakers are able to select the proper word in the wanted language are needed. Models of multilingual speech production generally assume that translation equivalent lexical nodes share a common semantic representation (Finkbeiner, Gollan, & Caramazza, 2006). Hence, if one of these lexical nodes is selected for language production, the other(s) will be equally activated. A problem with this assumption, referred to as ‘the hard problem’, is the question of how the lexical selection mechanism chooses between the two. The hard problem is based on the assumption that lexical selection is a competitive process. Thus, the selection of a target lexical node depends not only on its activation level, but also on the level of activation of the competitive nodes at the same time. From this, it follows that the more similar in meaning the target and the non-target words are, the harder it will be to select the right one, because their activation levels are almost equal. This competitive selection of lexical nodes should be most problematic for proficient multilingual speakers as the connections between the conceptual system and the L1 and the L2 lexica are thought to be equally strong (Finkbeiner et al., 2006). However, in unbalanced multilinguals the

connections may be stronger from the L1 lexicon to the conceptual store, than from the L2 lexicon to the conceptual store (cf. 3.3.2). Thus, multilingual speakers have to have ways to overcome the hard problem. Finkbeiner et al. (2006) reviewed three possible solutions, which will be presented in the following.

The *Inhibitory Control* (IC) model of Green (1986, 1998), which is highly influenced by Levelt's model (1989; 1999) (cf. 3.2), proposes the conceptualiser to be language independent. The lemmas are proposed to be associated with a language tag. Language selection thus takes place at the lemma level, and language use requires the bilingual speaker constantly to inhibit the non-target language (Green, 1998). Inhibition is assumed to be proportional to activation levels, and since the L1 is more strongly activated than the L2, according to this model, the L1 is thought to be the most strongly inhibited when it is not the target language. From this, it follows that the message first is planned in the conceptualiser, before lemmas of both languages are activated to create the message. Then there is a suppression of lemmas with incorrect language tags, before the message is 'sent' to phonetic planning and articulation. This has found support in a range of studies (for a review, see Kroll & Dussias, 2013). Green further suggests that the IC-model can be generalised to account for language control in trilingual or polyglot speakers, as well, making it relevant for this project (Green, 1986).

The other two possible solutions are based on competitive processes and do not involve suppression of nodes in the non-target language. The first, proposed by Costa and colleagues (Costa & Caramazza, 1999; Costa, Miozzo, & Caramazza, 1999), suggests that bilinguals circumvent the hard problem by only considering lexical nodes in the target language. Hence, the hard problem is not confronted, as lexical selection is not competitive across languages, but is rather language-specific. The other possible solution is La Heij's (2005) proposal, suggesting that the lexical selection occurs higher up in the system, in the preverbal phase. He assumes that the preverbal message contains all necessary information on language selection; hence, there is no hard problem in selecting words in the target languages.

In summary, selecting a target word depends on the activation level of both the target word for selection and that of the competing words. Thus, selection is facilitated by either preferentially enhanced activation of the target, inhibition of the competitor, or both (Bialystok, Craik, Green, & Gollan, 2009).

3.3.2 Models of bilingual language processing

Models of lexical retrieval in multilingual speakers have a lot in common with those of monolingual speakers (cf. 3.2). A main difference however, is an additional layer of selection due to the potential activation of words in the non-target language (Kurland & Falcon, 2011). The models differ as to the exact place in the process the language selection occurs.

One of the most influential models of bilingual language processing is the *Revised Hierarchical Model* (RHM) (Kroll & Stewart, 1994) (Figure 4)[9]. The RHM is a model of word production and it presents two independent, but connected lexica. The model demonstrates a developmental perspective where bilinguals first acquire new words in their L2 through the lexicon of their first learnt language, the L1-lexicon, via a direct connection between the L1- and the L2-lexica. This means that early in the acquisition of a second language, the words are strongly connected to the corresponding words in the first language. Hence, the RHM proposes a weaker link between the L2-lexicon and the conceptual store, than between this store and the L1-lexicon. With an increased proficiency in the second language, the connection between the conceptual store and the L2-lexicon will grow stronger. Thus, the bilingual speaker will gradually get direct access to the meaning of the words from the L2-lexicon to the conceptual store independently of the L1, in addition to access to other semantically and idiomatically related words in the second language (Obler & Goral, 2007).

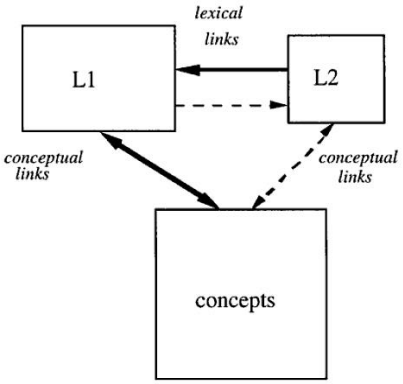

Figure 4. The Revised Hierarchical Model. Reprinted from Kroll and Stewart (1994, p. 25).

[9] Another influential model of the bilingual mental lexicon is the *Bilingual Interactive Activation Model* (BIA, BIA+) (Dijkstra & Van Heuven, 2002). This is essentially a model of orthographic (i.e. written) word recognition (although the authors argue that it can be generalised to apply also for word production). Still, as the data in the present project is on spoken word production, it is not considered as relevant for this dissertation as other models that are presented in this section.

The RHM has been criticised for its separated representation of the two lexica (Brysbaert & Duyck, 2010), given the load of evidence of parallel activation of languages, assuming shared representation for the two languages. This critique is met by Kroll et al. (2010) with a suggestion of two functionally separate lexica with parallel access and sublexical activation that generates resonance among shared lexical features. Additionally, the RHM has been criticised for its assumption that meaning in the L2 has to be mediated through the L1 translation equivalent. In a response to this critique, Kroll et al. (2010) point out that mediation via the L1-lexicon to *comprehend* meaning may be incorrect, whereas this may be the case for lexical access.

Green (1998) argues that even though the RHM suggests that translation equivalents are connected directly and through conceptual links, the model does not address how an individual is able to name only the translated word, and not the word that is to be translated. Thus, inhibition of the non-target language remains open in this model, and there is no proposed solution to the hard problem. Nevertheless, the developmental and dynamic aspect of the RHM makes it applicable to the usage-based theory, which assumes that with increased use and therefore increased frequency, the organisation of the language processing will consequently change.

A model that builds on the RHM is the *Modified Hierarchical Model* (MHM), proposed by Pavlenko (2009) (Figure 5). This model has kept the developmental aspect of the RHM. What distinguishes the MHM from the RHM is the organisation of the conceptual store. Rather than a mutual store for all concepts, this model assumes a threefold conceptual store, with one completely shared area, one area with partially overlapping concepts and one with fully language-specific concepts. In line with other language production models, the MHM assumes that when a bilingual speaker wants to say something, the intended formulation begins in the conceptualiser or the conceptual system (e.g. Levelt, 1989; Pavlenko, 2009). According to the complementarity principle (cf. 2.2.2), the different languages of multilinguals are used in different settings, and some linguistic categories may be language-specific; hence, only one of the languages may have the needed word form. This way, Pavlenko (2009) argues, the language activation process is a two-way interaction between the mind and the environment. In this view, the linguistic and the social contexts affecting the conceptualiser and concepts that are linked to the relevant language are activated. Meanwhile, concepts and frames that are not appropriate are inhibited and made less accessible. Language selection thus occurs at a preverbal stage, and the hard problem is

therefore solved. With the inclusion of the developmental aspect of the RHM, and with its view of the interaction between the environment and cognition, the MHM harmonises with the usage-based theory.

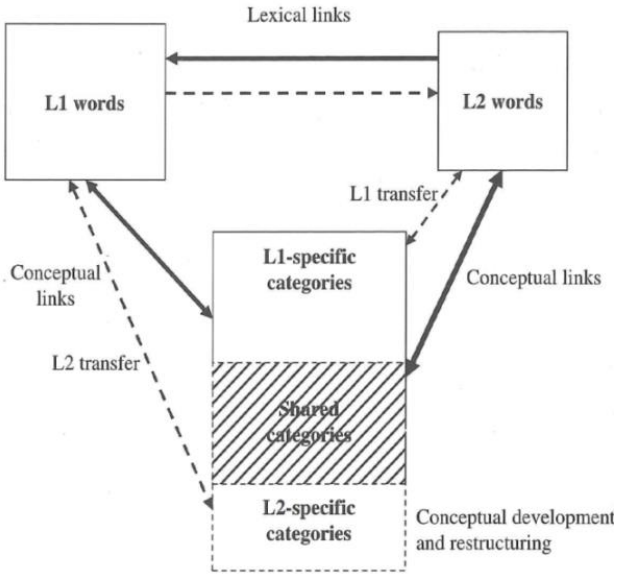

Figure 5. The Modified Hierarchical Model. Reprinted from Pavlenko (2009, p. 147).

As pointed out above, the two models presented so far are both models of how words are stored in and retrieved from the mental lexicon. However, in order to produce complete sentences, there is a need of a model that place these words in a sentence structure (Hartsuiker & Pickering, 2008). The *Multilingual Processing Model* (MPM) (de Bot, 1992, 2004) displays the process from planning to produce an utterance, via the selection of words and the application of grammatical rules, to planning and executing the articulation of an utterance by a multilingual speaker (Figure 6). The model is an extension of Levelt's model (1989; 1999), but has received relatively little attention in the literature. In line with the IC-model (Green, 1986, 1998), the MPM assumes that the different languages of a multilingual person can be activated and inhibited to varying degrees. de Bot proposes that the non-selective access does not mean that all languages have equal chances of being selected. On the contrary, he argues, languages that are more frequently used have a higher default level of activation. They are therefore more difficult to inhibit, and once they are suppressed they are more difficult to reactivate (de Bot, 2004). This is in line with the assumption of an *asymmetrical switching cost*; that it is harder to switch from a weaker to a stronger language. When bilingual speakers are switching between languages, this comes at a cost, and for neurologically healthy L2

learners it is harder to switch from a weaker to a stronger language (Costa & Santesteban, 2004; Goral et al., 2013; Green, 1998; Meuter & Allport, 1999). This counterintuitive notion is explained by the core assumptions of the IC-model, namely that when speaking a dominant language, it is easier to suppress the influence of a weaker language, whereas when speaking a weaker language, more effort is needed to inhibit the stronger language. Following this, word retrieval from a lexicon that has been suppressed takes more time than from a lexicon in a non-inhibited language (Costa & Caramazza, 1999).

The MPM model assumes that the preverbal message contains information about the meaning of the intended word, along with information about which language to choose for production. These two types of information spread simultaneously to separate representations. The first route is when the conceptual information spreads and activates lemmas of both languages. The other route is the one of the language intent. It spreads to an external language node (see Figure 6). The language node further has a direct link to both the lemmas (which triggers the syntactic procedures and the lexemes) and to the syllables (and/or phonemes) belonging to the selected language. An advantage of having the language node independently connected to the lexical and phonological levels, is that it permits the speaker to select lemmas from one language and sounds from another (e.g. when speaking with a foreign accent). In line with Levelt's model, this model assumes that there is a large set of syllables stored, and that these are shared between the languages. Along with the shared concepts and the shared syntactic procedures, it is argued that also the shared syllables can serve as a bridge between languages.

de Bot (1992) argues that the relationship between the lemma and form characteristics in multilinguals differs from the one in monolinguals. For multilinguals, a lemma can be linked to various forms of characteristics depending on the language(s) involved. The concepts that overlap in meaning share semantic features, and in line with spreading activation theory (cf. 3.1.3), the activation of a concept entails activation of its features, as well as other concepts with shared features (de Bot, 2004). This model thus combines aspects of the models of Levelt et al. (1999) and Dell et al. (1997). de Bot further proposes that *language* may be one of the features of a concept. Since words from different languages share semantic features, this poses for a possible bridge between languages through the conceptual system. With the language node's independent connection, this model solves the hard problem of bilingual access (Hall, 2011). It also harmonises with the usage-based approach and its dynamic organisation.

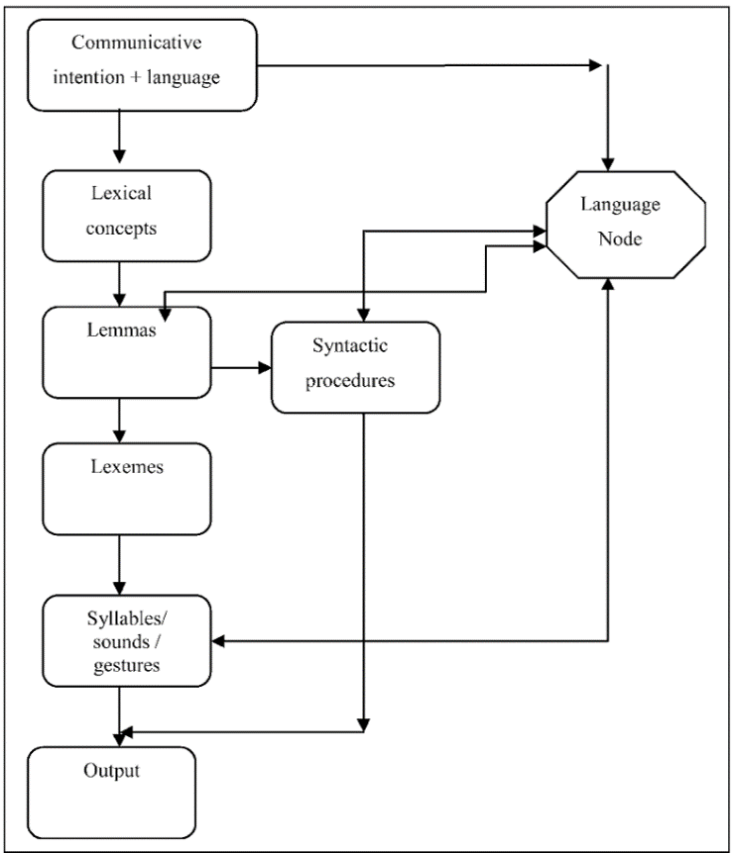

Figure 6. The Multilingual Processing Model. Reprinted from de Bot (2004, p. 29).

The presented models are all considered to be relevant to the present project and will be discussed and evaluated in light of the findings of the project in section 6.8.

4 Methods and materials

In this chapter the choice of design, the participants in the studies, the data collection process and other methodological aspects that are not covered in the papers, will be presented. As remarked in the Introduction, the project has a broad scope, and it intends to cover various aspects of the clinical work with individuals with multilingual aphasia. One of the main goals is to explore two different treatment methods and investigate their applicability for enhancing cross-linguistic treatment transfer. The use of these treatments warrants an expansive description of the methods and the procedures. Moreover, this will enable other researchers and clinicians to replicate the study.

Initially, an overview of the studies will be presented (cf. 4.1), followed by a description of the sampling procedure (cf. 4.2), before a presentation of the assessment material used in the project (cf. 4.3). In 4.4, the design and the procedures of the studies will be described thoroughly to ensure opportunities for replication, and a description of the data analysis is found in 4.5. Finally, a discussion of the reliability and the validity of the project is presented (cf. 4.6 and 4.7), before the chapter is closed with a discussion of ethical perspectives in 4.8.

4.1 Studies

An overview of the studies included in the present project and their application to the different papers is displayed in Table 1. For more detailed information on the studies, the reader is referred to 4.4, the summaries in Chapter 5, as well as the papers themselves.

Table 1. Overview of the studies.

Number of study	Type of study	Participants	Results reported in paper
Study 1	Single-subject descriptive study investigating assessment with the *Bilingual Aphasia Test* (BAT)	RF	I
Study 2	Single-subject treatment study addressing cross-linguistic transfer and inhibition of the untreated language, and the use of English as a lingua franca in language therapy	AF	II
Study 3	Multiple single-subject treatment study exploring two different treatment methods for multilingual speakers with fluent and nonfluent aphasia, investigating within-language gains and cross-linguistic transfer, as well as inhibition of the untreated language(s)	MA, PN, DT	III, IV

4.2 Sampling

4.2.1 Recruitment challenges

Recruitment of participants is a challenge in stroke rehabilitation studies in general (Kelly et al., 2010). Getting participants was challenging also in the present project, particularly since multilingual speakers with aphasia in Norway is a relatively limited group. In a review considering the care for elderly immigrants in Norway, Ingebretsen (2010) found that the use of care services among older people from ethnic minorities is lower than in the corresponding age groups in the majority population (cf. also Nergård, 2008). Poor economics, language problems and lack of knowledge about the services were proposed as barriers to make use of the service provision that exists.

Due to the challenges in recruitment, a wide range of channels was used. The stroke hospitals and rehabilitation centres in Oslo and in the Oslo region were contacted (Appendix 1 and 2)[10]. Several private practicing SLTs working with clients with aphasia, as well as SLTs in the author's professional network were also contacted. Furthermore, the project was announced on the webpage of the author's work place at that time (Appendix 3), and advertised in the journal of the aphasia association in Norway (Knoph, 2010), as well as in the

[10] For practical reasons information and invitations were not sent to hospitals further away than one-hour drive from the place where the treatment was going to take place.

journal of the SLT Association of Norway (Knoph, 2009). Presentation of the project was given at *Afasidagene*, an annual two-day national conference for SLTs working with aphasia, in 2012.

4.2.2 Inclusion and exclusion criteria

Study 1 and study 2 included one participant each, and since they were not to be directly compared to other participants, the criteria for inclusion and exclusion were less strict than for study 3. In addition, study 1 and study 2 were conducted in clinical settings and they were therefore more exploratory. For study 1, the only criterion for inclusion was that the participant had to be a multilingual speaker with aphasia. For study 2, the participant had to be a multilingual speaker with aphasia and s/he had to be at least six months post-onset. No exclusion criteria were used.

The participants of study 3 were required to meet the following criteria: They were to suffer from nonfluent aphasia as a result of a single lesion to the left hemisphere and they should be right handed. They were further to be multilingual speakers with a different L1 than Norwegian, and to have Norwegian as a late-acquired language after the age of 20 (i.e. to be sequential multilinguals). No restrictions for the L1 were made so not to exclude potential participants. To avoid any suspicion of spontaneous recovery, the subjects were to be more than six months post-onset. They were not to have any other known neurological or psychiatric diagnosis, nor other cognitive or linguistic disorders prior to the stroke. The initial exclusion of speakers with fluent aphasia was removed as a criterion after some months of recruitment challenges[11]. The broadening of the inclusion criteria provides the opportunity to compare the applicability of the treatments for individuals with fluent and nonfluent aphasia, and to contribute to the limited number of studies in fluent aphasia. The participants in the studies could not receive any other form of speech and language therapy during the study.

[11] Studying individuals with fluent aphasia is of research interest as well, as several studies have found that also individuals with fluent aphasia experience problems with verb production (Berndt et al., 1997; Luzzatti et al., 2002; Mätzig et al., 2009) (cf. 2.4).

4.2.3 Participants

Five multilingual speakers with aphasia participated in the project. An overview of their characteristics is found in Table 2. The participants signed an informed consent form prior to the studies (Appendix 4) (see discussion in 4.8).

Table 2. Overview of subject characteristics.

Participants	Age	G	Months post-onset	Aetiology	Severity	Aphasia fluency	Languages
RF	45	M	1	CVA	Mild	Nonfluent	Farsi (L1) English (L2) Norwegian (L3)
AF	64	M	36+	CVA	Moderate to severe	Nonfluent	Arabic (L1) English (L2) German (L3)
MA	59	F	7	CVA	Moderate	Nonfluent	Japanese (L1) English (L2) German (L3) Norwegian (L4)
PN	50	F	10	CVA	Moderate	Nonfluent	Ronga (L1*) Portuguese (L1*) Norwegian (L2)
DT	75	F	18	CVA	Moderate to severe	Fluent	English (L1) Norwegian (L2)

Abbreviations: G = gender; CVA = cerebrovascular accident; * = Acquired simultaneously

Aphasia type and severity are based on the *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987) and on clinical judgement, for all participants.

RF is a 45-year-old, right-handed trilingual speaker of Farsi (Persian) (L1), English (L2) and Norwegian (L3). He comes from Iran, and he grew up speaking Farsi. He acquired English during his school years. At the age of 23, RF came to Norway, where he learned Norwegian, and eventually achieved a bachelor degree. At the age of 45, RF sustained a left hemisphere stroke, resulting in nonfluent aphasia. Prior to the stroke, he used Norwegian and English daily at work and in his everyday life, and Farsi at a daily basis with friends and family. He was one-month post-onset at the time of the study. The participant reported to be fluent in speaking and writing all three of his languages before the stroke.

AF is from Palestine and is a 64-year-old, trilingual, right-handed speaker of Levantine Arabic (L1), English (L2) and German (L3). He learned English at the age of 10. He also learned German, but he had not used this language for many years. He lived with his wife and two young children, and Arabic was the only language spoken at home at the time of the

study. He sustained a left hemisphere stroke at the age of 61 (three years prior to the study), and suffered from moderate to severe nonfluent aphasia. AF was the only participant that did not speak Norwegian, because he suffered the stroke just a couple of months after his arrival to Norway.

MA is a 59-year-old, right-handed quadrilingual speaker of Japanese (L1), English (L2), German (L3) and Norwegian (L4). She grew up in Japan, speaking Japanese at home and learned English at school. Later on, she moved to England; hence, English was also acquired through immersion. Furthermore, she studied German in Japan before she moved to Germany as an adult. When she lived there, she passed an exam to work as a German-Japanese interpreter. She subsequently moved to Norway, where she learned Norwegian formally and through immersion. She lived with her husband and a grown-up daughter. In her self-report[12], she reported that she used Japanese frequently with her extended family and friends. English was the language she had used at work where she used it frequently. Norwegian, being the language of the environment and the language she spoke at home was used daily. She rarely spoke German. She suffered from moderate nonfluent aphasia and was seven months post-onset at the start of the study. Japanese was her strongest language post-stroke followed by English and Norwegian. German was her weakest language.

PN is a 50-year-old, right-handed trilingual speaker from Mozambique. She grew up as a simultaneous bilingual from birth, speaking both Portuguese (L1) and Ronga (L1) (a Bantu language spoken mainly in Mozambique). She moved to Norway as an adult and learned Norwegian, both by attending language classes and by immersion. All three languages were used on a daily basis; Portuguese and Ronga in her daily family life and with friends and Norwegian at work. The proficiency level was reported as high for all languages. She sustained a left hemisphere stroke ten months prior to the study, which caused a moderate nonfluent type of aphasia. Norwegian was the weakest language post-stroke.

DT is a 75-year-old bilingual, right-handed speaker of English (L1) and Norwegian (L2). She grew up in Scotland and spoke only English at home. She learned Latin and German at school, but rarely used these languages in her adult life. She moved to Norway as an adult, and acquired Norwegian by immersion. She spoke both English and Norwegian to her husband, and only English to her children and grandchildren. She was retired at the time of the stroke, but before the retirement, she spoke both languages at work, and reported that

[12] Information on the language use and the proficiency level of each of the languages, was obtained with the *Language Use Questionnaire* (Muñoz, Marquardt, & Copeland, 1999) and part A of the *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987) for MA, PN and DT.

she had good oral and written skills in both languages. She sustained a left hemisphere stroke that caused moderate to severe fluent aphasia about 18 months prior to the study. The BAT does not provide information on aphasia type. However, based on clinical judgement DT was suffering from fluent aphasia of the Wernicke type. English was her strongest language both prior to, and following the stroke.

4.3 Assessment tools

4.3.1 The Bilingual Aphasia Test

The *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987) was designed to be a comprehensive and comparative test for bilingual speakers with aphasia, and is the only test battery available for the languages relevant for this project. Hence, the BAT was chosen as an assessment tool for all three studies and was used to measure pre-post treatment changes. Participants PN and DT experienced fatigue following the stroke, and for these two participants the BAT was therefore shortened (Appendix 5).

The BAT is an assessment tool developed 'to determine whether one language is better recovered than another, to what extent, and in what area of functioning, in a valid and comparable way' (Paradis & Libben, 1987, p. 43). The test battery was adapted into Norwegian and is the only test for assessing multilingual aphasia available in Norwegian (Paradis & Knoph, 2010). The BAT is designed to be equivalent in all its more than 65 language versions (Paradis, 1998a). The different language versions of the tool are not mere translations, but adaptations to ensure linguistic and cultural equivalence. The BAT does not provide information about aphasia syndromes (e.g. Broca's aphasia, Wernicke's aphasia, etc.). However, it is well suited to perform pre- and post-therapy results for multilingual speakers (Miller Amberber, 2011).

The BAT consists of three parts. Part A is a self-rating of the premorbid language history and is to be assessed once and in the best language of the multilingual speaker with aphasia[13]. Part B is the language test, and this part has to be assessed in each of the multilingual person's languages, administered by native speakers (interpreters) of the relevant language. Part B comprises 32 subtests that assess all four language modalities (auditory comprehension, oral language production, reading and writing) in different linguistic domains

[13] For participant RF, BAT part A was collected in Farsi; for AF it was obtained in Arabic; for MA it was collected in Japanese; for PN it was collected in Portuguese; and for DT it was obtained in English.

(phonology, syntax, semantics, morphology and lexicon) at different language levels (word, phrase and sentence). Part C assesses the bilingual skills of the person with aphasia in a specific pair of languages and includes translation tests between the languages[14].

4.3.2 Action-naming test

Pictures from *The Newcastle University Aphasia Therapy Resources* (NATR) (Morris, Webster, Whitworth, & Howard, 2009) were used to assess verb production in studies 2 and 3 as well as for treatment tasks in the same studies. This set of resources is based on research in aphasia therapy, and it is designed to improve particular areas of language processing. Both treatment studies in this project (studies 2 and 3) targeted verbs in sentence contexts, thus pictures from the *Verb and Sentence resources* of NATR (Morris et al., 2009) which focus on verb retrieval and sentence production, were selected. The verbs in NATR are all everyday words with high naming agreement in both the English[15] (ibid.) and the Norwegian version of the resources (Morris, Webster, Whitworth, & Howard, 2012). Factors like word frequency, imageability, word length, etc. are not controlled for in the resources (cf. 6.9 for methodological considerations).

The NATR does not exist in Arabic, Japanese, German or Portuguese (J. Morris, personal communication, May 11, 2015). The English version of the NATR was used to assess verb production in Arabic in study 2 (cf. 4.4.3.1). To assess verb production in Japanese and German in study 3, pictures from two tests that have been widely used for assessing action naming; the *Naming of Verbs* subtest from the Norwegian version of *The Verb and Sentence Test* (*Verb- og setningstesten* (VOST)) (Bastiaanse, Lind, Moen, & Simonsen, 2006), and the *Action Naming Test* (Obler & Albert, 1979) were selected. These sets of verbs are all also everyday words. For naming-agreement in these languages, three native speakers of each language checked the pictures. Some of the items occurred in both materials and were therefore omitted. In total, the action-naming tests for Japanese and German consisted of 89 different verbs.

As mentioned, PN and DT experienced fatigue following the stroke, and the materials were therefore shortened. For DT 50 verbs from the English NATR were selected, and for PN the same amount of Portuguese verbs was selected. For Portuguese, the 50 verbs were chosen

[14] Part C was not applied in the project, since it does not exist in any language pairs that include Norwegian.

[15] The English version consists of 120 pictures. The Norwegian version was unpublished at time of the study and included 119 pictures.

from the English NATR, and then translated into Portuguese by a professional interpreter. The Norwegian version of the resources (Morris et al., 2012) was used for assessment in Norwegian, for all participants in study 3.

The action-naming test was used for pre- and post-treatment measurements, as well as for baseline testing in study 3. In assessing action naming, the participants in study 3 were required to produce a simple sentence describing the action in the pictures. For the scoring purposes, a mere score of the presence of the verb was obtained. That is, if the participants produced the target verb in any form, it was scored as correct. Since narrative production was collected separately in the study, it was decided to be sufficient only to register the presence of the verb. For more information on how the pictures were used in the treatments, see the description of the intervention methods in 4.4.3 (study 2) and 4.4.4 (study 3), respectively.

4.3.3 Narrative elicitation

In addition to the structural assessments, narrative elicitation was included in study 3. Beeke, Wilkinson, and Maxim (2003) argue that aphasic speakers' grammar (e.g. syntax) differ from one context to another, and that assessment results from single sentence production tasks, narratives and conversation samples are thus complementary in nature. Furthermore, since both treatment methods targeted verb production in sentence contexts, it was important to include assessments beyond the word- and sentence levels. Moreover, this also enhances the ecological validity of the study.

In study 3, the participants were asked to talk for a few minutes about a movie they had seen, a book they had read, a happy moment or a trip they had made (cf. e.g. Altman et al., 2012; Kempler & Goral, 2011). They were encouraged to tell a different story at each measurement point, so that they did not practice telling the same story every time. The personal narratives were conducted for baseline testing, as well as for pre- and post-treatment measurement. In addition, one picture description task[16] and one cartoon description[17] were collected in study 3, but due to time constraints, these have yet not been analysed and are thus not included in the papers. John, Loewenstein, and Prelec (2012) advise against excluding data on the basis of post hoc criteria to support a hypothesis. These semi-spontaneous narratives were not excluded as a result of their lack to support a hypothesis, but rather as a consequence of the combination of a huge data load and time constraints.

[16] The *Cookie Theft*, from the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972).

[17] The *Description* subtest from the BAT (Paradis & Libben, 1987).

4.3.4 Social validation and language history

Preceding the language assessment in study 3, social validation was conducted. The husbands of the three participants completed a measure of functional communication, the Norwegian version of the *Communicative effectiveness index* (CETI) (Lomas et al., 2006). To better understand the impact of the disease on a person's life, and to evaluate the efficacy of different therapeutic interventions it is advised to include assessment of health related quality of life for speakers with aphasia (Hilari & Byng, 2001). Therefore the SALK-39 (Berg, Haaland-Johansen, & Hilari, 2010), which is the Norwegian version of the *Stroke and Aphasia Quality of Life Scale* (SAQOL-39) by Hilari, Byng, Lamping, and Smith (2003), was conducted. For information on premorbid language history and language use, Part A from the BAT (Paradis & Libben, 1987) and a Norwegian adaptation of *the Language Use Questionnaire* (Muñoz et al., 1999), was used.

4.3.5 Interpreter use

The language assessments in Farsi, Arabic, Japanese, German, Portuguese and English were conducted by native speaking interpreters or by highly proficient speakers of each of the languages[18]. As pointed out earlier, the use of interpreters may influence the results of an assessment. The interpreters were therefore provided with general information about aphasia and about how to facilitate good communication with speakers with aphasia. Furthermore, the interpreters were given information on how to conduct a language assessment (e.g. not to change the stimuli, to give sufficient time for the speakers to respond, etc.) and the BAT was inspected and rehearsed (cf. 2.5 for the rationale). In addition, the author was present at a majority of the assessments. Moreover, all assessments were audio- and video recorded.

4.4 Design and procedures of the studies

4.4.1 Single-subject design

In aphasiology, both larger and smaller between-groups experimental designs were the most applied methodologies in the 1960s–1980s (Thompson, 2006). Several of the studies failed in describing the treatment methods properly, which made them difficult to replicate. Whereas

[18] The author conducted assessment of English in study 2. This was chosen since English was the language of treatment provision. The author, due to illness of the tester, conducted two of MA's test sessions in English in study 3.

randomised control trials (RCTs) are considered the best evidence in clinical research (Tate et al., 2008), they often cannot specify which treatment will work for whom (Howard, Best, & Nickels, 2015). Given the great individual variation amongst people with aphasia, large group studies may therefore not be the right method when one wants to study language ability, language use, or rehabilitation of impaired language.

Single-subject designs (also known as n-of-1, N=1 or single-case experimental designs) are studies where the individual serves as his or her own control (Tate, Perdices, McDonald, Togher, & Rosenkoetter, 2014). These have shown to be applicable in evidence-based aphasia rehabilitation, both for measuring efficacy (within-research settings) and also for measuring effectiveness in clinical settings (Fucetola, Tucker, Blank, & Corbetta, 2005; Links et al., 2010). Single-subject design was therefore chosen for the three studies in the present project. One advantage of this design is that it may be applied to only one, or to a small number of subjects who are to be evaluated as separate individuals rather than as members of a larger group (Schiavetti, Metz, & Orlikoff, 2011). Another advantage of single-subject designs is that they can easily be combined with clinical work (Robey, Schultz, Crawford, & Sinner, 1999); hence, the choice of design harmonised with the desire to conduct client compliant studies.

However, there are some challenges with the single-subject design. The greatest challenge may be the possible threat to the internal validity because of the difficulty of ensuring the experimental control condition. Moreover, since the participants serves as their own controls, and are not randomised, the results cannot be generalised (Pring, 2005; Schiavetti et al., 2011; Thompson, 2006) (however, see 4.7.2).

4.4.2 Study 1

For study 1, a single-subject descriptive approach was adopted. Knowing that some aspects of languages disorders are only detectable in some languages, the study was conducted with a participant with two structurally very different languages: Farsi and Norwegian. The aim of the study was to examine whether the BAT was sufficient in assessing his two languages, and how assessment with comparable tests in both his languages could reveal a deeper and broader understanding of his language disorders.

The participant was assessed once with the Farsi version of the BAT (Paradis & Paribakht, 1987) by a native speaking interpreter and once in Norwegian with the Norwegian version of the BAT (Paradis & Knoph, 2010) by the author. The test scores were then

calculated and compared. A qualitative approach was adopted to discuss the results of the assessment.

4.4.3 Study 2

4.4.3.1 Design and procedure

Study 2 was a treatment study adopting a single-subject pre-test–post-test (ABA) design (Pring, 2005). Verb-retrieval treatments were selected for the purpose of this study, given the verbs' importance for communication, combined with the verb-retrieval impairment experienced by the participant. The study examined the clinical work with a multilingual person with aphasia, addressing issues like cross-linguistic transfer and inhibition of the untreated language, as well as the provision of therapy in a mutual L2 for both the client and the clinician.

The participant was assessed with the Jordanian Arabic version of the BAT (Paradis & El Halees, 1989) by a native speaking interpreter and in English with the English version (Paradis, Libben, & Hummel, 1987) by the author. As described in 4.3.2, an action-naming test was also obtained, using the pictures from the NATR (Morris et al., 2009). However, since the test is based on English verbs, and the pictures were used to produce verbs in Arabic, the results were uncertain and therefore omitted from the paper.

4.4.3.2 Treatment

Although the results of the action-naming test were uncertain for Arabic, the test was used to choose verbs for treatment. To ensure the relevance for AF, a personal selection of 48 verbs from the full list of list of 120 pictures was compiled. These 48 pictures were divided into two equal sets of 24 verbs each. For treatment, one of the sets of verbs was semantically cued, and the other was phonologically cued. Treatment was provided twice a week, each session lasting for 1½ hours, for ten weeks (in total 30 hours of treatment). Treatment was carried out in English (the L2 of both AF and the SLT) and targeted production of verbs in complete sentences.

During the treatment, AF got to see a card with an illustration of the action in question, and the task was to produce an appropriate verb within a simple sentence. The semantic cues consisted of one verb and one noun that were semantically connected to the target word (e.g., if the target word was *drop,* the other verb could be *hold* and the noun could be *glass*). He was asked first to produce the target word, then to look at the illustration and the semantic cues,

and then repeat the target word, for reinforcement. Eventually, he was to produce a simple sentence that included the target verb. The procedure for the phonologically cued verbs was identical, although the cues were different. Here, the first sound or sound combination in case of an initial consonant cluster was presented together with a rhyming word (e.g., cues for the target word *bake* were *b* and *rake*).

Subsequently, when AF managed to produce most of the target words spontaneously and use them in a simple sentence, the task was changed, advancing to a more complex level of communication. *Informative exchanges* were used in exchange-based communicative tasks, henceforth referred to as *communication-based treatment*. The informative exchanges refer to exchanging information that is not known by the interlocutor (Goral & Kempler, 2009; Maul, Conner, Kempler, Radvanski, & Goral, 2014). The communication-based treatment consisted of a range of language-action games, using the same 48 verbs as in the first treatment block (see also 4.4.4.5 for more about this method).

4.4.4 Study 3

4.4.4.1 Design

Study 3 adopted a multiple single-subject across-behaviours design (ABACA design), that has its basis in cognitive neuropsychology (Pring, 2005). Two different treatment methods were provided to three multilingual speakers with aphasia. The study used a repeated measures design, with multiple baselines, pre- and post-therapies and maintenance testing. As in study 2, the focus of the treatments was the production of verbs in sentence contexts.

One characteristic of the selected design is that the performance of the trained and untrained items is probed sparsely, in contrast to other single-subject experimental designs, where the performance of the items are probed frequently, often at every session (Howard et al., 2015; Thompson, 2015). Since it was an aim for the study to have a balance between assessment and treatment, it was decided that such frequent testing would be exhausting for the participants – especially as it would have to be administered in all their languages. Another feature of the selected design is that the effectiveness of the treatment is evaluated by statistical analysis where the pre- to post-treatment performance of the trained and the untrained material is compared (cf. 4.5). With this method, the number of trained items and control sets is relatively large, often with 20–50 items (Howard et al., 2015).

Multiple single-subject studies are concatenations of two or more related case studies, where the intervention is replicated in a small number of participants (Schwartz & Dell, 2010;

Shallice & Buiatti, 2011). In addition to be client compliant, this design has several practical and theoretical benefits to testing models of language processing, with the use of data from a number of patients (Olson & Romani, 2011). Thus, it is well suited for the purposes of the dissertation. Similar designs have previously been used to explore the effects of naming therapy in multilingual aphasia (Croft et al., 2011).

4.4.4.2 Control measures

Experimental control is a challenge in single-subject designs. If improvements after therapy are found, it is important to ensure that the they are due to the therapy and not to other incidental factors, e.g. spontaneous recovery or Hawthorne effects (improvement caused just by receiving attention from a clinician), other events in the life of the speaker with aphasia, or poor experimental control. One solution to meet the demands for control conditions in single-subject designs is to use untrained items as a control for the trained items and compare them post-treatment (e.g. Howard et al., 2015). Hence, one set of verbs was selected for treatment and another set served as related controls. While generalisation to untrained items may be a clinical goal, it can lead to difficulties since generalisation to control sets weakens the internal validity (Thompson, 2015). Therefore, this approach alone is not very promising. However, the inclusion of an additional control task where gains are not expected will ascertain whether the gains are related to the intervention or not. To ensure the internal validity in the study, a control measure that was not targeted in therapy and for which no improvement was expected, was included. Since the treatment targeted verb retrieval, a test of non-word repetition (subtest 8 from the Norwegian version of *Psycholinguistic Assessments of Language Processing in Aphasia* (PALPA)) (Kay, Coltheart, & Lesser, 2009) was chosen. Assessment of related (verbs) and unrelated (non-words) control material were conducted during the intervention period in the treated language, Norwegian.

4.4.4.3 Procedure

Two treatment protocols were provided to the three subjects of the study: *Semantic Feature Analysis* (SFA) and *communication-based treatment*. DT and PN received communication-based treatment before SFA, whereas the order was reversed for MA. For DT and PN the treatment was provided by an SLT with long experience working with individuals with aphasia and for MA the author, who is also an experienced SLT, provided it. This counterbalancing of the order of the treatments was done to be able to rule out order effects of

the different treatment protocols, whereas the change in the SLT providing treatment was done to enhance the internal validity of the study by reducing the possibility of researcher bias (cf. 4.7.2.1 for internal validity).

The treatment was provided during an intensive schedule for all three participants, with approximately 6–12 hours of treatment per week in compliance with the recommendations from The Norwegian Directorate of Health (Helsedirektoratet, 2010) (see papers III and IV for a thorough description of each of the participants' treatment). Table 3 presents an overview of the assessment and treatment details of the participants in study 3.

Table 3. Assessment and treatment details of the participants.

Participants	**Assessment tools**	**Treatment type and order**	**Number of verbs trained in the SFA treatment**	**SLT**	**Treatment duration**
MA	BAT, action-naming test, personal narratives	1) SFA 2) communication-based	44	Author	22–25 hours of each treatment method
PN	BAT, action-naming test, narratives	1) communication-based 2) SFA	24	Colleague	22–25 hours of each treatment method
DT	BAT, action-naming test, narratives	1) communication-based 2) SFA	30	Colleague	22–25 hours of each treatment method

Abbreviations: BAT = Bilingual Aphasia Test; SFA = Semantic Feature Analysis

The study included the following stages presented in a timeline (Figure 7). The baselines were conducted with some days apart. At each baseline all the languages were assessed at the same day. At each pre- and post-testing point all the languages of the participants were assessed with some days apart.

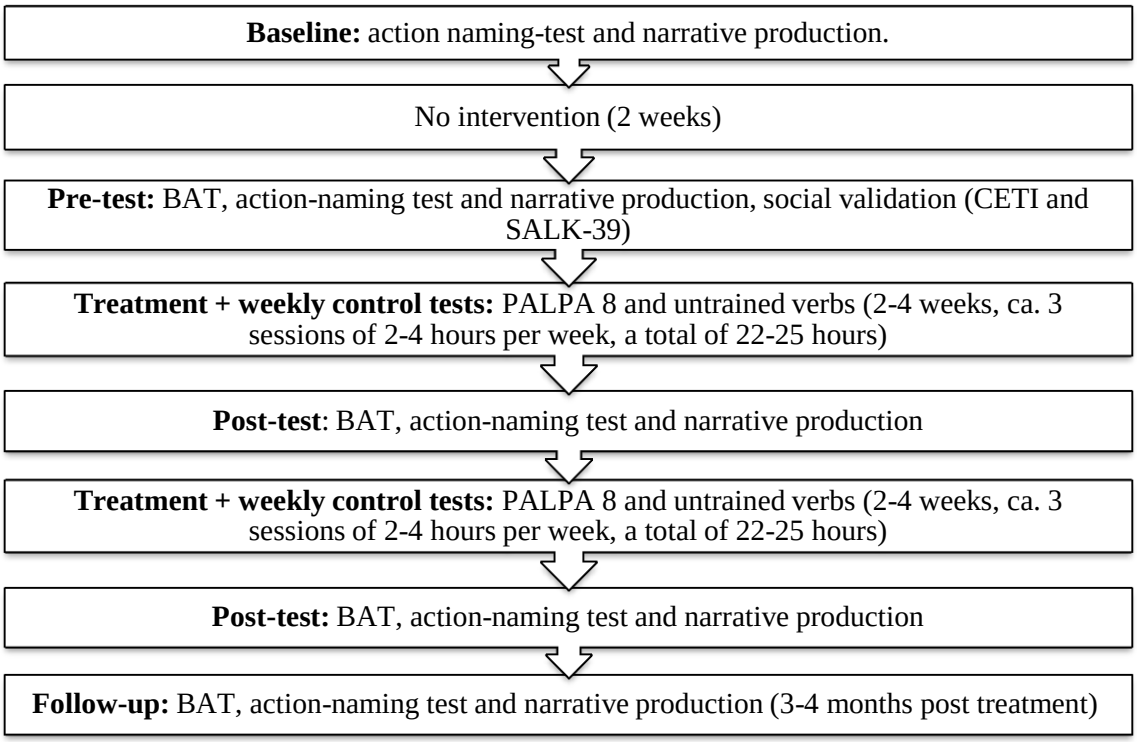

Figure 7. Timeline of the assessments and treatment.

4.4.4.4 Semantic Feature Analysis

Semantic Feature Analysis (SFA) (e.g. Boyle, 2004; Boyle & Coelho, 1995) is a treatment approach that aims at enhancing lexical retrieval by improving access to the semantic network through semantic feature generation. The method was initially designed to improve noun retrieval in monolingual speakers with aphasia, but was later adapted to verb retrieval (Wambaugh & Ferguson, 2007). The SFA procedure for this study was adopted from Wambaugh and colleagues (2007; 2014), with some modifications. The objective of SFA is that the person with aphasia is guided to produce words that are semantically related to the target word through common semantic features (Boyle, 2004). Words denoting the features of a target word are assumed to activate the semantic network of the word and to aid its retrieval (cf. 3.1.3 on spreading activation theory). This way semantically related words might benefit because they share features that are being accessed.

Since argument structure is found to be important to verb retrieval (Thompson, Lange, Schneider, & Shapiro, 1997) the features adopted were related to argument structure and semantic roles. Considering previous studies' findings of SFA as a promising method for word retrieval, with generalisation to discourse, it was sensible to adhere closely to the original SFA features (e.g. Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000). The

original SFA features of *location* and *association* were retained because they appeared useful for eliciting lexical-semantic information. The features added to address semantic roles included the *agent/experiencer* of the action, the *theme/patient*, the *purpose* of the action and the *instrument*. The semantic features were elicited by asking the following questions: 'Where does this action happen?' (location), 'Who usually does this?' (agent), 'What is it done to?' (theme), 'Why does this happen?' (purpose), 'What part of the body or what tool is used to make this happen?' (instrument), and 'What does it make you think of?' (associations).

For participants MA and PN the SFA treatment was carried out in the same way, in the following fashion: An illustration of the target action was placed in the centre of a diagram (Appendix 6), and the participants were requested to produce a relevant verb referring to the illustration. Whether they managed to do this or not, they were guided through each of the six semantic features by the SLT, by asking each of the questions above, to elicit information about each of the six semantic features. The features were addressed one at a time, and the participants' responses were listed on the diagram. In the cases where they did not access an appropriate feature, the SLT would suggest a response or prompt a possible feature. The prompts could be either semantic or phonological. Finally, the participants were asked to name the target action in the illustration and then to produce a simple sentence including the target word. If the participants did not succeed in producing the target verb or a correct sentence, the SLT would provide the verb and suggest a simple sentence, which was repeated by the participants. Positive feedback was then provided, and the next picture was presented.

Initially, this method was applied also for DT, who had fluent aphasia of the Wernicke type. However, due to her comprehension challenges, she did not fully grasp the rationale behind this method of treatment. She did not succeed in generating the required semantic features, and her approach was rather to describe the different illustrations in a relatively detailed manner. Furthermore, she often produced nouns to describe the pictures, instead of verbs. In collaboration with the SLT administering the treatment, the procedure was thus modified. Any three relevant associations produced by DT were accepted, instead of the six predetermined semantic features. Often she did not succeed with producing a sentence, and the SLT would suggest a simple sentence for her to repeat. However, she did not always manage to repeat these sentences.

The words chosen for treatment differed between the subjects. Based on their individual performances on the baseline tests in Norwegian a set of verbs were selected for treatment. Verbs that were produced correctly at the baselines were not included in the

treatment set (cf. 6.9 for a discussion of this choice). MA produced 41 of the 119 assessed verbs at all three baselines. 78 of the verbs she either did not produce at all, or once or twice throughout the baselines. These were divided into two groups, where 44 were used for training, and 34 were used as untrained controls. PN was assessed with a modified version of the NATR, comprising 50 verbs, and she named 26 verbs spontaneously, twice or three times in the baselines. The remaining 24 verbs were selected for training. An additional set of 22 filler verbs were included in the treatment to yield a larger practice set of 46 verbs, but only the 24 targeted items were tested before and after treatment. Additionally, 20 verbs were selected as untrained controls. DT also completed the modified version of the NATR, consisting of 50 verbs. No verbs were produced at all three baselines, and only eight verbs were named twice. For her, a smaller set of 30 verbs were selected for treatment, while 20 verbs were chosen to serve as untrained controls.

After approximately 10–12 hours of treatment, the stimuli pictures were changed from the black and white drawings from the NATR to coloured pictures from the internet for the trained words not to be connected to the concrete pictures only, but rather to be associated with a wider understanding of the words. Where it was possible, it was attempted to replace the images, so that they demonstrated the same action in a different context (e.g. from a boy blowing bubbles, to a man blowing out the candles on a birthday cake).

4.4.4.5 Communication-based treatment

In contrast to the SFA, where a number of verbs were selected and trained, the communication-based treatment involved no pre-selected and rehearsed verbs. The main task was to produce connected speech to describe different pictures so that the interlocutor could identify them. The method has certain similarities to the methodology underlying *Promoting Aphasics' Communication Effectiveness* (PACE) (Davis & Wilcox, 1985). As in PACE, the clinician and the participant participate equally as sender and receiver of the target stimuli. Furthermore, the dynamic exchange of new information between the clinician and participant is emphasised in both methods. Both also include the principle of providing natural feedback. However, one of the principles of PACE, that of free modality choice was not followed in this project. The participants were rather encouraged to speak (orally). In this respect, the method used in the present project, has similarities also to intensive language-action therapy (ILAT) (also referred to as constraint-induced language therapy (CILT) or constraint-induced aphasia therapy (CIAT)) (e.g. Berthier et al., 2009; Pulvermüller & Berthier, 2008). Communication-

based treatment also employs three other principles of ILAT, namely massed practice of treatment with high intensity, action-embedded language use relevant for daily life, and the focusing and tailoring of treatment to the individual speaker's communicative abilities and needs (Difranscesco, Pulvermüller, & Mohr, 2012). Different versions of ILAT and PACE have shown to be successful in improving language in monolingual speakers with chronic aphasia (e.g. Davis, 2005; Goral & Kempler, 2009; Kirmess & Lind, 2011; Kirmess & Maher, 2010)

By playing different language-action games, the participants were encouraged to produce simple, but complete sentences containing verbs in a 'normal' language setting, using informative changes. Similarly to ILAT, the treatment included duplicate picture materials, and the SLT and the multilingual speaker with aphasia had a cardholder each, so they were not able to look at each other's picture cards. They further took turns in describing and guessing the picture. If necessary, the participants were reminded of the sentence structure being used during treatment by the SLT who modelled correct sentence structure(s). Sentences that were produced incorrectly (e.g. when the verb was omitted), were corrected by the SLT. An important aspect of this method, according to Kempler and Goral (2011), is that there are no wrong answers; thus, any verb that exchanges relevant information in a sentence is accepted. This way the communication gets closer to a natural conversation, and it thus enhances the ecological validity of the treatment.

The language-action games included nonverbal actions, like handing over, or showing a card, as well as verbal communicative actions, like requesting a card or answering the SLT's question about a card. All the verbal actions included the production of the target word using complete sentences, and thus have similarities to the games used in study 2. Most of the exercises (*Go Fish*, *Memory*, *Master Mind (picture sequence)* and *Picture description*) used in this method have one feature in common: by describing the picture cards, the person describing the picture promote information not known to the interlocutor. By contrast, in *Story construction* the participant and the SLT collaborated in taking turns producing simple sentences to form a short story based on a single picture (cf. Kempler & Goral, 2011 for more information on the games.). Some of the pictures applied were relatively different (e.g. a crying baby, a man fishing, etc.), hence more easily separated from each other. Others were

more similar (e.g., a boy carrying cups of coffee and tea on a tray, a boy carrying empty cups on a tray, etc.), so the pictures had to be described very accurately[19].

4.5 Methods for data analysis

4.5.1 Analysis of the formal tests

The BAT scores were analysed in different ways, depending on the methods used in the different studies. In study 1, the scores were displayed in percentages and analysed qualitatively in a comparable fashion. The BAT-results from studies 2 and 3 were presented both subtest-by-subtest and also in linguistic clusters (based on Paradis and Libben (1987, p. 213) (cf. papers II, III and IV). For scores given in percentages, a change of 10 percent or more was considered clinically significant (in line with e.g. Altman et al., 2012; Holland & Crinion, 2012; Kempler & Goral, 2011; Peach & Reuter, 2010).

The *McNemar test* (Field, Miles, & Field, 2012) was used for statistical analysis of studies 2 and 3; both for BAT results and for the action-naming test. Like Fisher's exact test, this is a non-parametric statistical test for small sample sizes, but while Fisher's exact test assumes that the observations are independent, McNemar test is used on paired data, such as before-and-after observations of the same participants (McDonald, 2014). It is commonly used to verify significant changes in participants' scores on, for instance, language tests.

Aphasia rehabilitation studies have often used the McNemar test to compute statistical significance of treatment-induced changes (e.g. Boyle, 2004; Croft et al., 2011; Faroqi-Shah, 2008; Goral et al., 2012). In both study 2 and study 3, the tests were performed in the free software environment R (R Development Core Team, 2014) using RStudio (2014).

4.5.2 Effect size

While the level of significance may suggest whether there is a change between pre- and post-test results (primary analyses), the effect size is a measure of the magnitude of the difference between the pre- and post-test results. Thus, effect size may indicate more accurately how efficacious a therapy is, not just whether it is effective (Wisenburn & Mahoney, 2009). Furthermore, effect sizes present ways to compare treatment outcomes within and between

[19] The pictures used for these games were from the *ColorCards-series* (Speechmark, undated), *Sir James* (SCHUBI, undated), *Adamson-cartoons* (Jacobsen, 1975), *Pictures of verb tenses* (Photographic Teaching Materials, 1980).

individuals, and they may be employed to examine and compare the relative strength of different treatment protocols (secondary analyses) (Beeson, 2015; Robey et al., 1999). Reporting of effect sizes is common for group studies. Beeson and Robey (2006) advocate for doing this also in single-subject designs in aphasia rehabilitation. When effect sizes are included, it becomes possible for other researchers and clinicians to interpret the relative strength of the different treatment methods. This also facilitates meta-analyses (Beeson, 2015; Borenstein, Hedges, Higgins, & Rothstein, 2009).

Many measures of effect size have been proposed, and one of the most common ones is Cohen's *d* (Field et al., 2012). A variation of Cohen's *d* that is based on within-case variation (Shadish, 2014) is the Busk and Serlin's d_1 (1992). The formula for d_1 is:

$$d_1 = \frac{mean_{post} - mean_{pre}}{SD_{pre}}$$

Beeson and Robey (2006) argue that the d_1 is the most reliable estimator for quantifying changes in the performance level, and it has been used to calculate pre-post treatment effects in single-subject studies. However, to be able to calculate the effect size, at least two measurement points pre-treatment is a prerequisite to be able to calculate the standard deviation. Since a multiple baseline was not feasible in study 2 (cf. 4.4.3), another method to calculate changes in test scores was employed. In this study, change effect scores were calculated by subtracting the pre-treatment score from the post-treatment score. This provided a treatment effect score for the treated language, and a generalisation effect score for the untreated language (Dickey & Yoo, 2010; Miller Amberber, 2011).

In study 3 (cf. 4.4.4), d_1 was calculated for the narrative measures and the action-naming tests (where multiple baselines were obtained). Beeson and Robey (2006, p. 166) state that mathematically, only one observation in the post-treatment period is necessary to calculate d_1, and since multiple post-tests were not collected, this line was followed (see a discussion in 6.9). Estimation of the magnitude of the effect size is a challenge. For between-group designs Cohen (1988) sets 0.8 as a large effect size, 0.5 as moderate and 0.2 as a small effect size. This is not applicable to single-subject designs. Beeson and Robey (2006, p. 167) present different magnitude scales from different studies, pointing out that the interpretation of the magnitude of the effect size would emerge empirically from the aphasia treatment outcome literature. Some researchers report effect sizes larger than 2.0 (e.g. Altman et al.,

2012), referring to the article by Beeson and Robey (2006), while others report effect sizes larger than 1.0 referring to the same article (e.g. Goral & Kempler, 2009; Goral et al., 2013).

One of the research questions of this project considers inhibition of the untreated language(s). Since inhibition of untreated languages is highly unwanted, it seemed purposeful to set the cut off low, to be able to detect the slightest sign of inhibition. Thus, effect sizes larger than 1.0 were considered meaningful in the present project.

4.5.3 Analysis of the narratives

The personal narratives were audio- videotaped, and then transcribed orthographically by native speakers or highly skilled speakers with a university degree in the relevant language. Subsequently, all the transcripts were checked and put into an excel-file for further analysis. The analysis was carried out on various word-, sentence-, and discourse level variables. Lexical measures included the amount of verbs and nouns (types and tokens). The basic analytical sentence level unit was the *Analysis of Speech Units* (AS-units) (Foster, Tonkyn, & Wigglesworth, 2000). AS-units are defined as 'a single speaker's utterance consisting of an independent clause, or sub-clausal unit, together with any subordinate clause(s)' (Foster et al., 2000, p. 365). Each AS-unit was scored for completeness and complexity on a 5-point scale, as well as for grammaticality. The rating points for the completeness and complexity of the units were *1)* Incomplete, *2)* Simple and complete, *3)* Incomplete subordinate or coordinate clause, *4)* Complex coordinate, and *5)* Complex coordinate (cf. Altman et al., 2012). For analysis of the quality of the discourse, the total number of words produced (including false starts and repetitions) and the number of utterances were counted. A calculation of the speech tempo (words per minute) was also carried out. Furthermore, to analyse the possible improvement of the narratives in terms of content, the number of CIUs (correct information units), a measure of content production in discourse which comprises words that are 'accurate, relevant and informative relative to the eliciting stimuli' (Nicholas & Brookshire, 1993, p. 340) was counted. In addition, a calculation of the percentage of words that were CIUs was also carried out.

4.6 Reliability

The BAT subtests were scored jointly by the interpreters and the author, in line with the standards given in Paradis and Libben (1987). To ensure the reliability of the assessments in

the different languages, the interpreters were briefed about communicating with people with aphasia, how to conduct an assessment and informed about the BAT by the author, who was present during most of the assessments (cf. 4.3.5). As described previously (cf. 4.4.4.3) the treatment was provided by two different SLTs in study 3. To ensure the reliability of the treatments (cf. treatment adherence on the ROBiNT scale, section 4.7.2), the colleague SLT was provided with guidelines, and the two SLTs were in close contact during the treatment phases. In addition, all the treatment sessions were videotaped.

The transcribers were provided with a set of rules for what to consider (Appendix 7). Authors MK and ML (of papers III and IV) checked all the transcriptions, apart from the Japanese and Portuguese ones. Authors MK and ML segmented a minimum of 20 percent of the transcripts together into AS-units to ensure that this was done in the same way for all the transcripts, and the rest was divided between them. Two speakers of each of the languages transcribed the Japanese and the Portuguese narratives to ensure the reliability of the transcriptions. Transcription disagreements were discussed and resolved before scoring.

Inter-rater reliability is especially imperative in research studies where ratings or behaviours are scored, and high agreement between raters makes it more certain that the scores reflect what the test was designed to measure (Mildner, 2013). A coefficient of 0.8 or more is considered reliable (Kratochwill et al., 2013; Pring, 2005). For the inter-rater reliability of the transcripts of the narratives, authors MK and ML divided the Norwegian, English and German transcripts of study 3 between them and scored them. Some months after the initial scoring, between 25–35 percent of the transcriptions were rescored by the authors. The agreement exceeded the 0.8 criterion for all the measures.

4.7 Validity

Different types of validity influence one another. A study can have a high level of experimental control and thus have good internal validity. However, the high level of control may lead to a weaker ecological validity, in that the study becomes unnatural (Mildner, 2013). The ambition was to design a study that was client compliant, had high ecological and social validity, and still met requirements of measurement- and experimental validity.

4.7.1 Measurement validity

There is little research regarding the validity of the BAT (Ivanova & Hallowell, 2009), and the lack of published comparisons of the different language versions of the test is a weakness (Muñoz & Marquardt, 2008). Muñoz and Marquardt (2008) reported unequal levels of difficulty between the English and Spanish versions in neurologically healthy speakers. On the other hand, Juncos-Rabadán (1994) found that the BAT is a suitable instrument for evaluating linguistic capacities and comparing the performance in the two languages of neurologically healthy elderly Galician–Spanish bilinguals. In a master's thesis which investigated how 12 neurologically healthy Farsi-Norwegian bilingual speakers performed on selected subtests of the BAT, Mosgren (2011) found that on some of the subtests, some of the bilingual participants performed below average. Apart from this study, there are no published studies of the validity of the BAT in Norwegian compared to the other language versions used in this project. Despite the weak basis for estimating the validity of the BAT, it is the only comprehensive assessment tool which allows comparison between the languages relevant for this project. Additionally, an important feature of the test is that any single version of the test can be used on its own to assess language functioning in a single language; it is therefore well suited for measuring pre-post treatment changes.

The action-naming test used in study 3 is not a standardised assessment tool. It was beyond the scope of this project to validate the measurement tools used, but to increase the validity of the action-naming test; native speakers of each of the relevant languages examined the illustrations and found them to be well suited for the respective languages. Furthermore, the Norwegian and the English version have been examined for naming agreement (cf. 4.3.2). (Cf. 6.9 for an analysis of psycholinguistic variables.)

4.7.2 Experimental validity

Whereas measurement validity refers to aspects of the assessment tools used in a study, the experimental validity considers the procedures and the interpretations (Mildner, 2013). Tate et al. (2013) have developed guidelines for rating the methodological quality of single-case experimental designs for intervention (The Risk of Bias in N-Of-1 Trials (ROBiNT), Figure 8). The rating system will not be applied in the dissertation; however, the items included in the scale are relevant for the present project, and will be discussed in relation to the findings, in section 6.9.

Internal validity subscale	
1.	Design
2.	Randomisation
3.	Sampling behaviour (all phases)
4.	Blinding patient/therapist
5.	Blinding assessors
6.	Inter-rater reliability
7.	Treatment adherence
External validity and interpretation subscale	
8.	Baseline characteristics
9.	Therapeutic setting
10.	Dependent variable (target behaviour)
11.	Independent variable (intervention)
12.	Raw data record
13.	Data analysis
14.	Replication
15.	Generalisation

Figure 8. Items in RoBiNT Scale (Tate et al., 2013).

4.7.2.1 Internal validity

There are several possible threats to the internal validity; the most important ones for this project will be presented below. It is worth noting that the threats outlined below can interact with each other.

A threat that is especially relevant for the repeated measures design (study 3) is *history*. It refers to events that occur to the participant(s) and are not accounted for between the measurement points (Mildner, 2013; Schiavetti et al., 2011). The participants in the study did not receive any other speech and language therapy while participating in the study. In addition, the independent variable was changed, in that the three participants received two different treatment protocols. The motivation for doing this, was to substantiate that the changes in the dependent variable (assessment) were linked to the independent variable, rather to possible extraneous events (Richards, Taylor, & Ramasamy, 2014).

Another threat that is linked to history is *maturation*. For individuals with aphasia, spontaneous recovery may be a threat to internal validity. Study 1 differs from the other two in this aspect. As it contained only one measurement point, maturation was not an issue. For studies 2 and 3, some measures were taken to minimise this threat. In the chronic phase of aphasia, spontaneous recovery is not to be expected. Therefore, this project only included participants that were more than six months post-onset, which is well beyond the acute phase. A further precaution in study 3 was that the studies were conducted in an intensive manner. This attempt to limit the length of the studies also decreases the threat to the internal validity (Richards et al., 2014). Another precaution was the collection of multiple baselines prior to

the treatment. All participants showed a stable baseline, with less than 15 percent fluctuation on the Norwegian action-naming test. The stable baseline also minimised the threat of a *test-practice effect*. Repeated exposure to a test may affect how the participants react to the test in the subsequent measuring; hence this is of relevance for study 3 (Schiavetti et al., 2011).

Instrumentation is another relevant threat to the internal validity of all three studies since interpreters were used to conducting assessments in all the languages, except Norwegian and English. Ideally, one would use multilingual SLTs to administer the testing, but this is often not possible. However, Roger and Code (2011) found that the validity of a test can be maintained if professional interpreters use language tests that are designed or adapted for the language in question, and that the interpreters have been briefed about the assessment tool. Both these prerequisites were taken in all three studies. Moreover, the interpreter and the author in collaboration scored the tests. This cooperation with the interpreters was very valuable, and as a supplement, they were able to assist by pointing out dialectal differences. Furthermore, the BAT provides clear instructions on how to conduct an assessment. It includes specific directives to the test manager concerning the manner of presentation of stimuli and scoring (Paradis & Libben, 1987).

As already pointed out, to reduce the *researcher bias* threat to study 3, a colleague SLT with long experience in working with people with aphasia administered the treatments for participants PN and DT (Tate et al., 2013).

4.7.2.2 External validity

Findings from single-subject studies provide the opportunity to shed empirical light on some theoretical principles or concepts by 'corroborating, modifying, rejecting, or otherwise advancing theoretical concepts (…)' (Yin, 2014, p. 41). Thus, generalisable findings – or analytic generalisations – that go beyond the setting for this specific project are possible to achieve. A way to strengthen the external validity of single-subject studies, so that the results are transferable to other individuals, contexts and settings, is to replicate the study (Mildner, 2013; Richards et al., 2014). Three subjects were included in study 3; hence, the procedures were replicated. Due to the design and number of participants, generalisations to the larger population of multilingual speakers with aphasia should be made with caution. However, the thorough description of the participants, the procedures of assessment and treatment, permits for replication of the study. For study 3, where the participants were provided with two different treatment protocols, *multiple treatment interference* is a threat to the external validity

(Gast, 2014; Richards et al., 2014). The treatments may interfere with each other, and this carryover effect can make it difficult to decide which components of the independent variable (treatment) that leads to a change in the dependent variable (assessment), hence to determine which treatment had the highest efficacy. One way to decrease this threat is to carry on collecting data on the dependent variable continuously throughout the study. In study 3, related material was collected before, weekly and after each treatment protocol, to be able to suggest which of the independent variables had best efficacy for the participants (cf. 6.9).

4.7.3 Ecological and social validity

To increase the ecological validity and to minimise the gap between the treatment provided, and a more natural language environment, production of complete sentences was targeted in studies 2 and 3. Moreover, the communication-based treatment provided was based on the exchange of new information between the participants and the SLTs, to increase the similarity to a natural language environment. Furthermore, production of narratives was selected for assessment.

Social validity measures are not always included in treatment studies, but since clinical significance (i.e. the meaningfulness and practical value for the participants (Rubin, 2013)) was considered particularly important when designing the study, this was included (cf. 4.3.4).

4.8 Ethical perspectives

Potential participants and their significant others were briefed about the background and purpose of the study by their SLTs so that they could decide if they wanted to participate or not (Appendix 8). They were informed that even if they accepted to participate they could choose to withdraw at any time, without giving any reason for this. Only after they accepted to participate in the project, the author got to meet them. They were again informed about the research project both orally and in writing, before they signed an informed consent form (Appendix 4). The Norwegian Social Science Data Service (NSD) approved that the project ensure appropriate ethical standards (project number 29942) (Appendices 9, 10 and 11).

The aspect of informed consent may be a challenge when it comes to research on speakers with aphasia. They are a vulnerable group due to their language impairments and many of the speakers with aphasia have severe problems with auditory comprehension and reading comprehension. This is especially the case for speakers with fluent aphasia. To meet

this challenge, both the information and the consent form provided to the participants were written in an aphasia-friendly format. Thus, the information was written in a simpler language than usual, with shorter sentences and pictures to support the reader and to increase their understanding (Rose, Worrall, Hickson, & Hoffmann, 2011) (Appendix 12). The project plan was also explained to them orally. Additionally, a person independent of designing the research project was present when the project was explained to the participants, and both the independent person and the participants signed the consent form. In addition, the speakers with aphasia's next of kin were informed and could therefore advise the person whether to participate or not.

All the participants in the project have been anonymised. However, the question of anonymity may be difficult when doing research on multilingual speakers with aphasia, and in a country with as small a population as Norway's. Many of the multilingual speakers have rare language combinations and can be easily recognisable. However, the participants have given their permission for the procedure and the findings of the study to be published, both in the dissertation, and in scientific papers, as well as to be used in presentations to students and colleagues.

Many multilingual speakers with aphasia do not get the language therapy they are entitled to. Often this is due to the SLT's insecurity, not knowing how best to provide a proper treatment, or in which language. A survey of clinicians who worked with adults in the United States revealed that a majority felt that their academic and clinical training left them inadequately prepared for assessment and treatment of bilingual speakers with aphasia (Centeno, 2009). The present study hence had immediate gain for the participants in that they received intensive language treatment.

5 Summary of the papers

In this chapter, papers I–IV will be briefly summarised, and the main findings will be presented. Some methodological challenges will be pointed out in the present chapter, and possible solutions are discussed. Details on the methods are found in Chapter 4, and the findings of the studies are discussed in Chapter 6.

5.1 Paper I

Language assessment of a Farsi–Norwegian bilingual speaker with aphasia

The aim of this study was to explore the applicability of the *Bilingual Aphasia Test* (BAT) as an assessment tool for multilingual speakers with aphasia. Additionally, it examined whether assessment of two of the languages of a trilingual[20] (Farsi-English-Norwegian) speaker with nonfluent aphasia would reveal differences in the linguistic competence between the languages, with a special focus on morphology and lexical access. According to the participant himself, and his family, Farsi was his most proficient language post-stroke.

The analyses consisted of summarising the quantitative measures of the BAT scores of each of the tested languages. A further qualitative analysis of relevant linguistic domains was carried out.

In contradiction to the participants' own, and his family's understanding of his language impairments, the overall test scores from the two language versions of the BAT showed slightly higher scores in Norwegian, than in Farsi. The results of the morphological subtests and the subtests assessing lexical access showed an opposite pattern, that is, higher scores in Farsi. The findings of the study were discussed in relation to structural differences between Farsi and Norwegian. Differences between the linguistic components morphology and lexical access on one side, and for instance syntax on the other, and their importance for communication, were discussed. Furthermore, the question of differential impairment was addressed, in addition to the consequences of using interpreters in the assessment of bilingual speakers with aphasia.

The study underlined the importance of a thorough assessment of both languages of bilingual speakers with aphasia, as it found different test results in the two languages in question. The need for additional research regarding the linguistic equivalence of the different

[20] Only Farsi and Norwegian were tested.

versions of the BAT, together with a need for validating the test in the different languages was emphasised.

Comments

This single-subject study was set out to be a descriptive one, and not a treatment study. However, it would have profited by a more valid statistical analysis. The results were presented in percentages only, hence it may be challenging to evaluate the actual differences between the two languages and to decide whether they are significant, or not.

5.2 Paper II

Language intervention in Arabic–English bilingual aphasia: A case study

The study aimed to determine whether treatment provided in the L3 of a trilingual Arabic-German-English speaker with moderate to severe nonfluent aphasia could lead to improvement in the treated and untreated language[21]. In addition, it explored possible inhibition of the untreated language. Furthermore, the study aimed to investigate whether treatment in the mutual, non-native language of both the client and the SLT in an ordinary clinical setting could provide an effective treatment. According to the participant's self-report and that from his wife, Arabic was his best-preserved language post-stroke.

Language measurements were conducted pre- and post-treatment in Arabic and in English. Treatment was provided in English, the L2 of both the participant and the author, targeting verb production in sentence contexts. The language assessments were analysed quantitatively and the significance of the results were tested with the McNemar test and by a change effect score. This provided a treatment effect score for the treated language, and a generalisation effect score for the untreated language.

The participant showed treatment-related gains to some extent for the skills addressed in the treated language (L2), although the changes were significant only for the overall results of the BAT. Regarding cross-linguistic transfer, significant treatment-related transfer to Arabic, the untreated language, was found in some areas. The improvement found in the scores of the semantic domain is worth noting, and this was interpreted as a direct treatment related generalisation. He also showed some improvement in syntax, which again was

[21] German was not of relevance to the participant, thus assessments of this language were not obtained.

explained to be treatment related. No improvement in phonology, in either of the languages was found. The results indicated no inhibition of the untreated language. A finding of clinical relevance was that the participant became more verbal at home, speaking Arabic. His wife reported that to her impression, he regained access also to Arabic words in his daily speech.

The results support the theory of a shared conceptual system for the two languages of bilingual speakers, as depicted in the RHM (Kroll & Stewart, 1994). Moreover, the results showed greatest improvement in the semantic domain, thus providing additional support for this view. The study concluded with no inhibition of the untreated language. The paper further concluded that the provision of therapy in a mutual, non-native language of both the client and the SLT could constitute an effective intervention.

Comments

Additional testing (e.g. multiple baseline, control measures and follow-up measures) would have been beneficial from a research perspective. In addition, social validation could have provided systematic information about the participant's functional communication. However, the study was conducted in a clinical setting and this additional testing was considered too exhausting for the participant.

5.3 Paper III

Semantic Feature Analysis targeting verbs in a quadrilingual speaker with aphasia

The aim of this study is to explore the impact of Semantic Feature Analysis (SFA) on trained and untrained verbs, on semantics, syntax and narrative production in the treated and untreated languages of a quadrilingual speaker (Japanese, English, German, and Norwegian) with nonfluent aphasia.

Multiple baselines of all four languages were conducted three times for each language prior to the treatment. Furthermore, language measures were obtained pre- and post-treatment. SFA treatment was provided with a focus on the production of verbs in sentence contexts, and was conducted in Norwegian. The McNemar test was applied to test the significance of results of the pre- to post-treatment changes of the action-naming test and the BAT. Furthermore, effect size calculated with Busk & Serlin's (1992) d_1 were carried out for the narrative measures and the action-naming test.

The participant responded positively to the SFA treatment in general. A significant improvement of the trained verbs was found, but no transfer to untrained verbs in the treated language (Norwegian). In addition, the participant improved in the semantic domain, as well as in narrative production. Regarding generalisation to untreated languages, transfer to verbs in German was found, as well as significant increases in semantics and in syntax in both English and German. Furthermore, the participant showed an improvement in discourse in English and German, but no improvement of Japanese discourse. Inhibition of the untreated languages was not found in the study.

The paper concluded that SFA treatment in a late-acquired language can lead to within- and cross-linguistic transfer to both stronger and weaker languages, with variable patterns for the different languages. The lack of improvement of Japanese was interpreted to be an effect of high pre-treatment performance in this language, in addition to structural dissimilarity of Japanese, compared to Norwegian. Hence, SFA may be a promising method for treating multilingual speakers with aphasia. Moreover, the use of narratives as an assessment tool was recommended. It may contribute to the ecological validity of the findings, in addition to providing information not obtainable from the other assessment.

Comments

A concern in this study is that only one assessment was obtained post-SFA. The inclusion of repeated measures, would have given a better estimate of effect size. Additionally, the paper could have provided information about the long-lasting impact of the treatment by the inclusion of a follow-up measure. Social validation measures were not reported on in this paper due to length constraints of the journal (however, see 6.1.2).

5.4 Paper IV

Verb production treatment in sentence contexts in fluent and nonfluent multilingual aphasia

The aim of the study was to explore the effect of treatment targeting verb production in sentence contexts, and a combination of communication-based treatment and Semantic Feature Analysis (SFA) were chosen for treatment. Issues like cross-linguistic transfer and inhibition of the untreated languages, narrative assessment, and differences between aphasia types were investigated in the paper. Two speakers with multilingual aphasia participated in

the study. *PN* was a trilingual speaker (Portuguese, Ronga and Norwegian) with a moderate nonfluent type of aphasia. *DT* was a bilingual speaker (English and Norwegian) with moderate to severe fluent aphasia.

Multiple baselines were conducted in all languages prior to the treatment. Pre-, post- and follow-up-tests were conducted in all languages of both speakers [22]. SFA and communication-based treatment were provided during an intensive schedule, in Norwegian, with a focus of production of verbs in sentence contexts. The McNemar test was applied to test the significance of results of the pre- to post-treatment changes of the action-naming test and the BAT. Effect size calculated with Busk & Serlin's (1992) d_1 were carried out for the narrative measures and the action-naming test.

Both participants responded well to the treatment, and gains in the treated language were found for both participants. Significant increases of the scores in semantics, lexical access and in the total scores of the BAT were also found for both participants. PN showed great improvements in the narratives in Norwegian, both at the lexical level and at discourse level. For DT, some improvements were found in the Norwegian narratives.

Regarding cross-linguistic transfer, significant improvements were found for both participants at the lexical level, measured by the action-naming test and the narratives. The BAT however showed no increase in the untreated languages, apart from higher total scores of the BAT for DT. Both participants improved at several of the discourse measures in the untreated languages.

The results suggest that verb-retrieval treatment provided in sentence contexts in a late-learned weaker language may be beneficial for multilingual speakers with fluent and nonfluent aphasia. Inhibition of the untreated languages was not evident in this study, which is an important finding for clinicians, as well as for researchers. Finally, the administration of narrative productions revealed information about the treated language, as well as the speakers' untreated language that were not detected by the formal testing. Therefore, the inclusion of discourse tasks in the clinical work, as well as in research of speakers with aphasia was strongly recommended.

Comments

As in the previous papers, the inclusion of one additional post-treatment measure would have added value to this paper. It would have given a better estimate of effect size, in addition to

[22] Ronga was not assessed, due to the lack of assessment tools in this language.

allowing for a comparison of the effect size of the two treatment methods (cf. 6.9 for a discussion).

6 General discussion and conclusions

In this chapter, the main findings from the project will be summarised and discussed in relation to the research questions, the theoretical framework and the method presented in the previous chapters. The project had a relatively broad scope, with both clinical and theoretical purposes. It set out to cover aspects of assessment (cf. 6.1), the effect of verb-production treatment for speakers with multilingual aphasia (cf. 6.2), the applicability of verb-production treatment across aphasia types (cf. 6.5) and the impact of aphasia severity on treatment (cf. 6.6). Furthermore, the project addressed the use of a lingua franca in treatment (cf. 6.7). Issues of cross-linguistic transfer and inhibition of untreated languages were investigated specifically (cf. 6.3 and 6.4). A final aim was to investigate how the findings of this project could enlighten different models of multilingual language processing (cf. 6.8). Towards the end of this chapter, methodological considerations and limitations will be discussed (cf. 6.9), avenues for future research outlined (cf. 6.10), and clinical implications addressed (cf. 6.11). For an overview of the studies and their applicability to the papers, the reader is referred to Table 1 in Chapter 4.

6.1 Assessment of multilingual speakers

6.1.1 Formal assessment tools

The core goal of language assessment in multilingual aphasia is to discover the preserved and impaired communication abilities, in either language (Ansaldo et al., 2008). It is considered insufficient and unethical to assess only one of the languages of a multilingual speaker with aphasia, partly because specific symptoms of language impairment may be ascertainable in only one of the person's languages (Nilipour & Paradis, 1995; Paradis, 2008) (cf. 2.5). The *Bilingual Aphasia Test* (BAT) was developed for use with multilingual speakers with aphasia and the test permits a systematic and complete evaluation that quantifies the impairment for each of the languages of a multilingual individual (Paradis & Libben, 1987). Hence, it was chosen as one of the formal measures in this project. In all papers of this dissertation, the BAT was considered a useful tool for measuring pre- to post-treatment changes.

The importance of extending the assessment beyond the language of the environment was underlined by the results of study 1 (reported in paper I). It was evident from the study that testing with the BAT revealed differences between Farsi and Norwegian for the participant, differences that would not have been detected if he had been tested in only one of

the languages. RF scored higher in morphology and lexical access in Farsi than in Norwegian. These scores differed from the scores in other linguistic domains on the two language versions of the BAT, where he scored higher in Norwegian. Such differences between different language modalities and different linguistic levels are common in multilingual speakers (Grosjean, 2013; Roberts, 2008). According to the self-report, Farsi was his pre- and post- most-proficient language, whereas the BAT showed higher total scores for Norwegian, as well as on several of the subtests. It is possible that good skills in domains like morphology and lexical access are more important for communication than, for instance, good syntactic performance. The accuracy of self-ratings of language proficiency has been found to be robust, and to correlate with objectively measured proficiency (Gollan, Weissberger, Runnqvist, Montoya, & Cera, 2012). However, the self-ratings for speakers with aphasia may be uncertain, due to their language deficits. It is further possible that the self-rating of RF, who was only one month post-onset, was affected by his premorbid stronger proficiency in Farsi. Nevertheless, RF's impression of his language proficiency is important to take into account, and the rating is a good supplement to the formal language testing.

Several of the subtests in the BAT comprise relatively few items ($n \leq 5$), and therefore achieving statistical significance when measuring changes may be challenging. However, Paradis and Libben (1987, p. 213) allocate each of the BAT subtests to one or several linguistic levels. When the subtests were chunked together, statistical changes were detectable for some of the participants in the project. Study 2 (reported in paper II) showed that participant AF did not achieve statistical improvements on the separate subtests, but when clustered together, significant improvements were found in the semantic domain of the untreated Arabic. Comparable findings were evident in study 3 (reported in papers III and IV). The results showed that although the participants did not achieve statistically significant changes in all the separate subtests within a linguistic level, when clustered together some of the linguistic levels showed significant improvement. The BAT further allows for an objective assessment of the relative strengths and weaknesses of a multilingual person's languages. For instance in paper III, although MA reported English to be a stronger language than Norwegian, the overall scores of the BAT showed higher scores in Norwegian at pre-testing (but postmorbidly).

In study 3 an additional formal assessment tool was included, an action-naming test. Since treating verbs in sentence contexts was a focus in this study, and the BAT does not have subtests that examine verb production specifically, it was essential to include measures of

verb production in complete sentences. The action-naming test was found to be a useful tool for measuring pre- to post-treatment performance on verb production, as well as for a comparison of trained and untrained items selected for the SFA treatment (paper III). Furthermore, the scores from the action-naming test allowed for testing of significance with the McNemar test, which provided judgements of significance at lexical measures, not obtainable from the narratives. It was thus found to be a good supplement to the BAT (however, see 6.9 for a discussion of some psycholinguistic variables of the tool).

Thus, assessment with a formal tool, like the BAT, may display language differences that are not obvious to the speaker with aphasia, nor to the family. The findings from papers I, III and IV discussed above show that assessment of all of the relevant languages of multilingual speakers is necessary, as different test results were evident in the different languages of the speakers. This is important information for the diagnosis of the language impairments, as well as for planning appropriate treatment. Considering that the multilingual language system is not two (or more) unilingual language systems added together, but a complex integration of two languages into one language system (Grosjean, 1989), assessing only one of the languages will reveal only parts of the whole picture.

6.1.2 Functional assessment

Although some researchers have concerns regarding the sensitivity of formal aphasia tests to assess language impairments and recovery in speakers with aphasia (e.g. Marini, Andreetta, del Tin, & Carlomagno, 2011), many studies do not include other means of assessment. One of the aims of this project was to explore assessment of multilingual speakers with aphasia; therefore, narrative production was included in study 3 (reported in papers III and IV), as an addition to the formal or standardised testing. This was considered important, as the BAT is not designed to assess functional communication, only linguistic abilities in each of the speaker's languages (Paradis & Libben, 1987). Thus, assessment in the form of narratives was included both to address the lack of investigations of discourse production in multilingual aphasia research, and as a consequence of the selected treatment methods, that is, retrieving verbs in sentence contexts. Papers III and IV explored the impact of verb-retrieval treatment on discourse production and the use of narratives as a complementary assessment tool specifically.

The functional assessment revealed aspects of linguistic competence that neither the BAT, nor the action-naming test did uncover. For instance, while no significant improvement

in syntax in the treated language as measured by the BAT was found for participant MA (paper III), the narrative production showed an increase in completeness and complexity of sentences in the treated language. It seems that (for this participant, at least) the narrative production task taps other aspects of the syntax than the subtests of the BAT, which are all comprehension or judgement tasks, rather than production tasks. Furthermore, for the same participant, although no significant improvement in semantics was apparent in the BAT results, the narratives revealed a significant improvement of words that were CIUs in the treated language, that is, where the content of the words was appropriate in the sentence.

Correspondingly, a similar pattern was evident for both participants reported on in paper IV. Although the BAT showed no significant changes in the semantic domain of the untreated language, neither for PN (Portuguese) nor of DT (English), they both had large improvements in the number of CIUs in discourse production (syntactic measures were not analysed in paper IV). It may be assumed that the sentence structure provided in the treatments aided the word retrieval, and that this benefited the content of the sentences. The subtests assessing the semantic domain are both comprehension and production tasks. However, apart from Listening comprehension (where the SLT reads a little story and the multilingual speaker with aphasia is to answer five questions to the story), all tasks require single word answers, rather than responses in whole sentences.

Moreover, for participants PN and DT the discourse measures unveiled aspects not only at the discourse level, but also at the lexical level that were not identified with the BAT or the action-naming test. Whereas the BAT showed no measurable improvements of lexical access in PN's L1 (Portuguese), in the narratives, she produced a significantly higher number of verbs and nouns (both types and tokens) following treatment. Participant DT demonstrated a comparable pattern in the untreated language (English). For her, no significant improvement was found on the BAT, but an increase of verb types and tokens in the narratives were apparent. This improvement had long lasting effects for both participants reported on in paper IV (in paper III, follow-up measurements were not reported). This indicates that their word-finding abilities had improved in the untreated languages.

As described in 4.3.4, assessments of social validation were provided by the spouses of the participants in study 3. The *Communicative effectiveness index* (CETI) (Lomas et al., 1989) has been found to be a valid measure to assess change in pragmatic communication. In this study, the CETI was completed for two of the participants: MA and DT (reported for DT in paper IV). The total scores on the index did not change significantly for any of them. The

CETI has been reported to be sensitive to improvements in everyday communication, independently of what is assessed by standardised language tests (Pedersen, Vinter, & Olsen, 2001). Thus, the lack of significant improvement could indicate that their functional communication did not improve. However, MA scored significantly higher on half of the questions post-treatment. On five of the questions, the husband scored her communication abilities to be at 80 percent or more pre-intervention. Hence, in some areas of communication (e.g. Communicating her emotions, Communicating physical problems such as aches and pains, Participating in a conversation with strangers) she was already functioning relatively well. Also DT's scores increased significantly on several of the questions (e.g. Communicating her emotions, Starting a conversation with people who are not in close family and Describing and discussing something in depth). These increased scores were supported by the written feedback on the CETI from her husband. He described that she, contrary to pre-treatment, had approached strangers and talked to them on several occasions post-treatment. An additional interesting issue is that he had experienced that she listened to others more than before the treatments. The last statement is of key importance for speakers with fluent aphasia of the Wernicke type, since listening to others often is especially problematic for these speakers. This was also one of DT's challenges. Even if the treatments did not focus on slowing down the speech flow, the interaction between DT and the SLT, and that they participated equally as senders and receivers of information (cf. 4.4.4.5), may have made her more aware of her role as a listener. These anecdotal reports are clinically significant, and they illustrate that even if statistical significance is not achieved, the outcome of an intervention may have practical value for the participants and their family (Rubin, 2013). The participants' husbands scored the CETI. It is of course possible that the scores do not reflect the participants' own experience of communication, and the husbands could have been either too negative or too positive when scoring the index. Nevertheless, the husbands scored the index both pre- and post-treatment, thus this should not have affected the change effect.

Several studies have reported that speakers with aphasia have limited social activities and social contacts (e.g. Cruice, Worrall, & Hickson, 2006; Hilari & Northcott, 2006), and that they experience a decrease in quality of life (Hilari, Wiggins, Roy, Byng, & Smith, 2003; Ross & Wertz, 2003). The SALK-39 (Berg et al., 2010) was therefore included for all three participants in study 3 (reported for participants PN and DT in paper IV). For MA (the participant reported on in paper III) the total scores, as well as the psychosocial scores of the SALK-39 increased significantly (by one to three standard deviations). The communication

score increased some, and although the increase was statistically insignificant, it exceeded the mean performance on the norms. This indicates that MA's perception of her quality of life changed on some important measures. For neither PN nor DT did the SALK-39 show any significant changes. It is plausible that the impaired auditory comprehension of participant DT prevented her from fully comprehending the different questions in the measure. Furthermore, as Hilari and Byng (2009) point out, the language impairments of speakers with severe aphasia will often prevent them from expressing their views on their quality of life. This may have contributed to the absence of a measurable change for DT. However, DT's scores on this measure were significantly higher than the English norms on the general score, the psychosocial score, and on the communication score. This may indicate a lack of understanding of the extent of her language deficits, which is relatively common in Wernicke's aphasia (Heilman, 1991). Nevertheless, this reasoning does not apply for PN. She also had significantly higher communication scores than the norms, however her auditory comprehension would presumably allow her to understand the questions, and she would be able to provide answers. Another explanation may be that the relatively limited period of treatment, with a total of 5–6 weeks, was not long enough to detect any measurable changes in their experienced quality of life.

Improving functional language production is often an overarching aim in aphasia therapy. Thus, these findings endorse the views of other researchers, and conclude that formal testing alone may not be sensitive enough to identify language deficits and recovery in speakers with aphasia (e.g. Marini et al., 2011). The inclusion of other linguistic measures like assessment of narrative production and social validation may provide complementary information of the language impairment and improvement of speakers with aphasia and is therefore recommended, as a supplement to the formal language assessment.

6.2 Verb-production treatment in sentence contexts

Verbs are crucial for communication and for sentence production (de Diego Balaguer et al., 2006). Improved verb production may therefore enable speakers with aphasia to communicate more functionally in daily life contexts. As described in section 2.7.2, Bastiaanse and colleagues (2006; 2010) argue that verbs should be treated in sentence contexts. As described, there is to date a very limited number of published studies of verb production in sentence contexts in multilingual speakers with aphasia. Hence, the present project adds to this restricted load of research.

Studies 2 and 3 adopted different treatment methods, which however had in common that they treated verbs in sentence contexts. The results will be discussed below, divided into two sections; one for the implications for the lexical level and one for connected speech production, in the participants' treated language (cf. 6.3 for cross-linguistic transfer).

6.2.1 Implications for the lexical level in the treated language

Studies have found that verbs are more difficult to produce than nouns for multilingual speakers with aphasia. Reviews on verb treatment studies in monolingual aphasia have demonstrated that utilising different treatments for verb retrieval may improve verb production, but generalisation to untrained items is a challenge (cf. 2.7.2).

In study 3, at the lexical level, clear treatment effects were found for participants MA, DT and PN (reported in papers III and IV)[23]. The findings of a much greater improvement of the trained verbs than of the untrained verbs following the SFA treatment provide evidence for a direct treatment effect. Although paper IV did not compare the two treatment methods it is probable that since the SFA treatment focuses on strengthening the semantic network (Boyle & Coelho, 1995), and specific verbs were trained, it resulted in extensive improvement on the verbs in the treated language for the participants. Improvements were also apparent on the lexical variables in the Norwegian narratives. For PN it was clear that the treatment of verbs in sentences not only improved the amount and the variety of the verbs, but she also produced more nouns. This may be attributed to the nature of the treatments. When producing verbs in complete sentences, the verb is paired with nouns, hence an improved noun production was not surprising. The results furthermore conform with prior studies on verb production using SFA in monolingual speakers with aphasia, where improvement on the treated elements have been reported (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014). The lack of generalisation to untrained verbs as measured by the action-naming test for participant MA was disappointing. The findings are however consistent with other studies of verb retrieval with the SFA specifically (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014), and also conforms with the majority of verb treatment studies in general (Conroy et al., 2006; Webster & Whitworth, 2012). The lack of transfer to untrained items underlines the importance of selecting words for treatment that are relevant to the speaker with aphasia. Nevertheless, the lexical measures from the narratives revealed considerable improvements of

[23] Study 2 did not include measures at the lexical level.

both verb types and tokens, especially for participants MA and PN, and, although to a lesser extent, for DT.

If the participants showed improvements on the general measures, assessed with the BAT, it was interpreted as evidence of generalisation to other domains. This was evident for two of the participants (participants PN and DT), especially in the semantic domain and in lexical access. This was in line with the expectations, due to the lexical-semantic focus of the treatments (cf. 6.8 for a discussion related to models of bilingual language processing).

6.2.2 Implications for connected speech production in the treated language

Positive effects on sentence and narrative production have been reported in studies of verb production in sentence contexts in both monolingual (e.g. Bastiaanse, Hurkmans, et al., 2006; Goral & Kempler, 2009; Kempler & Goral, 2011) and multilingual speakers with aphasia (e.g. Altman et al., 2012; Goral et al., 2010). Confirming previous studies on SFA and communication-based treatment, MA and PN (papers III and IV) produced longer narratives, and this was done at a higher speech rate, measured by a larger number of words per minute.

Wambaugh et al. (2014) suggest that it is possible that improved feature generation could result in relevant or non-relevant feature production. The sentences of all three participants' in study 3 (MA, PN and DT) became more informative post-treatment (increased number of CIUs), indicating that they produced more relevant information. Thus, not only did the amount of words increase (for MA and PN), but the words they used were appropriate in the context. Furthermore, participants MA and PN also increased the amount of unrelated words (increased number of words without increased percentage of words that were CIUs). This increase in word production implies that even if the participant MA did not improve in the production of the untrained verbs, she was able to make use of SFA as a strategy to improve her discourse. For the same participant, the completeness and complexity increased in narrative production (syntactic measures were not included in paper IV). It is furthermore plausible that treatments like the communication-based, that target sentence generation without the practice of pre-selected items, can lead to a positive carryover to connected language production, as proposed by Altman et al. (2012). The overall improvements of the narratives of all three participants provide support to administering verb treatment in sentence contexts.

The improvement of the narratives may additionally be a consequence of the nature of the verb, specifically. According to Levelt (1989), argument structure information is an

integral part of the semantic representation of the verb. Thus, it may be assumed that training verbs might be especially important to enhance connected speech production. Verbs are considered to trigger both semantics and syntax, as they usually refer to events, and events often have participants (arguments) that need to be integrated into the sentence frame. Furthermore, verbs must have a subject, and they assign arguments with semantic roles such as agent and theme (Vigliocco et al., 2011). Thus, verbs are connected to larger grammatical structures, and an improved verb production may therefore enhance sentence production. When providing verb treatment in sentence contexts, as in studies 2 and 3, the verbs were presumably treated at the lemma level, rather than at the lexical level (cf. 3.2). The treatments did not primarily target the word form, which would have been the case if the treatment for instance consisted of a mere repetition task; rather, they focused on the meaning of the word. As the lemma contains information required for grammatical encoding in the particular language (de Bot, 1992, 2004; Levelt, 1989), it is assumed that the treatment strengthened the semantics (cf. the improved informativeness for all three participants in study 3) and the syntax of the narratives that was apparent from the increased completeness and complexity of the sentences of MA. Thus, treating verbs at the lemma level may have contributed to the findings.

6.3 Cross-linguistic transfer

Multilingual speakers rely on more than one language to participate fully in their lives. As pointed out earlier in the dissertation, improved communication abilities in both or all languages needed for participation in meaningful life activities of multilingual speakers with aphasia, is an overarching goal in treatment (Kohnert, 2009). Clinically, transfer from the treated to the untreated languages is a goal since generally treatment in only one of the languages (most often the language of the environment) is feasible. Cross-linguistic transfer is also of theoretical interest. If treatment gains in one language transfer to an untreated language, this implies that the two languages share structures and representations (Goral et al., 2010) (cf. 6.8 for theoretical implications).

Despite the growing body of studies of cross-linguistic transfer, the findings are still ambiguous. While cross-linguistic transfer has been shown to occur in a range of studies (see reviews by Ansaldo & Ghazi Saidi, 2014; Faroqi-Shah et al., 2010; Kohnert & Peterson, 2012), other studies have failed to find cross-linguistic transfer following treatment in one

language (e.g. Ansaldo et al., 2010; Miller Amberber, 2011). There are great challenges in predicting when transfer may happen, and for which languages (cf. 2.7.1).

It has been suggested that semantic treatment facilitates cross-linguistic transfer (Croft et al., 2011; Edmonds & Kiran, 2004; Kiran & Iakupova, 2011; Kurland & Falcon, 2011). Hence, one semantic treatment method (SFA) was included in the current project. Given the focus on producing verbs, the communication-based treatment was also expected to activate the semantic domain.

Paper III explored the impact of SFA only. Following treatment, transfer was found for MA to both untreated German and English verb production (measured by the action-naming test), as well as improvements in semantics and syntax in these languages. Given the challenges in obtaining transfer to untrained verbs in general (Webster & Whitworth, 2012) and following SFA treatment specifically (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014), these are important findings. The results are in line with earlier studies of SFA targeting nouns in bilingual speakers with aphasia, where cross-linguistic transfer in some conditions for some participants has been reported (Edmonds & Kiran, 2006; Kiran & Roberts, 2010). This corroborates the argument of semantic treatment being beneficial for cross-linguistic transfer. The improvement of the untreated languages did not occur for the trained elements (i.e. verbs) only, but a broader improvement in discourse production was found. The semantic nature of the treatment may have contributed to the findings, as the participants were able to apply semantic feature generation as a strategy. It is also conceivable that by stimulating the semantic network, and by activating a concept in the target language, semantically related words in the other languages were in turn activated (Costa & Caramazza, 1999; de Bot, 1992; Edmonds & Kiran, 2006; Green, 1998). The sharing of semantic features between languages, poses for a possible bridge between languages, through the conceptual system (cf. 6.8).

As for participant MA's first language (Japanese), no significant changes were found in the narratives, apart from a significant decrease in sentence complexity and speech tempo (cf. 6.4 for inhibition). The lack of improvement in Japanese could reflect a plateau effect. MA's pre- and post-stroke proficiency in this language was higher than in the other languages (and on some measurements within normal performance or almost at ceiling level). It is worth pointing out that in a review of cross-linguistic transfer (of Indo-European languages), Ansaldo and Ghazi Saidi (2014) did not find evidence that language distance affected the potential for cross-linguistic transfer in multilingual aphasia therapy. Nevertheless, Japanese

belongs to the Japonic language family and is the most structurally dissimilar language to Norwegian of all the untreated languages reported in papers III and IV. This may therefore have influenced the lack of transfer to Japanese.

The studies reported in papers II and IV did not aim at contrasting treatment protocols. Hence, a determination of the methods' individual contribution to the results was beyond the scope of these papers and only the cumulative effect of the treatments was examined. All three participants (AF, PN and DT) improved significantly in several aspects of the untreated languages. Treatment related gains at the lexical level were found for participants PN and DT in paper IV, and participants AF and PN showed significantly better results on the overall scores of the BAT following the treatments. In addition, AF increased the scores of the semantic domain. As stated above, these are promising findings, due to the previous equivocal findings of cross-linguistic transfer (Ansaldo & Ghazi Saidi, 2014; Faroqi-Shah et al., 2010; Kohnert, 2009). The results are consistent with the findings of Goral et al. (2012), where selective cross-linguistic transfer effects was found following SFA and sentence generation treatment. Paper IV also reported results of narrative production. Both the participants showed generalisation effects on some of the discourse variables, and especially participant PN showed great improvements (for more discussion of participant DT, see 6.5 and 6.6 about aphasia type and severity). Hence, to a great extent the findings support the idea of shared networks of the languages in multilingual individuals, indicated by the improvement for the participants (cf. 6.8 for a discussion of arguments). This may however not apply to structurally different languages.

All the participants in the project were provided with treatment in their latest-acquired, pre-, and postmorbid weakest language (except for MA, where German was weaker than the treated Norwegian). Some previous studies have advised against this, on the basis of possible inhibition of the untreated stronger languages (Goral, 2012; Goral et al., 2013) (see 6.4), while others have found that treatment in a weaker language may be beneficial to trigger cross-linguistic transfer (Edmonds & Kiran, 2004; Kiran & Iakupova, 2011). The positive outcome of the current project provides support to the recommendation of providing treatment in a late-acquired weaker language. In addition, treatment in typologically similar languages, like Norwegian and German, may contribute to cross-linguistic transfer.

Treating words at the lemma level may be beneficial also for cross-linguistic transfer. As pointed out previously, the lemma presumably contains information on semantic, as well as syntactic properties. Thus, treatment provided at the lemma level therefore may spread, not

only to the semantic and syntactic levels, but can also activate lemmas of untreated languages, according to de Bot (2004) (cf. 6.8). The retrieval of the verb lemma, along with the access of the conceptual store through L1 is suggested as an interpretation of the cross-linguistic transfer found in this project.

As noted above, this project cannot provide evidence for choosing one or the other of the treatment methods. However, the application of a communication-based treatment (provided to the participants reported on in papers II and IV) may support the idea that treatment that targets sentence generation and not necessarily practice specific items, can lead to a generalisation to connected language production (Altman et al., 2012). In this project, this may also have led to a positive carryover to the untreated languages. The findings are thus congruent with previous studies targeting verbs in sentence contexts in monolingual speakers with aphasia (Bastiaanse, Hurkmans, et al., 2006; Links et al., 2010), where generalisation to spontaneous speech and improved verbal communication were found following verb treatment in sentence contexts.

6.4 Inhibition of untreated languages

While some reviews have reported that providing treatment in a later-acquired language (often a weaker L2) does not harm the untreated languages (Faroqi-Shah et al., 2010; Kohnert, 2009), other researchers argue that treatment in postmorbidly weaker languages may have a negative impact on the untreated languages, often referred to as inhibition (Goral, 2012; Goral et al., 2013). This sense of inhibition is not to be confused with inhibition in the point of a general ability to keep the different languages apart, which is one of the aspects of executive control (cf. 3.1.2). This general ability is needed so that multilingual individuals are not uncritically mixing their languages when speaking. The type of inhibition that is not desired as an effect of speech and language therapy with multilingual speakers manifests as a deterioration of the untreated language. This is obviously a highly unwanted effect of treatment, and was therefore investigated specifically in papers II, III and IV. From the results of the formal testing and from the narrative production, no clear inhibitory effect was detected for any of the individuals.

Thus, the results are congruent with the suggestions of Kiran and colleagues (2006; 2011) that treatment in a premorbidly weaker language is more likely to enhance cross-linguistic transfer to untreated languages, rather than to cause inhibition. For MA, German was the only language that was pre- and postmorbidly weaker than the treated language, and here,

improvements at both the lexical, the semantic and the syntactic levels were found. Thus, there was no inhibition of this language either, following treatment in a stronger language. Regarding MA's L1, Japanese, no clear inhibition was detected, neither in the verb production, nor in the BAT scores. However, a significant decrease in sentence complexity and speech tempo in the narratives was found. The decrease of speech tempo in Japanese can be explained by an asymmetrical switching cost (cf. 3.3.2). When multilingual speakers use the stronger language, not much effort is required to inhibit the influence of a weaker language. On the other hand, when the weaker language is used, the stronger language has to be inhibited to a greater degree to avoid influence from this language. However, for MA, the decrease in sentence complexity and speech tempo in the Japanese narrative must also be seen in relation to the increase in the number of utterances. This increase in the production of utterances happens at the expense of complexity and speed in her L1.

Given the low cut-off for significance in the current project, the results are considered valid. The findings are thus in line with the conclusions of Kohnert (2009) and Faroqi-Shah et al. (2010), in that no harm is done to any of the untreated languages when providing treatment in a later-acquired language.

6.5 Aphasia type

Considering the vast number of treatment studies in nonfluent aphasia, the number of treatment studies on individuals with fluent aphasia is scarce (e.g. Edmonds, Nadeau, & Kiran, 2009; Edwards & Tucker, 2006; Fridriksson et al., 2012; Links et al., 2010; Wilssens et al., 2015), and there is no proven method for treatment of fluent (Wernicke's) aphasia (Altschuler, Multari, Hirstein, & Ramachandran, 2006). Verb deficits have been reported to be far more frequent than noun deficits in aphasia, and there has been some debate over the distribution of this difficulty across aphasia types. In addition to the verb impairments found in both fluent and nonfluent aphasia, Mätzig et al. (2009) reported noun retrieval impairments, in individuals with fluent aphasia only (cf. 2.4)

In paper IV, participant DT suffered from fluent aphasia. Speakers with fluent aphasia of the Wernicke type have been described to have predominantly lexical-semantic impairments, in addition to auditory comprehension deficits (Bastiaanse & Edwards, 2004), and previous studies have provided treatments with semantic, phonological and syntactic focus (e.g. Boyle, 2004; Edwards & Tucker, 2006; Sampson & Faroi-Shah, 2011; Wilssens et al., 2015). As reported previously in the dissertation, the SFA procedure was a challenge for

participant DT. In contradiction to the findings in other studies providing SFA (for noun production) for speakers with fluent aphasia (e.g. Boyle, 2004), DT did not seem to comprehend the rationale behind the treatment method and how to perform the tasks. This may partly be a consequence of her impaired auditory comprehension. Moreover, it may also reflect a lack of fully understanding the implications of her language deficits. As pointed out previously, such unawareness of one's one language disorder following stroke, is not uncommon in for instance Wernicke's aphasia (Heilman, 1991). Due to her challenges in mastering the procedure, it was changed (cf. 4.4.4.4). Consequently, she did not get much practice in sentence production from this treatment method.

The communication-based treatment protocol was provided in the same way for both the participants reported on in paper IV. The results of the assessment with the BAT and the action-naming test did not reveal systematic differences between the two participants, although DT generally showed poorer results (cf. 6.6). However, in the narratives differences appeared. The narratives of DT displayed improvements on fewer of the measures than for PN, both at the lexical, and at the discourse level. In addition, a substantial difference in verb- and noun production between the participants was found. In contradiction to PN, DT's noun production did not improve. Hence, conforming the findings of Mätzig et al. (2009), the lack of improvement of nouns is interpreted as a consequence of DT's noun retrieval impairments. Whereas the total amount of produced words in the Norwegian narratives comprised of 20 percent verbs on average, only four percent of the total number of words were nouns. The same pattern was found for untreated English. The verbs were 23 percent of the total number of words produces, while nouns were only seven percent. The fact that DT's nouns did not improve, may also be seen in relation to her lack of producing complete sentences in half of the treatment sessions (i.e. the SFA treatment). Even if noun retrieval was not targeted directly in the treatments, according to the proposals above about the nature of the verb, an improvement in noun production was anticipated.

6.6 Aphasia severity

Meinzer, Elbert, Djundja, Taub, and Rockstroh (2007) argue that greater improvements may be expected in speakers with more severe expressive language impairments. In this project, two participants were found to have more severe aphasia, AF with nonfluent aphasia and DT with fluent aphasia. Despite the degree of aphasia, including severe anomia, the findings reported in paper II showed that AF scored significantly higher on the BAT in both treated

English (L2) and in untreated Arabic (L1), following treatment. In addition, according to his wife, he talked more, had easier access to words, and did not give up as easily as before the treatment when speaking Arabic at home. Comparable results were found for participant DT (reported in paper IV). She improved significantly in the treated language and on some measures on the untreated language, measured by the formal assessments. In the discourse production, positive changes of DT's speech rate and in the informativeness (measured by CIUs) were found in both languages. Similar results have been found in previous studies of verb treatment with SFA (e.g. Wambaugh & Ferguson, 2007), indicating that SFA treatment may generalise to discourse production. Thus, DT's improvement may be interpreted as a combined effect of the two treatments, since also the communication-based treatment has been demonstrated to yield improvement of discourse production in multilingual speakers with aphasia (Altman et al., 2012).

Regardless of the greater severity of the language deficits of AF and DT, both participants showed improvements following the verb treatment, although to a lesser extent than MA and PN who had moderate aphasia. This is promising, showing that also for individuals with severe aphasia, treatment gains and cross-linguistic transfer is achievable in the chronic phase.

6.7 Therapy in a non-native language

There is no general agreement concerning which of the languages of a multilingual speaker to choose for treatment, this will vary between different individuals. For some multilingual speakers with aphasia bilingual treatment may be chosen, to utilise both languages, however this is often not feasible. Multilingual clinicians who speak (one or several of) the languages of their multilingual clients, are not available in many communities (Roger & Code, 2011; Wiener, Obler, & Sarno, 1995). Few studies have investigated the provision of language treatment in a mutual, non-native language of both the clinician and the client. Thus, one of the goals of study 2 was to explore this.

As pointed out earlier, AF showed significant improvements of the total BAT scores for the treated English, as well as transfer to the untreated Arabic. The cross-linguistic transfer was evident both on the overall scores of the BAT and in the semantic domain. This was interpreted to be related to the semantic nature of the treatment (cf. 6.8). The findings of gains in the treated language and cross-linguistic transfer to the untreated language therefore support the view that providing treatment in a mutual, non-native language of both the client

and the clinician can be effective, for both treated and untreated languages. To underpin this notion, the two languages of the client in study 2 (English and Arabic) share very few features, and belong to different language families (Indo-European and Afro-Asiatic). This therefore extend the findings of Ansaldo and Ghazi Saidi (2014), mentioned earlier. Providing treatment in a lingua franca may therefore be a viable option for clinicians who do not share their client's languages. Consequently, SLTs can no longer reject a client, merely on account of not sharing their client's L1.

6.8 Theoretical implications

Nickels et al. (2010) point out that data from clinical treatment studies of individuals with cognitive disorders may be useful in developing and evaluating theories of normal cognition. According to the usage-based approach, productivity is a result of knowledge generalised over usage events (Bybee, 2010). These usage events can be words, phrases, or sentences that form schemas at different levels of abstraction (cf. 3.1). The productivity of the schemas depends on their type frequency. An example of this is seen in the data from participant RF in study 1 (paper I). He showed patterns of overgeneralisation of the productive suffix *-i* from Farsi in the Derivational Morphology subtest of the BAT (turning nouns into adjectives). Derivation is a frequently used word formation process in Farsi, and the morphology is relatively regular (Nilipour & Paradis, 1995). Whereas in Norwegian both prefixes and a range of suffixes are used in derivational processes, suffixes predominate in derivational processes in Farsi, and there is only a small number of prefixes (Husby, 1999). Few of the Farsi suffixes are productive, but one that is productive is the suffix *–i*. It creates adjectives from nouns, for instance *irân-i* ('Iranian') from *Irân* ('Iran') (Lazard, 1957, p. 264). When RF for instance attaches the suffix *–i* to the Norwegian *makt* ('power') and responds *makteri* instead of *mektig* ('powerful'), this may be interpreted within the usage-based framework as a cross-linguistic generalisation, based on the productivity in his L1. The framework posits that more experience with a particular construction will result in reinforcement of the construction (Bybee, 2006; Tomasello, 2003). It is assumable that the range of Norwegian suffixes has prevented him from generalising across them.

The findings from the present project are compatible with a non-modular processing approach (cf. Chapter 3). Contrary to theories that argue for a strict distinction between lexicon and grammar (e.g. Ullman, 2001), the findings of this project showed an interplay between lexical-semantic processing (target of the treatments) and grammar. An example is

from paper III (the only paper reporting on syntax), where MA improves in sentence complexity and sentence completeness in the treated language, following the SFA treatment. In addition, a great increase of grammatical sentences in untreated German was found. It is worth pointing out that grammar was not targeted in the treatment, nor was correct sentence structure. Thus, the gains are attributed to treating the lexical-semantic domain. This suggests a close relationship between the lexicon and the grammar, indicating that non-modular approaches, like the usage-based ones are suitable to explain language impairments caused by aphasia.

Research on multilingual aphasia may provide deeper insights into language processing in multilingual speakers in general (Croft et al., 2011). There are two dominant approaches used to inform theory: through testing predicted correlations and through examining patterns of generalisation (Nickels et al., 2010). The last approach is especially relevant to this study. Generalisation can be found across items or across modalities. Through the logic of generalisation across items, treatment can be employed to investigate the nature of representations. If treatment of one set of items generalises to an untrained set of items, these sets of items must have shared or overlapping components. In a similar way, treatment can service the investigation of the basic architecture of the cognitive system, in using the logic of generalisation across tasks or modalities. If treatment provided in one modality, or treatment targeting a specific task, results in generalisation to other tasks or other modalities, there has to be a level where these two share representations, or where these representations interact (Nickels et al., 2010). In this project, generalisation – or transfer – was investigated, not only between items, tasks and domains, but also across languages. Following the assumptions above, the cross-linguistic transfer from one language to another found in this project serves as evidence for shared representations of the affected domains in the different languages.

Many models of lexical access assume that the search for words is semantically driven (Hall, 2011), and semantic treatment is therefore often a preferred approach in treating word-retrieval difficulties in speakers with aphasia (Peach & Reuter, 2010). This preference of semantic treatment is explained by several models of bilingual language processing, proposing that unbalanced bilinguals access the conceptual store through their L1 lexicon (cf. Kroll & Stewart, 1994; Pavlenko, 2009). Hence, semantic treatment in the L2 is expected to activate words in the L1 lexicon by accessing the conceptual store. Gains in the treated L2 may therefore transfer to the activated, but untreated L1, especially on the lexical-semantic level.

Findings from the present project lend support to the theory of a shared conceptual system for the two languages, as depicted in the *Revised Hierarchical Model* (RHM) (Kroll & Stewart, 1994), and the *Modified Hierarchical Model* (MHM) (Pavlenko, 2009). As described in paper II, participant AF had the largest improvement in the semantic domain in the untreated Arabic, which could provide support for a shared conceptual system for the languages. Additional support was found in paper III where participant MA showed significant gains in semantics in the untreated German and English, and in paper IV where both participants PN and DT improved in semantics (informativeness) in the untreated languages. Moreover, as a supplementary support to the RHM and the MHM, because all participants in this project learned Norwegian in their adult lives the Norwegian lexicon was likely sparser than the L1 lexicon. By examining the participants' BAT results, their scores in L2 were lower on average than the scores in their L1 (cf. papers II, III and IV). Following from this, one can assume that the connections between the L1 lexicon and the conceptual store were most likely stronger than from the Norwegian lexicon to the conceptual store. Thus, for the speakers to access their concepts, they had to do this at least partly through the L1 lexicon. Therefore, the findings provide support for shared representations of the languages of multilingual speakers, as depicted by the RHM and the MHM.

Both the RHM and the MHM are applicable in their description of how the lexica are organised, and of the process of lexical retrieval. An advantage is the dynamic aspect of these models. Although being relatively simple, they account for the development (growth) and variation in the lexical network, underlining the asymmetry between the sizes of the lexica that is often found in (unbalanced) bilingual speakers, as pointed out above. An additional strength of the MHM is its consideration of the complementarity principle by including a threefold conceptual store. As pointed out previously, the MHM proposes that language selection occurs at a preverbal stage, and the hard problem (i.e. how multilingual speakers are able to speak in one language instead of the other) is therefore solved within this model (cf. 3.3.2). The RHM does not account for the hard problem, explicitly. However, the RHM has been a very important model, and with its contribution to identifying an asymmetry between the two languages of bilingual speakers (supported by several researchers, e.g. Costa & Santesteban, 2004; Goral et al., 2013; Green, 1998; Meuter & Allport, 1999) it is fundamental to current developments on issues of bilingual language control. Following from this, the MHM is suggested as a more appropriate model than the RHM for interpreting the results of this project.

Another model that solves the hard problem is the *Multilingual Processing Model* (MPM) (de Bot, 2004), by assuming that the intention to use a specific language occurs at the conceptual/communicative intention level (de Bot, 2004) (cf. 3.3.2). An advantage of this model is that it in a transparent matter displays the whole speech production process in a transparent way – from the intention to speak (idea) via the actual selection of words and grammatical rules to articulation, in several languages. It is therefore applicable for interpretation of the findings in the present project that extended beyond the single word level. A further benefit of the MPM that is not addressed in simpler models like the RHM and the MHM is the inclusion of a lemma level. As described previously, the lemma is assumed to contain information on semantic, as well as syntactic properties. Following this line, treatment provided at the lemma level therefore may presumably spread, to the semantic and syntactic levels, as well as to lemmas of untreated languages. The retrieval of the verb lemma, together with the access of the conceptual store through the L1 is suggested as an interpretation of the cross-linguistic transfer found in the present project. Thus, the MPM is also considered a well-suited model for accounting for the findings of this project and may be seen as a complimentary, rather than a competing model to the MHM.

6.9 Methodological considerations and limitations

In all research, it is important to convey the results in a transparent way. In research on treatment effects, it is especially critical to show that the changes found in language production are due to the specific treatment provided. In spite of thorough attempts at achieving these goals, there are some caveats to this project. Many of them are related to the fact that this is not a pure research project, but a project where clinical goals had to be prioritised.

Findings from single-subject studies, like the present ones, cannot be statistically generalised to the multilingual aphasic population as a whole. However, analytic generalisations that shed light on some theoretical principles were possible to achieve (Yin, 2014). Moreover, given the scarce amount of research, new descriptions of multilingual speakers with aphasia, with different language pairs and with different aphasia types and degrees of severity are valuable in adding to our knowledge about multilingual aphasia in general. However, in order for studies to provide verifiable evidence, they must be well designed.

As noted in 4.4.1, there are some challenges with the single-subject design. These will be discussed in the following, in relation to the ROBiNT scale presented in section 4.7.2 (Tate et al., 2013). Some of the points on the ROBiNT scale may be more suitable for medical studies than for behavioural studies, as in this current project. For instance, ROBiNT 4 (whether the participants and therapists are blinded to the treatment condition) is often not possible, and perhaps not desirable in aphasia therapy. Study 2 is an example of this; in this study, participant AF (reported in paper II) was involved in the process of selecting items for treatment, for the words to have an importance for his daily life. Nickels, Best, and Howard (2015) acknowledge this issue, and argue that this lack of blinding in a study should not be penalised.

Different measurements to evaluate the effect of treatment will provide different information. As Beeson (2015) points out, one should separate between primary and secondary analyses, and these should be seen as complementary, rather than competitive approaches. Non-parametric tests like the McNemar test applied in the present project, are suitable for primary analyses, and are reliable when it comes to testing the statistical significance of change in performance between two testing points (e.g. pre-post treatment), that is, whether the change is above chance (Field et al., 2012; Howard et al., 2015). Thus, such tests answer the question whether a treatment is effective. Calculating effect size, on the other hand, may be seen as secondary analyses. The effect size has value as a standardised index of change in response to treatment, and it provides information on the magnitude of the difference between the pre- and post-test results, not only whether there is a significant difference (Wisenburn & Mahoney, 2009). Furthermore, effect size allows for a comparison to the broader treatment literature (Beeson, 2015). Despite the controversy whether effect size represents a meaningful change in single-subject studies (e.g. Beeson & Robey, 2006; Howard et al., 2015), it was deemed important to include in this project, where a relatively new treatment procedure (e.g. SFA targeting verb production) was applied in a new context (to multilingual speakers with aphasia). This allows for a comparison between the effects of this treatment method and other treatment methods reported in the literature. It furthermore enables this study to be included in possible meta-analyses of the single-subject literature (Beeson & Robey, 2006). Another reason for calculating effect size is the fact that study 3 included assessment of narrative production, and this measure provided gradient results that are not directly comparable to the discrete scores of the formal measures. The inclusion of

effect size therefore provided scores that were comparable between the formal and the functional assessment tools.

However, to ascertain the desired client compliance in the project, the amount of measurement points had to be kept to a minimum. This was crucial, especially since the participants had to be tested in all their languages, and two of the participants experienced fatigue (cf. 4.3.1). Thus, it was concluded that multiple assessments between the treatment blocks in study 3 (described in papers III and IV) would be too exhausting for the participants. This hampered the possibility of comparing the effect size of the two treatment methods. Nevertheless, the McNemar test provided measures of significance for each of the treatment protocols, although maintenance measures were not obtainable for each of the methods. Tate et al. (2013) recommend a collection of at least five data points per phase (ROBiNT 3; sampling behaviour). However, this is time consuming and tiring for the participants with larger therapy sets (Nickels et al., 2015). Additionally, the test load in this study was relatively broad and large. A solution could have been to select fewer and more precise tests to measure the changes in language production. In that case, some of the BAT-subtests could have been omitted, and a test of semantics, such as the *Pyramids and Palm Tree Test* (Howard & Patterson, 1992) or a subtest from the *Psycholinguistic Assessments of Language Processing in Aphasia* (PALPA) (Kay et al., 2009) could have been added (e.g. Subtest 47, Spoken word–picture matching). These options were considered, but as assessment tools are culturally dependent (Paradis, 2004), they were discarded as the abovementioned tests do not have norms for several of the languages relevant for this project. Thus, in this project, some ideal research methods were compromised, and endeavouring client compliance was prioritised.

Several of the other points on the ROBiNT scale, are less controversial, and were followed in this project. Blinding assessors (ROBiNT 5) was partially ensured, in that other persons than the SLT providing treatment conducted a majority of the assessments. The transcribers were also unaware of the different stages of the protocol, and the transcripts were scrambled so that authors MK and ML were blinded to which measurement point they scored. In addition, inter-rater reliability (ROBiNT 6) was calculated (cf. 4.6). Treatment adherence (ROBiNT 7) was also important to secure, especially since two different SLTs were providing the treatment in study 3. This was ensured by contact and discussions between the SLTs, as well as video recordings of all treatment sessions. All these factors contribute to a strengthening of the internal validity of the project. As discussed earlier, the SFA protocol

was changed for participant DT, therefore this modified SFA cannot be compared directly to the protocol administered for participants MA and PN (papers III and IV).

A possible weakness of the study was the selection of the trained verbs for the SFA treatment in study 3 (ROBiNT 2: randomisation). As pointed out in section 4.4.4, verbs were selected for treatment based on the performance on the baseline tests in Norwegian. Hence, verbs that were produced correctly at the baselines were not included in the treatment set. While it seems reasonable to exclude items that the participant is able to produce correctly, this might result in 'regression to the mean' (Howard et al., 2015). This is explained by the variability on language tasks by people with aphasia (e.g. Howard, Patterson, Franklin, Morton, & Orchard-Lisle, 1984). Thus, by selecting items that the speaker with aphasia fails to produce at one occasion, a better performance at the next (post-treatment) probe may be wrongly interpreted as a treatment effect. However, the verbs selected for treatment in this project were not selected on the basis of one measurement point only. They were rather selected on the basis of three baseline measurement points. In addition, as reported in papers III and IV, the verbs that were selected for training fluctuated less than 15 percent throughout the baselines, demonstrating that they were stable in their low performance. In addition, control measures of both related and unrelated materials were included, and these showed no significant changes. This indicates that the treatment effect found in the studies can be interpreted as valid, and not as a regression to the mean. Additionally, regardless of the clinical desire for generalisation to untrained items, the lack of generalisation to the untrained verbs in study 3 may provide additional support to the design of the study, in that the improvements were treatment specific (Nickels et al., 2015). This thus increases the internal validity of the study. Another weakness related to randomisation is that the verbs in the action-naming test were not matched for relevant psycholinguistic variables, like frequency, imageability, and number of syllables. However, a post hoc analysis of the verbs did not reveal great differences between the verbs (Appendix 13).

To secure the external validity in the project, several measures were taken. The treatment procedures were described thoroughly, that is, both the dependent (ROBiNT 10: the target behaviour) and the independent variable (ROBiNT 11: the intervention) have been described extensively in Chapter 4, and in the papers. This was important to allow for replication of the study (ROBiNT 14). The communication-based treatment was replicated across the three participants of study 3, and SFA (in its original form) was replicated between participants MA and PN. As Nickels et al. (2015) argue, replication across individuals

strengthens the evidence of the effectiveness of the treatment. It does not, however has an impact on the strength of evidence of the effectiveness for a specific individual. Another aspect that is useful for replicating the study is a complete and accurate description of the participants, for others to comprehend the deficits (ROBiNT 8). This was ensured by the description of the participants and their test results, both in Chapter 4, and in the papers. Furthermore, the data analysis has been described in detail (ROBiNT 13), and the dissertation has provided discussions of generalisation of the findings (ROBiNT 15), both at the lexical level (cf. 6.2.1), to discourse (cf. 6.2.2), to the untreated languages (cf. 6.3), in addition to a discussion of the analytical generalisations that go beyond the setting for this specific project (cf. 6.8).

A description of the therapeutic setting is included in the ROBiNT scale (item 9). For verb-retrieval treatment, as provided in the present project, it may be less important to describe the specific environment (including description of the therapy room, for instance) (Nickels et al., 2015). Moreover, the ROBiNT scale argues for a presentation of the raw data at a session by-session level (item 12). Nickels et al. (2015) extend this view, and argue for the availability of item-level scores. However, a presentation of all raw scores from all the different outcomes for all participants was judged too extensive to be published in the papers. Nevertheless, exhaustive presentations of scores from the different outcome measures are displayed in the papers.

6.10 Future research

The findings from the present project have raised new issues worthy of research in the field of multilingual aphasia. The BAT is an important assessment tool, and one of very few that enables assessment of all languages of speakers with multilingual aphasia in a comparable manner. Nevertheless, there is a need for additional research to ensure the linguistic equivalence between the different language versions of the test, as well as a need for validation of the test in the different languages. Furthermore, the positive outcomes of providing treatment in a mutual, non-native language of both the client and the clinician reported in paper II, showed that this could constitute an effective intervention. This should therefore be further explored in other language combinations. Additionally, to apply the NATR as an assessment tool and as treatment material, psycholinguistic variables of the tool should be included. As described earlier, this was done post hoc in this project (cf. 6.9). In later studies, this should be done prior to the intervention.

Another aspect considers the challenge for the speaker with fluent aphasia to implement the SFA procedure (paper IV). Even though the SFA has been used for fluent speakers with aphasia in previous studies, the applicability of this method for speakers with fluent aphasia should be investigated in future research.

Code-switching may be a symptom of language inhibition. Goral et al. (2012) found increased code-switching to English in the untreated French and German following treatment in English in their multilingual participant (cf. 2.7.2). This was interpreted as competition in naming between the languages, due to the increased activation of English. The present project did not investigate code-switching. However, this may have given more insights regarding a possible inhibition of the untreated languages, and remains a possible avenue of further research. In addition, Goral and colleagues found different results on inhibition and facilitation of languages on different outcome measures (ibid.). While the formal testing showed indications of inhibition, the narrative production indicated evidence for cross-language facilitation from English to both untreated, non-L1 languages. They argued that competition between languages are more likely to occur in assessment that consist of language production when the same items in related languages are tested on consecutive days, and that such processes may not inhibit production during narrative generation. The formal assessment tools used in the present project did not comprise the same items in the different languages. However, their suggestion that the types of outcome measures can explain the different results across studies of cross-language treatment effects employed should be further explored. The findings of Goral et al. (2012) underline the importance of including assessment tools at different linguistic levels.

In the present project, the use of narratives as an assessment tool provided information at the lexical level, the sentence level and the discourse level that was not obtainable from the formal testing. Additionally, the use of narratives for assessment enhanced the ecological validity of the findings, given that improving functional language production was a goal. However, conducting and analysing narratives are time-consuming, it is therefore important to develop reliable and practical methods to assess and analyse the connected speech of the clients, both for clinical and for research purposes.

Finally, replication is generally an important issue in single-subject designs (Tate et al., 2013). To strengthen the conclusions of this project, replications with other individuals, with other language combinations than in the present project, should be conducted.

6.11 Clinical implications and conclusions

Assessment and treatment of multilingual speakers with aphasia is clinically challenging. It is however essential to study, as there is a growing number of multilingual speakers and an increase in the number of individuals with aphasia globally (Ansaldo & Ghazi Saidi, 2014). As pointed out previously in the dissertation, studies in multilingual aphasia emphasise the importance of comprehensive assessments of all the languages of multilingual speakers (e.g. Roberts & Kiran, 2007), and the findings from the present project strongly support this notion. Assessing only one of the languages does not present a complete picture of the language impairments of the multilingual speaker, as was evident for instance in paper I. The BAT was considered a suitable instrument for measuring pre-post treatment changes. In addition, including connected speech production by the means of narrative production was found to complement the formal assessment, as it uncovered language aspects that were not attainable from the formal assessment tools. Moreover, given that the improvement of functional language production often is the overall goal in aphasia therapy, applying narratives is advocated, in the clinical work with speakers with aphasia, as well as in research.

To sum up, the present doctoral dissertation is novel in a national context, being the first dissertation on multilingual aphasia in Norway. Furthermore, its combination of clinical practice and foundation in an explicit theoretical framework makes it potentially useful for clinicians as well as researchers in inter- and multidisciplinary fields (e.g. speech and language therapy, aphasiology, linguistics, clinical linguistics, psychology, multilingualism), both nationally and internationally. The dissertation contributes new knowledge regarding the impact of Semantic Feature Analysis on verb retrieval among multilingual speakers with aphasia (paper III). It underlines the importance of assessing all the languages of multilingual speakers with a comparable measure (papers I and II), as well as the importance of complementing the assessment with more functional assessment tools (papers III and IV). Moreover, it adds to the very limited number of studies of verb production in sentence contexts for multilingual speakers with different aphasia types, including language combinations that have not been reported before (papers II, III and IV). The dissertation emphasises that treatment gains are attainable, even when treatment is provided in a non-native language for both the client and the clinician (paper II). The findings of cross-linguistic transfer and absence of inhibition of untreated languages (papers II, III and IV) are important contributions to the relatively limited amount of research in the field, and is of great importance for clinicians, as well as researchers.

The present project did not set out to evaluate or test different models of bilingual language production explicitly, nevertheless, the findings of generalisation to connected speech production following verb production treatment corroborates theories on the nature of the verb, and its importance to sentence production. Moreover, the outcomes of generalisation to untreated languages provide evidence for shared networks of these languages; thus, contribute to enlightening the relative strengths and weaknesses of current models of bilingual language processing. The applicability of some of these models was discussed, and the project contributed with data that supported the asymmetrical and dynamic aspects of models like the Modified Hierarchical Model. Furthermore, it highlighted the advantages of more complex models of word production, postulated by the Multilingual Processing Model.

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Språklig rehabilitering for tospråklige personer med afasi

Informasjon om prosjektet *Afasi på bortebane*

Bakgrunn

Antall tospråklige med afasi øker. Forskning viser at det er svært viktig at begge språkene til en tospråklig afasirammet blir kartlagt, både med tanke på diagnose og undervisning. Lite publisert litteratur beskriver språklig rehabilitering av tospråklige personer med afasi.

Afasi på bortebane

Afasiforbundet i Norge har mottatt midler fra stiftelsen Helse og Rehabilitering til prosjektet *Afasi på bortebane*. Prosjektet gjennomføres av Bredtvet kompetansesenter. Prosjektet søker å finne faglig begrunnede tiltak for tospråklige afasirammede; en oppgave som på nasjonalt plan til i dag ikke har vært prioritert. Målet med prosjektet er å utvikle et egnet kartleggings- og undervisningsopplegg for personer med afasi av ikke-norsk opprinnelse, som ikke har norsk som morsmål. Gjennomføring og evaluering av prosjektet skal gi kunnskap om språklig rehabilitering av tospråklige afasirammede som skal spres til norske logopeder som står overfor problemstillingen. **Prosjektet søker nå tospråklige med afasi fra det sentrale østlandsområdet.**

Hvem kan være med?

Det er av praktiske hensyn ønskelig at deltakerne bor i Oslo/Akershus-området. Målet er å gjennomføre individuell undervisning to ganger per uke, hver på ca. 1 time, over 17 uker.

Prosjektet er ettårig, og vil ha oppstart høsten 2009, med avslutning våren 2010. Det vil konkret bestå i å:

kartlegge de tospråkliges afatiske språkvansker på begge språkene deres med et egnet kartleggingsinstrument. The Bilingual Aphasia Test, BAT, (Paradis 1987) er velegnet til dette formålet.

planlegge og gjennomføre et individuelt tilpasset undervisningsopplegg.

Tolk vil brukes både i forbindelse med kartlegging av språkvanskene, i den direkte logopediske undervisningen og eventuelt i samtaler med og veiledning til familien.

Ta kontakt!

Hvis du kjenner til pasienter som kunne tenke seg å delta i prosjektet, eller du har spørsmål, ta gjerne kontakt med logoped Monica Knoph på Bredtvet kompetansesenter.

Telefon: 22 90 28 17, e-post: monica.knoph@statped.no.

Bredtvet kompetansesenter
Statlig spesialpedagogisk støttesystem

HELSE OG REHABILITERING
Stiftelsen for norske helse- og rehabiliteringsorganisasjoner

ExtraStiftelsen
Helse og Rehabilitering

AFASIFORBUNDET I NORGE
- SPRÅKVANSKER ETTER HJERNESKADE

Mai 2012

Språklig rehabilitering for tospråklige personer med afasi

Informasjon om forskningsprosjektet *Afasi og tospråklighet*

Bakgrunn

Antall tospråklige med afasi øker. Dette er en særlig utfordring for klinisk praksis, da klientenes tospråklighet kommer i tillegg til kompleksiteten ved selve afasien. Et sentralt spørsmål er om logopediske tiltak på det ene språket til den tospråklige personen kan føre til bedring i det utrente språket.

Doktorgradsprosjekt

Afasiforbundet i Norge har mottatt midler fra stiftelsen ExtraStiftelsen Helse og Rehabilitering til doktorgradsprosjektetprosjektet ***Afasi og tospråklighet***. Prosjektet gjennomføres av doktorgradsstipendiat Monica Knoph.

Prosjektet har tre hovedmål:

1) Å undersøke virkningen av **logopediske tiltak** rettet mot produksjonen av verb med spesielt fokus på **overføringseffekter** av tiltakene på tvers av språkene til den tospråklige afasirammede.
2) Å øke kunnskapen om afasi hos tospråklige med norsk som andrespråk.
3) Å bidra til forskningen på psykolingvistiske modeller for gjenkalling og lagring av verb hos tospråklige.

Prosjektet søker nå personer som har **norsk som andrespråk** med **ikke-flytende afasi**. Personene bør ha hatt afasi i **mer enn seks måneder** og må ha fått afasi som følge av en enkelt skade. Det er av praktiske hensyn ønskelig at deltakerne bor i Oslo/Akershus-området.

Prosjektet er treårig, og hadde oppstart 01.02.12. **Aktuelle personer kan starte opp i august/september 2012.**

Prosjektet vil konkret bestå i å:

- **kartlegge** de afatiske språkvanskene på begge språkene deres med et egnet kartleggingsbatteri.
- planlegge og **gjennomføre** to ulike **undervisnings-/behandlingsopplegg**.

Tolk vil brukes både i forbindelse med kartlegging av språkvanskene og eventuelt i samtaler med og veiledning til familien.

Ta kontakt!

Hvis du kjenner til pasienter/elever som kunne tenke seg å delta i prosjektet, eller hvis du har spørsmål, ta gjerne kontakt med Monica Knoph på:
telefon: 917 21 595, **e-post: monica.knoph@iln.uio.no**.

ExtraStiftelsen Helse og Rehabilitering

UiO : Universitetet i Oslo

Bredtvet kompetansesenter
Statlig spesialpedagogisk støttesystem

Vedlegg 2: Omtale på www.statped.no/bredtvet

statped

Om nettstede

Søk i Statped

Lytt til teksten

Forsiden
Tjenester
Fagområder
Kompetansesenter
Publikasjoner og bibliotek
Lover og regelverk
Om Statped
Ledige stillinger
Bredtvet kompetansesenter
Om Bredtvet kompetansesenter
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Føringer for inntak
Nyhetsarkiv

TRAS
TIDLIG REGISTRERING AV SPRÅKUTVIKLING - I DAGLIG SAMSPILL

HJELP TIL AFASIRAMMEDE

03.12.2008 Skriv ut

I høstens tildeling for 2009 fra stiftelsen Helse og Rehabilitering av midler fra tv-spillet Extra, fikk Afasiforbundet midler til tolv prosjekter for afasirammede. Bredtvet kompetansesenter samarbeider med Afasiforbundet og med fagpersoner fra andre institusjoner om gjennomføringen av fire av prosjektene.

Disse dreier seg om arbeid med tospråklige afasirammede, barn som pårørende av afasirammede, undersøkelse av livskvalitet hos afasirammede og fotokurs for afasirammede. Faglige ansvarlige fra Bredtvet er Line Haaland-Johansen, Monica I. K. Knoph og Ingvild Røste.

Afasi på bortebane. Hvordan kan språklig rehabilitering legges til rette for minoritetsspråklige afasirammede?
Tallet på tospråklige, eller minoritetsspråklige, afasirammede øker. Forskning de siste to–tre tiår viser at det er svært viktig at begge språkene til en tospråklig afasirammet blir kartlagt. Dette er avgjørende med tanke på både diagnose og undervisning. Det er svært lite litteratur som beskriver språklig rehabilitering av minoritetsspråklige afasirammede. Mangelen på publisert informasjon fører til at hver logoped må stole på sitt kliniske skjønn, prøve og feile, og kanskje "gjenoppfinne" mer eller mindre faglig funderte tilnærminger, som kolleger andre steder allerede har kommet fram til

Målet med prosjektet er å planlegge et egnet kartleggings- og undervisningsopplegg for tre–fem afasirammede av ikke-norsk opprinnelse, og å gjennomføre, evaluere og spre erfaringer om tiltaket, bl.a. gjennom en utgivelse av en publikasjon. Hvis noen er interessert i å delta i prosjektet, kan de ta kontakt med Monica I. K. Knoph på Bredtvet kompetansesenter.

Mor mangler ord. Grupper for barn med afasi i familien.
I Norge rammes 17 personer av afasi hver eneste dag. Afasi rammer ikke bare ett individ, men en hel familie. Særlig barns tilværelse forrykkes når en kjent og trygg voksen forandrer seg radikalt på kort tid. Barn er en gruppe av pårørende som ofte blir oversett, til tross for sine store behov for lettfattelig informasjon om afasi. Undersøkelser viser at halvparten av barna til foreldre som rammes av hjerneslag, utvikler atferdsproblemer eller depresjon.

Målsettingen for dette prosjektet er at barn av afasirammede foreldre, gjennom deltakelse i en barnegruppe som skal møtes på fire dagssamlinger, skal få økt viten om afasi og få møte andre barn i samme situasjon. Gruppedeltakelsen er ment å bidra til å stimulere til å se nye muligheter, samt å sette ord på hva afasien betyr for barnets liv. Målgruppen for prosjektet er barn på 11-12 år i familier der en av foreldrene har afasi. Hvis noen er interessert i å delta i prosjektet, kan de ta kontakt med Line Haaland-Johansen eller Monica I. K. Knoph på Bredtvet kompetansesenter.

Fullført

Appendix 4. Informed consent form

Statped

UiO : Universitetet i Oslo

Erklæring om samtykke

Opplysningene om prosjektet har blitt forklart JA _____

Jeg **samtykker** i å delta i prosjektet **Afasi og tospråklighet**.

JA _____ NEI_____

Jeg samtykker i at det kan taes **lydopptak**.

JA _____ NEI_____

Jeg samtykker i at det kan **filmes** med **videokamera**.

JA _____ NEI_____

Jeg **samtykker** i at **videoopptak** kan brukes **etter** at prosjektet er ferdig:

- i **fremlegg** av forskningen JA _____ NEI_____
- i **undervisning** JA _____ NEI_____

Jeg har fått kopi av dette skjemaet.

JA _____ NEI_____

Underskrift deltaker _____ Dato: _____

Underskrift pårørende/vitne _____ Dato: _____

Skjemaet returneres ferdig utfylt til prosjektansvarlig Monica Knoph.

OVERVIEW OF SUBTESTS ON THE SHORT FORM OF THE BILINGUAL APHASIA TEST

Part B

Language background. Items 4–17

Pointing. Items 23–32

Commands. Items 33–47

Syntactic Comprehension. Items 66–70, 71–76, 81–88, 111–114, 125–128, 137, 140, 142, 143, 145, 148, 150, 151

Semantic Categories. Items 125–157

Synonyms. Items 158–162

Antonyms. Items 163–172

Verbal Fluency. Items 263–266 (phonological fluency). In addition was one task of semantic fluency added, due to the focus of the treatment.

Naming. Items 269–288

Sentence Construcion. Items 289–313

Picture Description. Items 344–346

Listening Comprehension. Items 362–366

Appendix 1. SFA diagram

HVEM GJØR DETTE VANLIGVIS? *Who does this usually?* _____	HVA BLIR DET GJORT MED? *What/who is it done to/with?* _____	HVOR SKJER DETTE VANLIGVIS? *Where does this usually happen?* _____
	MÅLBILDE *Picture of target word*	
HVORFOR SKJER DET (MENINGEN)? *Why does it happen?* _____	HVILKEN DEL AV KROPPEN/HVILKET VERKTØY? *Which part of the body/What tool is used?* _____	HVA FÅR DET DEG TIL Å TENKE PÅ? *What does it make you think of?* _____

English translation in italics.

Appendix 6. SFA diagram

Criteria for transcription and glossing

(Modified from Lind, Kristoffersen, Moen, & Simonsen, 2009)

A - Transcription

- Please name the transcription with the name of the audio file.
- The narratives are to be transcribed orthographically, in the way and in the order they are produced with lowercase letters.
- No punctuations are to be used.
- Do **not** correct if words or utterances are not correctly produced.
- Every word is to be separated with a single space.
- The units are separated with a carriage return. When a unit is too long to fit on one line and it is necessary to break a long unit into two successive lines, the reminder (that is shifted into the next line) should be intended five to ten spaces from beneath the first word of the line above.
- All the words, nonwords and phonological paraphasias uttered are to be transcribed the way they are produced:
    - for instance: *vatation* for vacation or *kubrys* (neologism)
- Words that are truncated are to be transcribed the way they are produced and to be marked with a single dash:
    - for instance: *I ha- have had a nice vacation*
- Phrases or sentences (= units, see B) that are truncated are to be transcribed the way they are produced and the units are marked with a double dash:
    - for instance: *did you get a* --
- Indecipherable syllables are marked with X
- Longer indecipherable stretches are marked with X=
- Hesitation sounds, like *er, eh* are also to be transcribed and put in curly brackets {}
- Verbs, nouns and light verbs[1] are to be marked with brackets and noted like this:
    - verb $[jump]_V$
    - noun $[ball]_N$

[1] (Butt, 2010; Korpijaakko-Huuhka & Lind, 2012)

- light verb [take]$_{LV}$

- Code-switchings are to be written in italic
    - for instance: {eh} nach {eh} * {eeh} *fjellet* (latter)
- Use a stopwatch to measure the pauses. Pauses shorter than 1 second are to be marked with an asterisk (*).
- Pauses longer than 1 second are to be marked with the length in seconds in parenthesis, with half second intervals:
    - for instance: (1.0) for 1 second, (2.5) for two and a half seconds
- Extralinguistic phenomena: To be transcribed in simple parenthesis in English where they occur
    - for instance: *the book was* (cough) *good*,
      you might say that (laugh)
- Comments from the transcriber are to be written in double brackets
    - for instance if the person makes a gesture that is important to the understanding of the utterance: ((illustrative gesture: painting))
- Each speaker is identified by the letters T for *tester* (the person administrating the test) and the letter A for *person with aphasia*.
- Speech overlap: Double brackets are used to indicate the beginning and the ending of overlap between the utterances of two speakers. One set is inserted surrounding the first speaker's utterance portion, and a second set of brackets surround the second speaker's overlapping portion. The second speaker's left brackets are aligned vertically under the first speaker's left bracket.
    - for instance: Nobody wants [[to leave]]
      [[They don't]] move
- Each line is marked with line numbers.

B – Units (utterance)

- The transcription is to be segmented into the following units:

1. **Independent clause**: that minimally includes a finite verb
    - for instance: *that's right*
      i take a different way
      did she finish the meal

2. **Sub-clausal unit**: can be elaborated to a full clause by means of recovery of elements from the context of discourse
    - for instance: *yes*
      with the bicycle
      the old house

To identify each unit one has to take intonation contour, pauses, meaning and syntactic construction into account.

C – Gloss

Interlinear morpheme-by-morpheme glosses give information about the meanings and grammatical properties of individual words and parts of words. Its primary aim is to make the reader understand the grammatical structure of the L1 text by identifying aspects of the free translation with meaningful elements of the L1 text. The ultimate purpose may be to aid the reader in grasping the spirit of the language, to control the linguistic argument the author is making by means of the L1 example.

The first line is the L1 text line, the second line contains the *interlinear morphemic gloss* (IMG), and the third line contains an idiomatic translation into L2 and is marked with an apostrophe. Segmentable morphemes are separated by hyphens, both in the L1 text line and in the gloss. There must be exactly the same number of hyphens in the L1 text line and in the gloss. Both the glossing and the translation should be in English.

For instance (Kirmess, 2011):

mange	*mennesk-er*	*som*	*komm-er*	*innom*
many	people-PL	who	come-PRES	by

'a lot of people who come by'

For more information about the basics and the principles of interlinear glossing, see the enclosed article (Lehmann, 2004).

The purpose of the present glossing is to give **morphosyntactic** information. For a list of grammatical categories and their glossing labels, see p. 15 in the enclosed article.

For a complete list of the glossing rules, see p.27 in the enclosed article.

D – Translation

In this project I need idiomatic translations to English, with all the wrongly produced words or syntax there might be in the recorded material. I don't need a translation of how the utterance was supposed to be if produced correctly, but how it was *actually* produced.

E – Analysis

LEXICAL VARIABLES:

- **Total verb count** (verbs: words that convey an action, an occurrence or a state of being)
- **Verb diversity** (number of different verb types)
- **Verb form** (number of correctly conjugated verb forms)
- **Total noun count** (nouns: words that often denote a person, thing, place or idea)

SENTENCE VARIABLES:

- **Lexical density** of utterances/units: Count the proportion of content words (noun, verb, adverb or adjective) of the total words, and also the proportion of function words (prepositions, pronouns, auxiliary verbs, conjunctions, grammatical articles or particles) of the total words.

- **Completeness**: Take into account both the complexity of the structure and presence of obligatory elements (utterances should be considered complete if they contain all the obligatory elements even if the result is not grammatical due to poor grammatical form (e.g. Katten skal spiser fuglene). The units are to be identified and rated on a 5-point scale: 1 = incomplete sentence; 2 = simple and complete; 3 = complex sentence containing a subordinate clause; 4 = complete and coordinate structure, 5 = complete containing a subordinate clause.

DISCOURSE VARIABLES:

- **Total number of words** (excluding exact repetitions, false starts, interjections, or

formulaic expressions)

- **Total number of units**
- **Three elements of narrative structure**:
    - **Local coherence** (whether each utterance was directly related to the prior utterance by elaboration, sequencing, focus etc.)
    - **Global coherence** (refers to the relevance of each utterance to the general topic). For coherence a 3-point scale: 1 = unrelated; 2 = possible related; 3 = clearly related. The final discourse measure
    - **Story line** ratio: number of utterances that described a clear story line divided by the number of utterances that contained a description of the setting or background for the narrative

F – Light verbs

A **light verb** is a verb that has little semantic content of its own and it therefore forms a predicate with some additional expression, which is usually a noun (Butt, 2010; Korpijaakko-Huuhka & Lind, 2012). Common verbs in English that can function as light verbs are *do, give, have, make, take,* etc. Some Norwegian examples of light verbs are: *å ha, å være, å bli, å holde på med, å gå, å komme, å la og å ta*.

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UiO : Institutt for lingvistiske og nordiske studier
Det humanistiske fakultet

Forespørsel om å delta i doktorgradsprosjekt om afasi og tospråklighet

Jeg er doktorgradsstipendiat ved Universitetet i Oslo. Temaet for forskningsprosjektet mitt er afasi og tospråklighet.

Jeg ønsker å finne ut om behandling av språket ditt på norsk kan gjøre at også morsmålet ditt blir bedre. For å finne ut av dette, ønsker jeg å teste begge språkene dine og å tilby deg logopedisk behandling på norsk. Språktestingen vil bli gjort både før behandlingen begynner og etter behandlingen er avsluttet.

Du vil ikke kunne få annen språkbehandling mens du er med på prosjektet. Selve språkbehandlingen vil ta 4–6 uker, avhengig av hvor mange timer om dagen vi har. Kartleggingen og behandlingen vil bli videofilmet eller tatt lydopptak av, og senere skrevet ned.

Du har fått dette brevet fra logoped XXXX, som på vegne av meg har plukket ut aktuelle deltagere til studien. Jeg kjenner ikke til hvem som har blitt kontaktet før du har sagt at du vil delta.

Det er helt frivillig å være med og du har mulighet til å trekke deg når som helst underveis, uten å begrunne dette nærmere. Dersom du trekker deg vil alle innsamlede data om deg bli makulert. Opplysningene vil bli behandlet konfidensielt, og ingen enkeltpersoner vil kunne gjenkjennes i publikasjoner.

Prosjektet er ferdig 15. februar 2015. Etter prosjektet er godkjent kan

Postadresse: Postboks 1102, Blindern, 0317 Oslo
E-post: henvendelser@iln.uio.no
www.hf.uio.no/iln/

videoopptakene og lydopptakene bli slettet, hvis du vil det, og alle opplysninger som kan identifisere deg blir makulert.

Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste A/S. Jeg har taushetsplikt, og vil ikke fortelle noe du ikke ønsker videre.

Dersom du har lyst å være med på prosjektet, er det fint om du skriver under på den vedlagte samtykkeerklæringen og sender den til meg.

Hvis det er noe du lurer på kan du ringe meg på telefon 91 72 15 95, eller sende en e-post til monica.knoph@iln.uio.no.

Med vennlig hilsen

Monica Knoph

Appendix 9. Recommendations from the Norwegian Social Science Data Service (NSD)

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr: 985 321 884

Monica I. K. Knoph
Institutt for lingvistiske og nordiske studier
Universitetet i Oslo
Postboks 1102 Blindern
0317 OSLO

Vår dato: 27.03.2012 Vår ref:29942 / 3 / HIT Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 21.02.2012. Meldingen gjelder prosjektet:

29942	*Afasi og tospråklighet*
Behandlingsansvarlig	*Universitetet i Oslo, ved institusjonens øverste leder*
Daglig ansvarlig	*Monica I. K. Knoph*

Personvernombudet har vurdert prosjektet, og finner at behandlingen av personopplysninger vil være regulert av § 7-27 i personopplysningsforskriften. Personvernombudet tilrår at prosjektet gjennomføres.

Personvernombudets tilråding forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/forsk_stud/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://www.nsd.uib.no/personvern/prosjektoversikt.jsp.

Personvernombudet vil ved prosjektets avslutning, 15.02.2015, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Knut Kalgraff Skjåk

Hildur Thorarensen

Kontaktperson: Hildur Thorarensen tlf: 55 58 26 54
Vedlegg: Prosjektvurdering

Appendix 10. Application for extension of the project period

Monica Knoph

From: Monica Knoph
Sent: 9. februar 2015 14:59
To: 'personvernombudet@nsd.uib.no'
Subject: Ad. prosjekt 29942

Hei,

jeg er nå i innspurten med doktorgradsprosjektet mitt, og har i den forbindelse noen spørsmål.

Jeg var delvis sykmeldt en periode, derfor er innleveringsdato utsatt til 15.05.15. Det vil derfor være problematisk å måtte slette lyd- og videoopptak nå. Jeg har videre en mengde data jeg ikke har fått analysert, grunnet stor datamengde. Kan det la seg gjøre å utvide prosjektperioden?

Dette bringer meg til det neste spørsmålet. Alle informantene har godkjent at jeg bruker materialet til studentundervisning og til forskningsformidling etter prosjektslutt. Kan det la seg gjøre å ikke slette lyd- og videofilene, men selvfølgelig anonymisere navn, personopplysninger etc.

Håper på snarlig og positivt svar.

Beste hilsen Monica

--
Monica I. Norvik Knoph

Doktorgradsstipendiat, logoped MNLL

MultiLing Senter for flerspråklighet (SFF) Institutt for lingvistiske og nordiske studier Universitetet i Oslo Postboks 1102 Blindern
0317 Oslo

Tlf: +47 22 84 49 08
E-post: monica.knoph@iln.uio.no

Besøksadresse: Henrik Wergelands hus, rom 427

Appendix 11. Confirmation of extension of the project period

Monica Knoph

From: Hildur Thorarensen <hildur.thorarensen@nsd.uib.no>
Sent: 3. mars 2015 11:00
To: Monica Knoph
Subject: Prosjektnr: 29942. Afasi og tospråklighet

BEKREFTELSE PÅ ENDRING

Personvernombudet viser til epost mottatt 09.02.2015 og bekrefter å ha registrert følgende endringer:

- Dato for prosjektslutt endres til 15.05.2015.

- Etter prosjektslutt vil lyd- og videofiler bli brukt til undervisning og forskningsformidling. Deltakerne har samtykket til dette. Øvrige personopplysninger anonymiseres.

Vi vil ta ny kontakt ved prosjektslutt. Ta gjerne kontakt dersom noe er uklart.

--
Vennlig hilsen

Hildur Thorarensen
Rådgiver/Adviser

Norsk samfunnsvitenskapelig datatjeneste AS Personvernombud for forskning Harald Hårfagres gate 29, 5007 BERGEN

Tlf. direkte: (+47) 55 58 26 54
Tlf. sentral: (+47) 55 58 81 80
Email: hildur.thorarensen@nsd.uib.no
Internettadresse: www.nsd.uib.no/personvern

Appendix 12. Aphasia-friendly information

Statped
Bredtvet kompetansesenter

UiO : Universitetet i Oslo

Vil du delta i forskningsprosjekt?

Jeg heter **Monica Knoph**.
Jeg er **logoped**.

Jeg forsker på **afasi** hos personer som snakker **mer** enn **ett** språk.
Jeg jobber på **Universitetet i Oslo**.
Prosjektet heter **Afasi og tospråklighet**.

Hva handler prosjektet om?

Prosjektet handler om hvordan logopeden kan **behandle tospråklige** med **afasi**.

Hva skal skje?

Jeg skal gi logopedisk **behandling.**
Jeg skal **kartlegge begge** eller **alle** språkene dine før og etter behandlingen.
Dette tar til sammen omtrent **3–4 måneder**.
Du kan **ikke** gå til en annen logoped **samtidig**.

Hvis du vil kan vi ta **pauser**.

Kartleggingen og behandlingen blir **filmet** eller tatt **lydopptak** fra.

Etterpå blir noe av det du har sagt **skrevet ned**.

~~Navn~~

Navnet ditt blir **ikke** brukt i artikler eller den ferdige oppgaven.

Du kan **stoppe** kartlegging eller behandling når som helst.

Du kan **trekke deg** fra prosjektet, og du trenger **ikke** å si hvorfor du ikke vil være med.

Da blir alle data **slettet**.

Det du sier i intervjuet blir behandlet **konfidensielt**.

Alt som blir samlet inn i prosjektet blir låst inn i et skap.

Statped
Bredtvet kompetansesenter

UiO : Universitetet i Oslo

FERDIG

Prosjektet avsluttes 1. februar 2015.

Data blir oppbevart til 2020 for å bevare mulighet for oppfølging over tid.

Alle opplysninger som kan identifisere deg, blir **makulert**.

Monica skal levere artikler og en oppgave om prosjektet når det er ferdig.

I oppgaven vil det ikke være noe som kan kjenne deg igjen.

Hvis du har noen **spørsmål** om prosjektet kan du snakke med Monica Knoph

TUSEN TAKK!

Statped
Bredtvet kompetansesenter

UiO : Universitetet i Oslo

Med vennlig hilsen

Monica Knoph

Telefonnummer: ***91 72 15 95***

@

E-postadresse: ***monica.knoph@iln.uio.no***

Appendix 13. Psycholinguistic variables of verbs

Verbs participant MA

	Imageability	Frequency	Syllables
Trained (n=44)	**Low** 0 0 %	**Low** 7 16 %	**1** 4 9 %
	Medium 32 73 %	**Medium** 23 52 %	**2** 37 84 %
	High 2 5 %	**High** 4 9 %	**3** 1 2 %
			4-5 1 2 %
Untrained (n=34)	**Low** 1 3 %	**Low** 3 9 %	**1** 5 15 %
	Medium 25 74 %	**Medium** 19 56 %	**2** 26 76 %
	High 2 6 %	**High** 6 18 %	**3** 3 9 %
			4-5 0 0 %

Verbs participant PN

	Imageability	Frequency	Syllables
Trained (n=24)	**Low** 0 0 %	**Low** 4 17 %	**1** 4 17 %
	Medium 15 63 %	**Medium** 8 33 %	**2** 18 75 %
	High 1 4 %	**High** 4 17 %	**3** 0
			4-5 1 4 %
Untrained (n=25)	**Low** 0 0 %	**Low** 1 4 %	**1** 3 12%
	Medium 20 80 %	**Medium** 11 44 %	**2** 22 88 %
	High 1 4 %	**High** 9 36 %	**3** 0 0 %
			4-5 0 0 %

Verbs participant DT

	Imageability	Frequency	Syllables
Trained (n=30)	**Low**	**Low**	**1**
	1	3	1
	3 %	10 %	3 %
	Medium	**Medium**	**2**
	22	14	28
	73 %	47 %	93 %
	High	**High**	**3**
	1	7	1
	3 %	23 %	3 %
			4-5
			0
			0 %
Untrained (n=21)	**Low**	**Low**	**1**
	0	4	2
	0 %	19%	9 %
	Medium	**Medium**	**2**
	19	12	17
	90 %	58%	81 %
	High	**High**	**3**
	1	4	1
	5 %	19 %	5 %
			4-5
			1
			5 %

I

Paper I

Language assessment of a Farsi–Norwegian bilingual speaker with aphasia

Author: Monica I. Koumanidi Knoph

Published: 2011. *Clinical Linguistics & Phonetics*, *25*(6-7), 530–539

II

Paper II

Language intervention in Arabic–English bilingual aphasia: A case study

Author: Monica I. Koumanidi Knoph

Published: 2013. *Aphasiology*, *27*(12), 1440–1458

Paper III

Semantic Feature Analysis targeting verbs in a quadrilingual speaker with aphasia

Authors: Monica I. Norvik Knoph, Marianne Lind, and Hanne Gram Simonsen

Published: in press. *Aphasiology*, doi: 10.1080/02687038.2015.1049583

III

Semantic Feature Analysis targeting verbs in a quadrilingual speaker with aphasia

Monica I. K. Knoph[1,2], Marianne Lind [1,2], Hanne Gram Simonsen[1]

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Abstract

Background: Semantic Feature Analysis (SFA) (e.g. Boyle & Coelho, 1995) is a treatment approach aimed at enhancing lexical retrieval by improving access to the semantic network in speakers with aphasia. Although there are promising results on trained items, previous studies exploring the impact of SFA on verb production in monolingual speakers have shown mixed results for generalisation to untrained items and discourse. There are few published studies investigating SFA and action naming in multilingual speakers.

Aims: The study explores the impact of SFA on trained and untrained verbs, semantics and syntax, and narrative production in the trained and untrained languages of a multilingual speaker (Japanese-English-German-Norwegian) with moderate non-fluent aphasia. Treatment was conducted in a late-acquired language (Norwegian).

*Methods & Procedures***:** SFA was provided during an intensive schedule of about 22 hours of therapy, with approximately ten hours per week over two and a half weeks. The treatment focused on the production of verbs in sentence contexts.

Outcomes & Results: Outcome measures include the *Bilingual Aphasia Test* (BAT), an action-naming test, and production of semi-spontaneous narratives.

Outcomes in the treated language: Overall, the participant responded positively to the SFA treatment. The trained verbs improved significantly, but no transfer was observed to untrained verbs. There were no changes in the formal testing of semantics or syntax, but improvements were noted in narrative production.

Cross-linguistic outcomes: Transfer to verbs in untreated German was evident. There were significant increases in the semantics and syntax in both English and German. The participant showed an improvement in discourse in English and German, although not in Japanese.

Conclusions: SFA treatment in a late-acquired language can lead to gains in the treated language and transfer to both stronger and weaker languages, with different patterns for the various languages. This indicates that SFA may be a promising method for treating multilingual speakers with aphasia. The authors further advocate the use of narratives as an assessment tool. In addition to enhancing the ecological validity of the findings, the narratives provided information not obtainable from the other assessment tools for within- and cross-linguistic therapy gains for the participant.

Keywords: aphasia; multilingual; cross-linguistic transfer; Semantic Feature Analysis (SFA); verb; action naming

Treatment of aphasia in multilingual speakers is clinically challenging. It is nevertheless important to study as there is a growing number of multilingual speakers and an increase in the number of individuals with aphasia globally (Ansaldo & Ghazi Saidi, 2014). In line with Grosjean (2013) we define the terms 'bilingualism' and 'multilingualism' as the use of two or more languages in everyday life, and we will use the terms interchangeably. Studies of linguistic capacities of multilingual speakers with aphasia are furthermore important as they can offer insights into language processing, and thus contribute to evaluating theories of normal cognition (Nickels, Kohnen, & Biedermann, 2010). Key concerns can be raised around the transferability of treatment effects across languages and contexts of language use. Another concern is the risk of harming the other language(s) when providing treatment in only one of the speaker's languages. The present study explores the impact of Semantic Feature Analysis (SFA) therapy (Wambaugh & Ferguson, 2007; Wambaugh, Mauszycki, & Wright, 2014) on the naming of trained and untrained verbs, semantics, syntax, and narrative production in the treated and untreated languages of a quadrilingual speaker (Japanese-English-German-Norwegian) with non-fluent aphasia. Treatment was provided in Norwegian, a late-acquired language of the participant.

Word retrieval and semantic networks

Word retrieval difficulty is a core symptom of aphasia. For some individuals, naming can be a challenge due to impaired access to the semantic network while, for others, it can be due to impairments in the semantic network itself. Models of lexical access assume that word meanings are represented in the lexical-semantic network as sets of semantic features and properties (Caramazza, 1997). The nodes in the network will typically contain information about a concept and the properties that describe it (e.g. shape and colour, function and semantic roles), in addition to how they link to other related concepts (e.g. synonyms and antonyms and phonologically related words). In a large network, each concept would assumably be linked to many other concepts. According to Bybee (2001, p. 29) words in the lexicon are linked not only through their meaning and contexts of use, but also through their phonological form. Hence, activation of a word may be facilitated by accessing semantically or phonologically related words. Furthermore, it is assumed that by strengthening the connections between a concept, its semantic features, and its lexical representation, one can facilitate easier access to the word.

Semantic Feature Analysis

Semantic Feature Analysis (SFA) (e.g. Boyle, 2004; Boyle & Coelho, 1995) is a treatment approach aimed at enhancing lexical retrieval by improving access to the semantic network through semantic feature generation. SFA was initially developed to improve the retrieval of nouns in monolingual speakers with aphasia. It has shown promising results on trained items for reports on 16 of 17 monolingual individuals (Boyle, 2004; Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Lowell, Beeson, & Holland, 1995; Rider, Wright, Marshall, & Page, 2008). Generalisation to untrained items occurred in some cases (Lowell et al., 1995), but not all (see Boyle, 2010 for a review).

SFA can facilitate generalisation to untrained items through at least two mechanisms: by stimulating the semantic network and by implementing semantic feature generation as a strategy for the person with aphasia (Wambaugh et al., 2014). Some studies have also reported generalisation to connected speech following SFA treatment, even when the treatment focused on single words (Coelho et al., 2000; Davis & Stanton, 2005; Peach & Reuter, 2010). In other studies, generalisation to discourse was difficult to obtain, even when SFA was used to treat words connected to specific discourse tasks (Boyle, 2004; Boyle & Coelho, 1995; Rider et al., 2008).

To date, a very limited number of studies have been published using a form of SFA with bilingual speakers, and all but one (Goral, Rosas, Conner, Maul, & Obler, 2012) focus on noun retrieval (Edmonds & Kiran, 2006; Kiran & Roberts, 2010). Goral et al. (2012) included both noun and verb retrieval, using a modified SFA treatment protocol in addition to a sentence generation task and a rapid naming task, to examine cross-language generalisation in a multilingual speaker with aphasia. Some generalisation to untreated languages was found. However, the authors do not separate the outcomes of each treatment protocol; it is therefore difficult to say if the generalisation was due to the SFA or to one of the other treatments (or a combination).

All seven participants in the studies by Edmonds and Kiran (2006) (three English-Spanish bilinguals) and Kiran and Roberts (2010) (two Spanish-English and two French-English bilinguals) showed improvement of the trained items in the treated language, indicating that SFA may be a fruitful method for treatment of nouns in bilingual speakers with aphasia. The generalisation patterns differed among participants. All three participants in the study by Edmonds and Kiran (2006) showed cross-language transfer, and the authors concluded that treatment in the weaker language of an individual with bilingual aphasia may

be more beneficial in facilitating cross-linguistic transfer than treatment in a stronger language. Cross-linguistic transfer was found only for one of the four participants from the Kiran and Roberts (2010) study.

Although SFA was developed to target noun retrieval, this method has also been adapted to treatment of verb retrieval in two studies of monolingual speakers. Wambaugh and Ferguson (2007) explored the effect of SFA on action naming in a person with anomic aphasia. They found improvement in naming trained verbs. Furthermore, they found improvement in discourse (an increase in correct information units (CIUs) (Nicholas & Brookshire, 1993)), even though the treatment focused on single words. They also reported improvement for untrained items, but this was partially explained by the repeated probing of these items, and there was no generalisation to untrained items that the person was not exposed to during treatment. Using the same treatment protocol, Wambaugh et al. (2014) studied four individuals with different aphasia types (conduction, anomic, and Broca's aphasia). They found improvement in naming trained items for three of the four participants, but no generalisation to untrained items. An improvement in discourse, measured as an increase in CIUs, was found for one participant only. Wambaugh and colleagues state that the other participants in this study may not have been able to make use of SFA as a strategy to assist them in naming untrained items.

The somewhat surprising finding that treatment of single words may generalise to discourse is explained through the original aim of SFA, namely to strengthen the lexical-semantic network (Massaro & Tompkins, 1994; Wambaugh et al., 2014). One can further assume that training verbs might be especially important in order to enhance connected speech production. Verbs have an important role in constructing a sentence. Semantically, verbs usually refer to events, and events often have participants (arguments) that need to be integrated into the sentence frame. Syntactically, verbs must have a subject, and they assign arguments with semantic roles such as agent and theme (Vigliocco, Vinson, Druks, Barber, & Cappa, 2011). It follows from this that a person who does not increase word retrieval in a naming task after SFA treatment can in fact still make use of SFA as a strategy to improve connected speech (Wambaugh et al., 2014).

Bilingual language processing and cross-linguistic treatment effects

There is a growing body of evidence showing that all the languages of a multilingual speaker are active when s/he is producing words in one of the languages (e.g. Brysbaert & Duyck, 2010; de Bot, 1992; Green, 1998; Kroll, Bobb, & Wodniecka, 2006; Kroll, Dussias, Bice, & Perrotti, 2015; Kroll, Van Hell, Tokowicz, & Green, 2010). This is the case not only when the speaker is using a weaker L2 or L3 (and so on), but also when using the L1. Current models of bilingual language processing also agree that multilinguals have a shared conceptual system for both/all of their languages (Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994; Pavlenko, 2009). de Bot (1992, 2004) further argues that the conceptual information spreads to and activates lemmas of both/all languages, and the lemma can be linked to various form characteristics depending on the languages involved.

Cross-linguistic influence is found not only at the lexical level, but also at the phonological and syntactic levels. Furthermore, the influence is bi-directional, which implies that not only does the L1 influence the L2, L3 and so on, but the L1 is itself influenced by the L2, L3 etc. (see Kroll et al., 2015 for a discussion). This corresponds with the approach of Bybee (2010) stating that cognitive representations are sensitive to linguistic experience, such as frequency of use. Based on the above approach one can assume that exposure to an L2 will have an impact on the cognitive representations also in L1.

The fact that conceptual representations are shared and that there are links between the lexical representations in the various languages of a multilingual speaker opens up for cross-linguistic effects of language therapy. This is a field which has received an increasing amount of attention since the early 2000s. The findings of the research are, however, still equivocal. Overviews show that therapy transfer may occur from a treated to an untreated language, but not always (Faroqi-Shah, Frymark, Mullen, & Wang, 2010; Kohnert, 2009).

Among those who found transfer, Ansaldo and Ghazi Saidi (2014) reported in a recent review that semantic therapy is more likely to lead to transfer than phonological approaches (e.g. Croft, Marshall, Pring, & Hardwick, 2011). Pre- and postmorbid proficiency are also important factors in transfer. Several studies have shown that in bilinguals with a higher proficiency in one language than in another, treatment in a premorbidly weaker language may benefit the untreated, stronger language (e.g. Edmonds & Kiran, 2004, 2006; Kiran & Iakupova, 2011). In contrast, Goral (2012) found that therapy in a postmorbidly stronger language enhanced the possibility for cross-linguistic transfer (cf. also Croft et al., (2011)). In

addition, studies have shown that treating the language of the environment may enhance the possibility of treatment gains and cross-linguistic transfer (Fredman, 1975; Goral et al., 2012).

Contrary to these findings of cross-linguistic transfer, multiple studies have failed to find a generalisation effect from a treated non-native language to an untreated L1 (Filiputti, Tavano, Vorano, De Luca, & Fabbro, 2002; Goral, Levy, & Kastl, 2010; Miertsch, Meisel, & Isel, 2009). It is likely that the degree of linguistic similarity between the languages plays a role (Goral et al., 2010; Miertsch et al., 2009). It may be easier to find transfer effects between languages with higher degrees of structural overlap than between languages with larger cross-linguistic structural differences. For instance, Ansaldo and Ghazi Saidi (2014) report that therapy gains have been found to transfer between the Indo-European languages (e.g. Bengali-English in Croft et al. (2011), French-English and German-English in Goral (2012) and Spanish-English in Kiran & Roberts (2010)).

Most of the prior studies have examined cross-linguistic effects at the lexical level, like noun cognates (Kohnert, 2004), and nouns assessed in single word contexts (Croft et al., 2011; Edmonds & Kiran, 2006; Kiran & Roberts, 2010). However, Altman, Goral, and Levy (2012) found positive changes to varying degrees in narrative structure and sentence grammaticality in all the languages of a trilingual speaker with aphasia for whom treatment was provided in only one of the languages.

Verbs tend to be morphologically more complex and have more complex semantic representations than nouns (Mätzig, Druks, Masterson, & Vigliocco, 2009). Several studies show that action naming and verb production are more difficult than object naming and noun production for people with aphasia (Black & Chiat, 2003; Faroqi-Shah, 2012; Links, Hurkmans, & Bastiaanse, 2010; Mätzig et al., 2009; Webster & Whitworth, 2012). Verbs are crucial for communication; hence, there is an increased interest in targeting verbs in aphasia treatment. A vast number of studies show that bilingual speakers with aphasia have greater difficulties with action naming than object naming (e.g. Ansaldo, Ghazi Saidi, & Ruiz, 2010; Faroqi-Shah & Waked, 2010; Hernández, Costa, Sebastián-Gallés, Juncadella, & Reñé, 2007; Kambanaros & van Steenbrugge, 2006). In a review of verb treatment studies with monolingual speakers, Webster and Whitworth (2012) found that verb retrieval therapy is effective in improving trained verbs, and verbs respond to similar treatment methods as nouns. However, generalisation to untrained items is still a challenge following verb treatment. Improvements in sentence production have been seen in several studies, including Bastiaanse, Hurkmans, and Links (2006) and Webster, Morris, and Franklin (2005).

Inhibition

The convergence hypothesis states that the two languages of a bilingual speaker share neural networks, and that the acquisition of an L2 involves the same neural regions as the L1 (Abutalebi & Green, 2007). The Inhibitory Control (IC) model predicts that both languages of a bilingual speaker are active during language processing, even when the speaker is using only one of the languages (Green, 1998). This prediction has found support in a range of studies (see Kroll & Dussias, 2013). Language use thus requires the bilingual speaker to constantly inhibit the non-target language.

For multilingual speakers with aphasia, overviews suggest that providing therapy in one language does not seem to harm the other untreated languages, in the sense that the proficiency in these languages deteriorates (Faroqi-Shah et al., 2010; Kohnert, 2009; Kohnert & Peterson, 2012). However, Goral and colleagues point to the possible inhibition of the stronger language when treatment is provided in the weaker language, at least in the short term (Goral, 2012; Goral, Naghibolhosseini, & Conner, 2013). This inhibition manifests itself as a negatively affected performance in the untreated language.

Research questions

Given the limited number of studies on SFA and action naming – both in monolingual and in multilingual speakers – and the mixed results on generalisation to discourse, further research is needed to explore the effect of SFA on verb production in sentence contexts. For multilingual speakers it is also important to explore the possibility of inhibitory effects of language treatment.

The present study investigates the impact of SFA treatment focusing on verbs in a quadrilingual speaker with non-fluent aphasia (Japanese (L1), English (L2), German (L3), Norwegian (L4)). In line with the suggestions of Kiran and colleagues (2004; 2011), treatment was provided in Norwegian, a late-acquired language as well as the language of environment. Since intensive aphasia therapy in the chronic stage has proven to be effective (Bhogal, Teasell, & Speechley, 2003) and SFA has shown promising results for the retrieval of trained verbs and in some cases with an improvement in discourse, it is predicted that the SFA treatment of verbs in sentence contexts should have an impact at several linguistic levels. An improvement for trained verbs in the language of treatment is expected. Generalisation to untrained items, semantics, syntax, and discourse production in the treated language is

expected if the participant is able to implement semantic feature generation as a strategy and/or if the semantic network is strengthened sufficiently (Wambaugh et al., 2014).

The assumption that the languages of bilingual speakers share neural networks means that cross-linguistic transfer may occur, at least for some linguistic properties. The greatest gain is expected in the lexical-semantic domain because of the semantic nature of the treatment. Changes in syntax are also expected since the treatment focused on production of verbs in complete sentences. Furthermore, verb training was carried out at the lemma level, which contains information on semantic as well as syntactic properties (de Bot, 1992; Levelt, 1989, 2001). It is anticipated that an improvement in lexical access to verbs combined with an improvement in sentence production might lead to an improvement in discourse production even in the untreated languages.

These expectations apply only to the languages that are linguistically most similar to the language of treatment, namely German and English. Regarding transfer of therapy effects to the participant's L1, Japanese, findings from previous studies are, as mentioned, mixed; hence, the authors have no firm expectations. The L1 of the participant is also structurally and lexically different from the language of treatment.

As noted above, prior research results are inconclusive about the potentially inhibitory effect on untreated languages following treatment in one language, so this issue is approached without firm expectations.

In sum, the following research questions are addressed:

1. Does SFA therapy targeting verbs in sentence contexts result in improvements at the lexical, semantic and syntactic levels, and/or in discourse production in the language of treatment?
2. Does SFA therapy targeting verbs in sentence contexts result in cross-linguistic transfer in the linguistic areas mentioned above?
3. Does treatment in a late-acquired language lead to inhibition of earlier-acquired languages, the L1 in particular?

Method and procedure

Case details

The participant is a 59-year-old, right-handed female who grew up in Japan speaking Japanese. She learned English at school and through immersion when living in the UK for a

few years as an adult. She studied German formally in Japan before moving to Germany, where she passed an exam to work as a German-Japanese interpreter. Norwegian was learned formally and through immersion after she moved to Norway as an adult. She reported using Japanese frequently with her extended family and friends. English was her working language, which she used frequently in her job as a secretary in an international context at the time of the aphasia onset. Norwegian was her home language, and the language of the environment; she used it daily. Her proficiency level was high in Japanese, English and Norwegian and medium in German, a language she rarely used. Information on language use and proficiency levels for each of the languages was obtained using the *Language Use Questionnaire* (Muñoz, Marquardt, & Copeland, 1999) and part A of the *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987).

She suffered a single left-hemisphere stroke seven months prior to the intervention, resulting in a moderate, non-fluent aphasia. Assessment of aphasia type and severity is based on the BAT (Paradis & Libben, 1987) and on clinical judgement. She did not demonstrate dysarthria or apraxia of speech and had no other history of neurologic impairment. She demonstrated normal hearing and had corrected to normal vision. Based on her results on the *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987), Japanese was her strongest language post-stroke, followed by Norwegian, and then English and German (see Figure 1). The participant signed a consent form prior to the study, and the Norwegian Social Science Data Service (NSD) approved the ethical standards of the project.

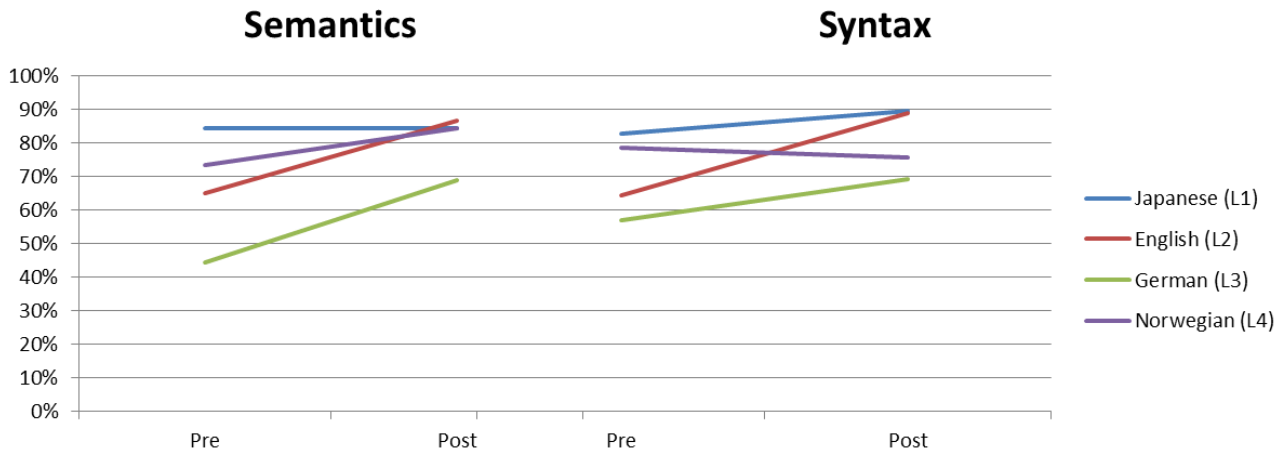

Figure 1. Per cent accuracy pre- and post-SFA on the Bilingual Aphasia Test, divided into linguistic clusters (Paradis & Libben, 1987, p. 213)

Treatment protocol

The treatment was provided during an intensive schedule of 29 sessions divided on three days per week for 2.5 weeks. In total this amounted to about 22 hours of therapy. Most of the sessions lasted for 45–55 minutes, and between nine and fourteen verbs were addressed in each session. Each verb was trained approximately seven times, and the pictures were presented in a random order. The treatment lasted until 80 percent accuracy in naming of the trained verbs was reached.

The treatment programme consisted of three baseline sessions for all languages, followed by two weeks of no treatment, then one pre-test session for each language, 29 SFA treatment sessions and finally one post-treatment session for each language.

Procedure

The SFA therapy provided was essentially adopted from Wambaugh and colleagues (2007; 2014) with some modifications. The semantic features used in this intervention were mostly related to argument structure and semantic roles. They were chosen to trigger information about

- the *agent/experiencer* of the action (asking: "Who usually does this?"),
- the *theme/patient* ("What/who is it done to?"),
- the *usual location* ("Where does this action happen?"),
- the *purpose of the action* ("Why does this happen?"),
- the *means of carrying out the action* ("What part of the body or what tool is used to make this happen?"), and
- the *related objects or actions* that reminded the participant of the target verb ("What does it make you think of?").

Even though these features in reality trigger a noun, the underlying focus was to retrieve the verb describing the action of the pictures, focusing on features connected to the argument structure of the target verbs. The aim was thus to strengthen the connections in order to retrieve the verb. The studies of Wambaugh and colleagues focused on single word retrieval, while this study aimed to retrieve the verb within a simple sentence.

In the intervention a picture of the target action was placed in the centre of a diagram (Appendix 1), and the participant was asked to name the verb referring to this action. Often (especially in the first sessions) she was not able to name the verb, and then the speech and language therapist (SLT) guided her through each of the six semantic features mentioned above, by asking the questions: "Who usually does this?" etc., to elicit information about each of the six features. These features were addressed one at a time and in the same order for each target verb. The participant's responses were written on the diagram. When she was unable to produce an appropriate feature, the SLT would prompt or suggest a response. The prompts could be either semantic or phonological. If this procedure was still unsuccessful, the whole word was provided for repetition. After eliciting all six features, the participant was asked to name the target action in the picture once more. If she was unable to respond appropriately, the SLT again prompted her or provided a plausible verb. Then the participant was asked to repeat the verb, and to produce a simple sentence containing it. If the response was appropriate, affirmative feedback was provided, and the next picture was presented. If she had difficulty in producing a correct sentence, the SLT would help her to make a simple sentence. Lastly, the participant repeated the sentence.

The pictures used initially were chosen from the *Verb and Sentence Resources* of *The Newcastle University Aphasia Therapy Resources* (NATR) (Morris, Webster, Whitworth, & Howard, 2012). These are black and white drawings of everyday actions with high naming-agreement. Approximately halfway through the intervention, the pictures were changed so that the participant should not associate the target verb with a particular picture, but rather gain a wider understanding of each trained verb. The new pictures were found online, and were all coloured photographs or drawings. Weekly testing (cf. control measures) showed no effect of the switching of stimulus material.

Assessment

Various types of assessments – more standardised methods as well as spontaneous narrative production – were conducted before, during and after the period of intervention.

Baseline

Three baseline examinations were conducted prior to a two-week period of no intervention to establish a stable baseline. Two measures were obtained for the baseline in each of the

participant's languages: an action-naming test where the aim was to produce a simple sentence for each picture, and the production of a personal narrative (see descriptions below). The narratives were conducted in two of the three baselines. Each baseline was conducted with three days apart, and at each baseline all four languages were assessed on the same day. The language order of the assessments was counterbalanced, to avoid an order effect.

Control measures

Weekly, during the SFA treatment, the participant was tested with one related and one nonrelated task as a control in the treated language. The related task consisted of naming of 20 untrained verbs, and the nonrelated task consisted of repetition of 30 nonwords. For repetition of nonwords, subtest 8 from the Norwegian version of PALPA (Kay, Coltheart, & Lesser, 2009) was used.

Pre- and post-tests

Before and directly after the SFA treatment an action-naming test (cf. action-naming test) and the BAT were administered[4], in addition to the elicitation of a personal narrative. The following versions of the BAT were used: Norwegian (Paradis & Knoph, 2010), English (Paradis, Libben, & Hummel, 1987), German (Paradis & Lindner, 1987) and Japanese (Paradis & Hagiwara, 1987).

Lexical measures

For the action-naming test pictures from the NATR were used both in Norwegian (119 pictures) (Morris et al., 2012) and English (120 pictures) (Morris, Webster, Whitworth, & Howard, 2009). This tool does not exist for Japanese and German, so for these two languages pictures from two tests that have been widely used for assessing action naming were selected, namely the *Naming of Verbs* subtest from *Verb- og setningstesten* (VOST) (Bastiaanse, Lind, Moen, & Simonsen, 2006) and the *Action Naming Test* (Obler & Albert, 1979). These sets of verbs are all everyday words. Factors like word frequency, imageability, word length etc. are not controlled for in the resources. To control the naming-agreement of these assessment tools for Japanese and German, they were checked by three native speakers of each language. Some

of the items overlapped and were therefore omitted. In total, the action-naming baselines for Japanese and German consisted of 89 different verbs.

In the Norwegian baseline tests, the participant produced 41 of the 119 verbs at all three baselines. Seventy-eight of the verbs she produced either not at all or only once or twice at the baselines. These were divided into two groups: 44 were used for training, and 34 were used as untrained controls.

Semantic and syntactic measures

To assess semantic and syntactic abilities in general, selected subtests from the BAT were chosen. A primary aim of the BAT is to enable comparison of multilingual individuals' relative ability in their languages (Paradis, 2008; Paradis & Libben, 1987); hence, it is relevant for measuring therapy transfer (Miller Amberber, 2011). The BAT was chosen because it is the only assessment tool available in all the languages relevant for the present study. The semantic domain was assessed with the following subtests: semantic categories, synonyms, antonyms, semantic acceptability, semantic opposites and listening comprehension (Paradis & Libben, 1987, p. 213). To measure changes at the syntactic level the following subtests were used: syntactic comprehension, semi-complex and complex commands and grammaticality judgment (Paradis & Libben, 1987, p. 213).

Highly proficient speakers of each language administered the testing, and the first author was present during most of the assessments. The BAT subtests were scored in line with the BAT manual (Paradis & Libben, 1987). In order to ensure the reliability of the testing, the test administrators were briefed about conducting the test and also about communicating with people with aphasia by the first author. The BAT subtests were scored jointly by the test administrators and the first author, in line with the standards given in Paradis and Libben (1987).

Measures for narrative analysis

For the narrative production, the participant was asked to talk about a movie she had seen, a book she had read, a trip she had made or a happy moment in her life, in all languages (cf. e.g. Kempler & Goral, 2011). She was encouraged to tell a different story at each measurement, so that she did not practice the same story every time. The narrative production sessions were audio- and videotaped.

The narrative analysis relied on various word, sentence, and discourse-level variables. Lexical measures included the number of verbs produced (types and tokens), including auxiliaries, modal verbs etc. At sentence level, the basic analytical measure was the *Analysis of Speech Units* (AS-unit), defined as "a single speaker's utterance consisting of an independent clause, or sub-clausal unit, together with any subordinate clause(s)" (Foster, Tonkyn, & Wigglesworth, 2000, p. 365). Each AS-unit was scored for completeness and complexity on a five-point scale in line with Altman and colleagues (2012). In addition, each unit was scored as grammatical or ungrammatical.

To investigate the quality of the discourse, the total number of words produced (including false starts and repetitions) and the number of utterances were counted, and a calculation of the speech tempo (words per minute) was performed. In addition, to investigate whether the narratives improved in terms of content, the number of correct information units (CIUs), a measure of content production in discourse which comprises words that are "accurate, relevant and informative relative to the eliciting stimuli" (Nicholas & Brookshire, 1993, p. 340) was counted, and the percentage of words that convey appropriate information were also measured.

All the narratives were transcribed orthographically by a native speaker or a highly skilled speaker with a university degree in the relevant language. The first and second author checked all the transcriptions apart from the Japanese. The Japanese narratives were transcribed in collaboration by two proficient speakers in order to ensure reliability of the transcriptions. The printed transcriptions of the narratives were used for scoring, and transcription disagreements were discussed and resolved before scoring. The two first authors scored all the transcripts in Norwegian, English and German. Six months after the initial scoring, approximately 1/3 of the transcriptions in Norwegian and English were rescored by the two first authors. For both languages, interrater agreement for scoring of the different variables varied between 82 % and 97%.

Analysis

The results given below show performance in the treated language, within-language performance and cross-linguistic transfer effects on the action-naming test, the BAT and the narratives. To evaluate the significance of the results on the action-naming test and the BAT, the McNemar test for paired analysis was used. This is a non-parametric alternative to the t-

test, typically used to measure changes in participants' scores on, for instance, language tests (Field, Miles, & Field, 2012). Here it was used to measure pre- to post-SFA changes.

Pre- and post-treatment scores were also compared by calculating the effect size. This provides a measure of observed change which allows clinicians and researchers to develop a sense of the strength of the specific treatments (Beeson & Robey, 2006). Busk and Serlin's d_1 (1992) is a variation of Cohen's *d* for determining effect sizes, and according to Beeson and Robey (2006) it is the most reliable estimator for quantifying changes in the level of performance and has been used to calculate pre-post treatment effect for within-subject studies. d_1 was calculated for the narrative measures and the action-naming tests (where multiple baselines were obtained). Only one observation in the post-treatment period was used to calculate d_1. A larger number of observations would doubtlessly have given a better estimate and could also have provided information about the long-lasting impact of the treatment. However, since the participant in the study received another treatment after the SFA, the follow-up results are likely to be affected by this last method and are hence not reported here. Effect sizes larger than 1.0 were considered meaningful, and for scores given in percentages, a change of 10 % or more was considered clinically significant (e.g. Goral & Kempler, 2009; Goral et al., 2013; Holland & Crinion, 2012).

The participant was stable throughout baseline testing, and the results of the action-naming test fluctuated less than 15 % for the verbs in all the languages across the trials. During the intervention period, no change could be seen on either of the control tasks; neither in the naming of untrained verbs (p = .288) nor in the repetition of non-words (p = 1).

Results

In the following, the results on the standardised tests are presented first – i.e. the pre- and post-SFA results of the action-naming test and the results of the standardised assessment of syntax and semantics in the BAT. Then the results from the narratives are presented – on lexical, sentence, and discourse variables respectively.

Action-naming test

For details of the action-naming test results, see Table 1.

Table 1. Action-naming test results in Japanese (L1), English (L2), German (L3) and Norwegian (treated L4) (percentage accuracy and effect size)

Languages	Pre-SFA	Post-SFA	Effect size
Japanese	48 %	45 %	d_1 = -0.08
English	61 %	54 %	d_1 = **-1.70**
German	11 %	**23 %***	d_1 = **10.50**
Norwegian trained	10 %	**71 %*****	d_1 = **10.07**
Norwegian untrained	53 %	60 %	d_1 = 0.97

*** $p < .001$; ** $p < .01$; * $p < .05$

Significant changes are highlighted in bold.

Effects in the treated language

In Norwegian (L4), the production of trained verbs increased significantly post-SFA ($p < .001$), with a large effect size ($d_1 = 10.07$). No generalisation to the untrained verbs was found.

Cross-linguistic transfer

Different patterns of cross-linguistic transfer to verbs in the untreated languages were found. Following the treatment a decrease was evident in English (L2) ($d_1 = -1.70$). For German (L3) there was a significant increase in naming target verbs ($p = .033$) with a large effect size ($d_1 = 10.50$). In Japanese (L1) there were no significant changes in verb naming.

BAT results: Semantics

For details on the BAT results, see Table 2.

Table 2. BAT results in semantics and syntax in Japanese (L1), English (L2), German (L3) and Norwegian (treated L4), pre- and post-SFA treatment in Norwegian (percentage accuracy)

BAT subtest	**Cutoff**[a]	**Japanese (%)**		**English (%)**		**German (%)**		**Norwegian (%)**	
		Pre-SFA	**Post-SFA**	**Pre-SFA**	**Post-SFA**	**Pre-SFA**	**Post-SFA**	**Pre-SFA**	**Post-SFA**
Semantics									
Semantic categories	4 (80)	80	80	80	80	40	40	60	**100**
Synonyms	4 (80)	100	**80**	20	**100**	20	**100**	80	**100**
Antonyms	8 (80)	70	70	70	**90**	60	**80**	90	**80**
Semantic acceptability	9 (90)	100	100	90	**100**	70	**90**	100	**90**
Semantic opposites	9 (90)	70	**80**	50	**60**	30	30	40	**80**
Listening comprehension	4 (80)	100	100	NA	100	20	**80**	60	60
Syntax									
Simple & semi-complex commands	9 (90)	100	100	100	100	60	**100**	100	100
Complex commands	12 (60)	80	80	40	**20**	0	**60**	40	**20**
Syntactic comprehension	75 (87)	80	88	66	**94**	64	71	82	83
Grammaticality judgment	9 (90)	100	100	50	**70**	40	40	60	**30**
Clusters									
Semantic cluster	-	84	84	65	**87***	44	**69***	73	**84**
Syntactic cluster	-	83	90	64	**89*****	57	**69***	79	76
Overall score	–	86	90	72	**85*****	59	68*	76	81

[a)] Cutoff scores for normal performance given in Paradis & Libben, 1987, p. 210; percentages in brackets.

*** $p < .001$; ** $p < .01$; * $p < .05$

Changes exceeding 10 % are highlighted in bold.

Effects in the treated language

For Norwegian (L4), no significant improvement was found in semantics as a cluster.

Cross-linguistic transfer

In English (L2) a significant increase was evident in the semantic domain (p =.026), with improvements in nearly all subtests. Also in German (L3) there were significant increases in this domain (p = .021), with positive changes in most of the subtests. For Japanese (L1), no significant improvements in semantics were found.

BAT results: Syntax

Effects in the treated language

In Norwegian (L4) no change was apparent in the syntactic cluster.

Cross-linguistic transfer

For English (L2) a significant increase was evident in the syntactic domain (p < .001). Also in German (L3) there were significant increases in the syntax (p = .036). In Japanese (L1) no significant changes in syntax were found.

Narrative production

For details of the narrative results, see Table 3.

Table 3. Narrative results in Japanese (L1), English (L2), German (L3), and Norwegian (L4) with effect sizes

Narrative		**Japanese (L1)**			**English (L2)**			**German (L3)**			**Norwegian (treated L4)**		
		Pre-SFA (mean)	**Post-SFA**	**Effect size**	**Pre-SFA (mean)**	**Post-SFA**	**Effect size**	**Pre-SFA (mean)**	**Post-SFA**	**Effect size**	**Pre-SFA (mean)**	**Post-SFA**	**Effect size**
Lexical variables	**Verb tokens**	82 (42.58)	68	d_1 = -0.33	33.25 (15.39)	56	**d_1 = 1.48**	15.33 (18.39)	27	d_1 = 0.62	41.67 (23.01)	77	**d_1 = 1.54**
	Verb types	69.67 (33.86)	59	d_1 = -0.32	29.75 (15.67)	45	d_1 = 0.97	12.67 (15.14)	18	d_1 = 0.35	35.33 (16.50)	68	**d_1 = 1.98**
Sentence variables	**Complex sentences**	5	1	**d_1 = -1.14**	1	0	d_1 = -0.87	0	1	*	0	7	**d_1 = 11.55**
	Sentence completeness	2.89	2.16	**d_1 = -1.08**	1.34	1.26	d_1 = -0.61	1.14	1.25	**d_1 = 5.82**	1.54	2.16	**d_1 = 20.24**
	Grammatical sentences	25/34 (74%)	34/47 (72%)	-2%	34/62 (55%)	48/80 (60%)	5%	13/30 (43%)	30/60 (50%)	**50%**	26/51 (51%)	19/49 (39%)	**-12%**
Discourse variables	**Total words**	595 (283.61)	440	d_1 = -0.79	269.75 (182.95)	377	d_1 = 0.59	123 (102.2)	254	**d_1 = 1.28**	254 (146.84)	403	**d_1 = 1.01**
	Words/minute	30.25	26.27	**d_1 = -2.02**	18.64	23.44	**d_1 = 1.06**	7.75 (3.08)	14.21	**d_1 = 2.10**	19.03	30.04	**d_1 = 4.51**
	Number of utterances	34	47	d_1 = 0.98	62	80	d_1 = 0.33	30	60	**d_1 = 1.23**	51	49	d_1 = -0.05
	CIUs	250	209	d_1 = -0.37	100.50	163	d_1 = 0.92	37	28	d_1 = -0.24	111	242	**d_1 = 2.21**
	CIUs/total verbal units	43 %	48 %	5 %	37 %	43 %	6 %	28 %	11 %	**-17 %**	44 %	60 %	**14%**

Significant effects are in bold

* Not available since pre-mean is 0

Lexical variables

Due to the treatment focus on verbs in sentence contexts, the lexical measures are total number of verb tokens and the number of verb types produced.

Effects in the treated language

In Norwegian (L4) there was a significant increase in the number of verb types (d_1 = 1.98) and tokens (d_1 = 1.54) in the narrative production post-SFA.

Cross-linguistic transfer

Analyses of the lexical variables in the untreated languages show mixed results. In English (L2) there was an increase of verb tokens (d_1 = 1.48). In German (L3) and Japanese (L1) there were no changes at the lexical level.

Sentence variables

The sentence variables are completeness, complexity and grammaticality of sentences.

Effects in the treated language

Following treatment the sentences produced in Norwegian (L4) were more complete (d_1 = 20.24). There was also a considerable increase of complex sentences (level 4 and 5 in the AS-unit scale) post-treatment (d_1 = 11.55). However, a decrease of the number of grammatical sentences was evident (-12 %).

Cross-linguistic transfer

In English (L2) no changes in the sentence variables were found, in either direction. In German (L3), the participant's sentences were more complete following treatment (d_1 = 5.82). In addition, the number of grammatical sentences increased post-SFA (50 %). In Japanese (L1), a significant

decrease of the complex sentences (d_1 = -1.14) was evident, and the sentences also became less complete (d_1 = -1.08).

Discourse variables

The discourse variables are the total number of words produced, the number of utterances, of CIUs and the percentage of words that were CIUs, as well as speech tempo (words per minute).

Effects in the treated language

The total number of words increased in the Norwegian (L4) narrative production (d_1 = 1.01), as well as the speech tempo (d_1 = 4.51). The number of utterances produced did not change, but the content in discourse improved significantly (d_1 = 2.21), as did the percentage of words that were CIUs (14 %).

Cross-linguistic transfer

In English (L2) no significant changes in the discourse was found, apart from an increase in speech tempo (d_1 = 1.06). In German (L3) an increase in the total number of words produced (d_1 = 1.06) and in speech tempo (d_1 = 2.10) was found, as well as a significant change in the number of utterances (d_1 = 1.23). However, a significant decrease in the percentage of words that were CIUs (-17 %) was evident. In Japanese (L1), no significant changes were evident, apart from a decrease in speech tempo (d_1 = -2.02).

An overview of all the assessment outcomes is found in Table 4.

Table 4. Overview of assessment outcomes

	Japanese (L1)		**English (L2)**		**German (L3)**		**Norwegian (treated L4)**	
	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
Lexical level (action-naming test)	×	×		√	√		√ (trained)	
Semantics (BAT)	×	×	√		√		×	×
Syntax (BAT)	×	×	√		√		×	×
Lexical level (narratives)	×	×	√ tokens		×	×	√ types tokens	
Sentences (narratives)		√ complete complex	×	×	√ complete grammatical		√ complete complex	√ grammatical
Discourse (narratives)		√ words/ minute	√ tempo		√ words/ minute, words, number of utterances	√ CIU	√ words, tempo, content, CIU	

√ = significant improvement; × = no significant change

Discussion

This study investigated the impact of SFA treatment on verbs in sentence contexts of a quadrilingual speaker with aphasia. The findings are discussed in relation to the three research questions presented above. Several of the findings are consistent with the expectations.

Intervention effects in the treated language (Norwegian)

The first research question concerned whether SFA therapy on verbs in sentence contexts would result in improvements at different linguistic levels in the treated language.

At the lexical level, clear effects were found. SFA treatment focuses on strengthening the semantic network (Boyle & Coelho, 1995), and this resulted in great improvements on the trained items in the treated language for the participant in the study. The trained verbs improved so much

more than the untrained verbs that this can be taken as a direct treatment effect, providing support for the benefit of this type of therapy for this multilingual participant. The lack of improvement in the control tasks also gives support to the assumption of a direct effect of the treatment. An improvement was also found in the lexical variables in the Norwegian narratives. Post-treatment the participant produced more words, more verbs, and a wider variety of verbs. This was in line with the expectations, given the focus of the treatment. Furthermore, it is in line with other studies on verb retrieval using SFA (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014), but the effect of this method on verb retrieval has not been investigated for multilingual speakers in previous studies. The above also supports the findings of SFA studies on object naming, where an improvement on the trained items occurred for most participants (Boyle, 2010).

In general, it seems to be harder to achieve generalisation from trained to untrained items for verbs than for nouns (Webster & Whitworth, 2012), and the above-mentioned studies by Wambaugh and colleagues did not succeed in facilitating generalisation to untrained items. This was also found in this study. The participant did not show any generalisation effects to the untrained verbs in the action-naming test in the treated language.

In the semantic and syntactic domains as measured by the BAT no significant improvements in the treated language were found. However, even if the syntactic domain of the BAT did not improve, the sentences in the narrative were more complete and complex post-SFA, although they also became less grammatical. It seems like the narrative production task taps other aspects of the syntax than the subtests of the BAT, which are all comprehension or judgement tasks, rather than production tasks. It is possible that when she aims at producing sentences that have a more complete and complex structure, this happens at the expense of grammaticality. It should be noted that sentence grammaticality was not targeted directly in the treatment. Thus, this did not confirm the expectations. It was furthermore anticipated that the semantic nature of the treatment would have an impact in the semantic domain. One possible explanation is that the treatment did not trigger the semantic network of this speaker. However, the semantic subtests of the BAT are few, and in the narratives the content of the sentences actually improved.

The increase of complex and complete sentences in the narrative may be a result of the treatment triggering verbs at the lemma level in that the trained features tapped argument structure. As the lemma contains information required for grammatical encoding in the particular language (de Bot, 1992, 2004; Levelt, 1989) it was predicted that the treatment would strengthen the semantics and the syntax, and this was partially what was found.

Cross-linguistic transfer

The second research question addressed whether SFA therapy on verbs in sentence contexts could lead to cross-linguistic transfer. No transfer was found to Japanese; this will be discussed later. Transfer was found to German in the naming of verbs, as well as improvements in both semantics and syntax. In English, apart from the decline in the naming of verbs, the participant seemed to benefit from the treatment. She produced more verb types and tokens in the English narratives, as well as showing improvements in the semantics and syntax following the treatment.

This improvement of verbs in the untreated languages is an important finding, given the challenges in achieving transfer to untrained verbs in general (Webster & Whitworth, 2012) and following SFA treatment specifically (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014). Similar results have been found in prior studies of SFA in bilingual speakers (Edmonds & Kiran, 2006; Kiran & Roberts, 2010), with cross-linguistic transfer in some conditions for some participants.

Cross-linguistic transfer may be difficult to achieve (Ansaldo & Ghazi Saidi, 2014; Faroqi-Shah et al., 2010; Kohnert, 2009). However, it was expected that the semantic (rather than phonological) nature of the therapy would lead to transfer, and this was partly confirmed. The results are hence consistent with the findings of Altman et al. (2012) where, following treatment of sentence production, positive changes to varying degrees in narrative structure and sentence grammaticality in the languages of a trilingual speaker with aphasia was found. Such cross-linguistic semantic transfer may occur when a concept in the target language is activated, which in turn also activates semantically related words in the other languages (Costa & Caramazza, 1999; de Bot, 1992; Edmonds & Kiran, 2006; Green, 1998).

In the present study, the goal was to improve verb naming in sentence contexts, thus the participant's improvements in sentence complexity for some of the languages serve as evidence for generalisation from the treatment provided to more functional language skills. This may be related to the nature of verbs, which are connected to larger grammatical structures, for instance through argument structure. In addition, the nature of the treatment may have contributed to these improvements, in that the treatment indeed stimulated the semantic network. The participant's improvements on verbs in German, carrying over to semantics and syntax, suggest that she managed to apply semantic feature generation as a strategy, at least for this language.

Discourse production

In aphasia rehabilitation, an overall goal is to enable people to improve their general language skills, to be able to communicate functionally in daily life contexts. SFA treatment of single words (both object and action words) resulted in an improvement in the participants' discourse production in some, but not all, of the earlier studies (Coelho et al., 2000; Davis & Stanton, 2005; Peach & Reuter, 2010; Wambaugh et al., 2014). The two first research questions therefore also addressed the issue whether SFA therapy on verbs in sentence contexts could have a positive effect at the discourse level (narrative production) in all the speaker's languages. It was expected that an improved access to verbs and improved sentence production could lead to an improved discourse production.

In the treated language the participant showed great improvements of the narratives. Even if the sentences became less grammatical, the increase in speech tempo and the great increase of complex sentences, in combination with the improved content of the sentences, indicate that the communication skills in the treated language improved substantially.

The findings are congruent with results from past studies on monolingual aphasia, for instance Bastiaanse, Hurkmans, et al. (2006), who reported gains in sentence production where verb retrieval in sentence contexts was targeted. Similar findings were reported by Webster et al. (2005), where the focus was on verb and argument structure. The features used in the present intervention were related to argument structure and semantic roles; hence, the findings of the

present study support these previous studies. Also, Wambaugh and colleagues (2007; 2014) found improvement in discourse production in some of the participants following SFA treatment.

Following treatment in Norwegian the participant increased speech tempo in both English and German. When it comes to the content of the discourse in the untreated languages, measured by amount of CIUs, no clear improvements were detected, apart from a somewhat better content in English, which can be interpreted in relation to the increased use of verbs. It may therefore seem that she, at least for some of the languages, was able to implement the SFA strategy in new contexts of language use. Wambaugh et al. (2014) point out that increased feature generation could result in relevant or non-relevant feature production. The increase in words per minute in all the languages but L1, the increase of verb tokens in Norwegian and English, and also the finding of a larger production of related information (CIUs) in Norwegian and English and a great improvement of several of the measures of German all indicate that this was the case for most of the languages of the participant.

Inhibition of untreated languages

Finally, for the last research question – whether treatment in a late-acquired language would lead to inhibition of earlier-acquired languages – no clear inhibition of the untreated languages was found. The results for English are in line with the suggestions of Kiran and colleagues (2006; 2011) in that treatment in a premorbidly weaker language is more likely to enhance cross-linguistic transfer to untreated languages. As previously presented, treatment transfer to several of the domains in English was found and hence there was no inhibition of this language. As for German, overall improvements at both the lexical, the semantic and the syntactic levels were evident, hence there was no clear inhibition of this language either. German was the pre- and postmorbidly weakest language, and it is likely that this language had the greatest potential for recovery. Thus, this contradicts the view of Kiran and colleagues (2006; 2011), but supports Goral (2012) who suggests that treatment in a postmorbidly stronger language can enhance the possibility of treatment transfer. Another explanation could be that German is structurally very

similar to Norwegian, and this can increase the possibility of transfer (Ansaldo & Ghazi Saidi, 2014; Goral et al., 2010; Miertsch et al., 2009).

Regarding Japanese, the participant's L1, no clear inhibition was detected neither in the verb production nor in the BAT-scores. In the narratives, no significant changes were identified, apart from the significant decrease in sentence complexity and speech tempo. However, this may be seen in relation to a near-significant increase in the number of utterances. When producing more utterances, the outcome happens at the expense of complexity and speed in the L1. This decrease may be too small to be interpreted as a negative effect of the stronger language, as reported by Goral et al. (2013). The slight decrease in some of the measures may be due to the increased activation of Norwegian – and German, which she had not used frequently for years. On the other hand, the results in Japanese could also reflect a plateau effect, given the fact that both pre- and post-stroke proficiency was higher in this language than in the other languages (and on some measurements almost at ceiling level). In addition, it is also the most typologically dissimilar language to Norwegian of all the untreated languages. This, too, might have influenced the lack of transfer to Japanese.

These results are considered valid, given the low cut-off for significance. Hence, no clear inhibition to any of the untreated languages was found. The findings corroborate the conclusions of Kohnert (2009) and Faroqi-Shah et al. (2010), in that no harm is done to any of the untreated languages when providing treatment in a late-acquired language.

Clinical implications and conclusion

The participant in this study demonstrated improvements on trained verbs following SFA treatment. She also improved in semantics, syntax, and in discourse production in both the treated and in some of the untreated languages. The results discussed above indicate that SFA targeting verbs may be a promising therapy not only for monolingual speakers, but also for multilingual speakers with aphasia.

The concern for inhibition of the untreated languages, especially the L1, was not confirmed. This is an important finding theoretically as well as clinically. Greater harm may be done to a

bilingual speaker with aphasia if no treatment is provided at all (which is sometimes the case, at least in Norway (cf. Knoph, 2013)), than if treatment in a weaker language is provided. As this study demonstrated, treatment in a late-acquired language can even benefit untreated, stronger languages at different linguistic levels.

This study was not conducted to evaluate the multilingual language system, but data from clinical treatment studies of individuals with cognitive disorders may be useful in developing and evaluating theories of normal cognition (Nickels et al., 2010). As reported initially, there is a general consensus that both/all the languages of bilinguals are active when they are producing utterances in one of their languages (e.g. Kroll et al., 2015), and that multilingual speakers have one shared conceptual system for all of their languages. Cross-linguistic transfer from a treated to an untreated language in aphasia therapy is an indication of such shared networks. Thus, to a large extent the findings support the idea of shared networks of multilinguals, indicated by the great improvement of German and English.

The use of narratives as an assessment tool provided information not obtainable from more specific tests and general language assessment for within- and cross-language therapy gains for the participant. Both for strong languages, like the participant's L1, Japanese, and for the weaker L4, Norwegian, the narratives revealed a different pattern than, for instance, the BAT scores. In addition, using narratives for assessment enhances the ecological validity of the findings, since improving functional language production often is the overall goal in aphasia therapy. It seems important to develop reliable and practical methods to assess the connected speech of the clients in supplement to more traditional assessment methods.

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Declaration of interest

There are no conflicts of interest.

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Appendix 1. SFA diagram

HVEM GJØR DETTE VANLIGVIS? *Who does this usually?* _____	HVA BLIR DET GJORT MED? *What/who is it done to/with?* _____	HVOR SKJER DETTE VANLIGVIS? *Where does this usually happen?* _____
	MÅLBILDE *Picture of target word*	
HVORFOR SKJER DET (MENINGEN)? *Why does it happen?* _____	HVILKEN DEL AV KROPPEN/HVILKET VERKTØY? *Which part of the body/What tool is used?* _____	HVA FÅR DET DEG TIL Å TENKE PÅ? *What does it make you think of?* _____

English translation in italics.

Paper IV

Verb production treatment in sentence contexts in fluent and nonfluent multilingual aphasia

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IV

Verb production treatment in sentence contexts in fluent and nonfluent multilingual aphasia

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Abstract

Previous research on bilingual aphasia shows equivocal results of cross-linguistic transfer and inhibition. This study explores the impact of verb-production treatment in the treated and untreated languages of two bilingual speakers with fluent and nonfluent aphasia. Main goals are to explore two different treatment methods and explore their applicability for enhancing cross-linguistic treatment transfer, and to investigate possible inhibition of the untreated languages. The data provide evidence to positive effects of treatment in one language, both in the treated language, and in the other, untreated language of the speaker. Importantly, treatment in one language did not harm the other language. Furthermore, verb-production treatments in sentence contexts resulted in improvement in discourse production. The results corroborate theories on the nature of the verb and its role in sentence production, and provide evidence for a shared conceptual network of the languages in bilingual speakers, supporting current models of bilingual language processing.

Keywords: bilingual; aphasia; cross-linguistic transfer; inhibition, bilingual language processing

Aphasia is an acquired language disorder induced by a focal damage to the brain, most commonly caused by stroke (Lesser, 1989). Language comprehension and production are impaired to varying degrees in speakers with aphasia. In this paper, two aphasia types will be distinguished: fluent and nonfluent aphasia (Tesak & Code, 2008). Aphasia syndromes that are characterised with fluent speech are e.g. Wernicke's aphasia, conduction aphasia and anomic aphasia, according to the Boston classification (Tesak & Code, 2008). Aphasia syndromes that are associated with nonfluent speech are e.g. Broca's aphasia and transcortical motoric aphasia (ibid.). One of the core symptoms of aphasia is word retrieval impairments, known as anomia. Verb retrieval is found to be especially challenging, both for monolingual (e.g. Berndt, Haendiges, & Wozniak, 1997; Mätzig, Druks, Masterson, & Vigliocco, 2009) and multilingual speakers with aphasia (Ansaldo, Ghazi Saidi, & Ruiz, 2010; Faroqi-Shah & Waked, 2010; Kambanaros & van Steenbrugge, 2006). The present study explores the impact of verb-production treatment in the treated and untreated languages of one trilingual speaker (Portuguese-Ronga-Norwegian) with nonfluent aphasia and one bilingual speaker (English-Norwegian) with fluent aphasia. Treatment was conducted in Norwegian, a late-acquired language for both speakers, and treatment effects were measured in restricted (formal language testing) and less restricted (narrative production) tasks. Research on multilingual aphasia is clinically important. In addition, it is highly relevant for linguistic models as it may provide insights on language representation and processing in the brain of a bilingual speaker.

Cross-linguistic transfer and inhibition

The overall goal in aphasia therapy is to improve the individual's abilities to communicate despite his or her language impairment. Following this, treatment aims not only to improve the trained items, but also to generalise the effects to untrained items or untreated modalities. For multilingual speakers with aphasia, improved communication abilities in both or all languages needed for participation in meaningful life activities is an overarching goal of treatment (Kohnert, 2009). Consequently, cross-linguistic transfer is often a goal, since treatment of all the languages of the client is often not achievable. Several studies have reported transfer to the untreated language(s) when treatment was provided in a weaker language (e.g. Edmonds & Kiran, 2004, 2006; Knoph, 2013; Knoph, Lind, & Simonsen, in press; Kurland & Falcon, 2011; Marangolo, Rizzi, Peran, Piras, & Sabatini, 2009). Moreover, it has been suggested that semantic treatment facilitates cross-linguistic transfer more than phonological treatment does (Croft, Marshall, Pring, & Hardwick, 2011; Edmonds & Kiran,

2004; Kiran & Iakupova, 2011; Kurland & Falcon, 2011). Cross-linguistic transfer is attainable on the assumption of a shared conceptual system of all the languages, as proposed by current models of multilingual language processing (e.g. de Bot, 2004; Kroll & Stewart, 1994; Pavlenko, 2009), and the idea is that the less proficient L2 relies upon the stronger L1.

A possible unwanted effect of language treatment in one of the languages of a multilingual speaker with aphasia is inhibition or decline, of the untreated languages. Contradicting the above-mentioned findings of cross-linguistic transfer, some studies have found inhibition (i.e. decline) of a stronger language when treatment is provided in a postmorbidly weaker language (Goral, 2012; Goral, Naghibolhosseini, & Conner, 2013). The authors explain this inhibition with an asymmetric switching cost. That is, when an individual is speaking in one language, the other language needs to be inhibited. Inhibiting a stronger language is more demanding than inhibiting a weaker one, due to a presumably stronger activation of the stronger language in the first place (Costa & Santesteban, 2004; Green, 1998; Meuter & Allport, 1999). However, this question needs further examination, as recent reviews of therapy studies for multilingual speakers with aphasia have found no clear evidence that therapy in one language harms the untreated languages (Faroqi-Shah, Frymark, Mullen, & Wang, 2010; Kohnert, 2009).

Verbs and verb-treatment studies in multilingual aphasia

Verbs have a central communicative role in language production (de Diego Balaguer et al., 2006). Thus, difficulties in verb retrieval may lead to problems in daily communication. Verbs in general have more complex semantic representations than nouns (Masterson, Druks, & Gallienne, 2008). In a sentence, verbs must have a subject, assign arguments with semantic roles such as agent and theme, and are connected to other words and larger grammatical structures, both semantically and syntactically (Levelt, 1989; Vigliocco, Vinson, Druks, Barber, & Cappa, 2011). According to the spreading activation theory (Collins & Loftus, 1975), activation of a concept involves activation of its features, as well as other concepts with shared features. When the treatment focuses on the meaning of the word and not primarily on targeting the word form (which would have been the case in a mere repetition task), and when verb treatment is provided in sentence contexts, the verbs are presumably treated at the lemma level, rather than at the lexical level. Given parallel activation in all languages of a multilingual speaker (Kroll, Dussias, Bice, & Perrotti, 2015), treatment

provided at the lemma level will presumably spread to the related lemmas of the target language and activate lemmas of the untreated languages (de Bot, 2004).

Despite the findings of impaired verb retrieval in multilingual speakers with aphasia (e.g. Hernández, Costa, Sebastián-Gallés, Juncadella, & Reñé, 2007; Kambanaros, 2008, 2010; Kambanaros & van Steenbrugge, 2006; Miozzo, Costa, Hernández, & Rapp, 2010; Weekes & Raman, 2008), verb-treatment studies are scarce in this field. This also reflects the number of verb studies in monolingual aphasia, where few studies have focused on treatment of verb retrieval, regardless of the fact that many speakers with aphasia suffer greater retrieval impairment of verbs compared to nouns (see Mätzig et al., 2009 for a review). Literature on monolingual aphasia indicates that naming of actions can be improved by various treatments for verb retrieval, however, generalisation to untrained items is a challenge (see reviews by Conroy, Sage, & Lambon Ralph, 2006; and Webster & Whitworth, 2012). Bastiaanse and colleagues (Bastiaanse, Hurkmans, & Links, 2006; Links, Hurkmans, & Bastiaanse, 2010) have proposed that verbs should not be treated in isolation, but rather in sentence contexts. In several studies of monolingual aphasia this has shown to benefit sentence production (e.g. Bastiaanse et al., 2006; Edwards & Tucker, 2006; Webster, Morris, & Franklin, 2005). When treating verbs in sentence contexts, the speaker with aphasia is exposed to verbs, nouns, as well as the argument and syntactic structures.

As mentioned, so far few studies have focused on verb retrieval in multilingual aphasia. Goral and colleagues treated a trilingual speaker (Hebrew, English, and French) with nonfluent aphasia in his L2 (English) (Altman, Goral, & Levy, 2012; Goral, Levy, & Kastl, 2010), in two different studies. Both of the studies targeted language production using complete sentences, and not focusing specifically on verb production. Various tasks were used, e.g. picture description, sentence elicitation, exchange of information, and the participant was encouraged to produce complete sentences. Altman et al. (2012) found positive changes to varying degrees in narrative structure and sentence grammaticality in all the languages, including the L1 (Hebrew). Goral et al. (2010) also found improvements in both the treated language and the untreated L3 (French). However, in contradiction to Altman et al. (2012), little transfer was found to the L1 (Hebrew). The lack of generalisation to the L1 was explained by ceiling performance in this language, as well as a possible differential representation and processing of the treated L2 (English) and the untreated L1 due to structural differences between the two languages. Moreover, the authors suggest that the L1, being the first-acquired language, may have a different mental representation from the other

languages. In addition, they assume that, since the L1 was the more-proficient language, this may have affected the occurrence of cross-linguistic transfer to this language.

A similar pattern of a lack of transfer to the untreated L1 was found by Miertsch, Meisel, and Isel (2009) and by Knoph et al. (in press). Miertsch et al. (2009) provided therapy in the L3 (French) of a trilingual speaker (German, English, and French) with Wernicke's aphasia. The treatment focused on exercises with prepositions, semantic–conceptual relationships between words, and word finding of verbs and nouns in a discourse context. The participant showed significant gains in the treated L3, as well as cross-linguistic transfer to the L2 (English), but not to the L1 (German). The findings were explained with the participant's close-to-ceiling performance in the L1. In addition, the treatment was provided over a short time span (23 sessions over 3.5 weeks), and the authors suggest that this may not have been long enough to lead to significant improvements in a language with an already stable linguistic performance. Knoph et al. (in press) investigated transfer effects following treatment in the L4 of a quadrilingual speaker (Japanese, English, German, and Norwegian), with nonfluent aphasia. The treatment focused on verb production in sentence contexts using Semantic Feature Analysis (SFA). Following treatment, an increased ability to name the trained verbs was evident, but there was no improvement of untrained verbs, semantics or syntax in the treated language (Norwegian). However, the participant showed improvements in narrative production in this language. Cross-linguistic transfer at the lexical level and in semantics and syntax was found to L3 (German) and partially to L2 (English). Improvements in discourse production were also evident in these two languages. No changes in the L1 (Japanese) were found. Also in this study, the authors argued that the lack of transfer to Japanese could be a result of an already high (close-to-ceiling) proficiency in this language. Additionally, Japanese is the structurally most dissimilar language to Norwegian compared to the other untreated languages.

In contradiction to the above-mentioned studies where treatment was provided in a later-acquired language, Goral, Rosas, Conner, Maul, and Obler (2012) and Ansaldo et al. (2010) provided treatment in the L1 of the participants. Goral et al. (2012) provided noun and verb retrieval treatment to examine cross-linguistic transfer in a quadrilingual speaker (Spanish, German, French, and English) with nonfluent aphasia. Treatment was administered not only in his strongest language, that is, Spanish (L1), but also in his weakest language, that is, English (L4). Overall, the treatment in English (L4) resulted in improvements in this language, and to cross-linguistic transfer the untreated languages. Treatment provided in

Spanish (L1), on the other hand, led to only slight changes in naming of objects and actions in Spanish, and a limited degree of generalisation to the untreated languages. The authors suggest that treating the language of the environment, which was also his weakest language (English) may have contributed to the findings. Also Ansaldo et al. (2010) provided treatment in the language of the environment. The participant was a bilingual speaker (Spanish and English) with aphasia, for whom verb and noun production treatment was provided in Spanish (L1). Two different treatment protocols were used interchangeably, Switch Back Through Translation and a modified form of SFA, to increase activation of target semantic features. The results showed significant improvement on naming of trained nouns and verbs in Spanish. Regarding cross-linguistic transfer to English, the improvement almost reached significance for both nouns and verbs; however, no transfer to untrained nouns or verbs was found.

Summing up, the findings from all of these studies indicate that treating a later-acquired language may be beneficial in enhancing cross-linguistic transfer (Altman et al., 2012; Goral et al., 2010; Goral et al., 2012; Knoph et al., in press; Miertsch et al., 2009). However, transfer to an untreated L1 seems to be challenging (Goral et al., 2010; Knoph et al., in press; Miertsch et al., 2009).

Aphasia type

The language impairments associated with nonfluent aphasia are described as predominantly grammatical in nature, whereas those associated with fluent aphasia are primarily lexical-semantic. However, lexical processing is also compromised in nonfluent aphasia, and grammatical errors are regularly observed in fluent aphasia (Bastiaanse & Edwards, 2004). There has been some controversy regarding aphasia type and verb deficits. It has been suggested that verb impairment pertains mainly to speakers with nonfluent aphasia (e.g. Links et al., 2010; Webster & Whitworth, 2012). However, difficulties with verbs have been found in speakers with fluent aphasia as well (Berndt et al., 1997; Luzzatti et al., 2002). In a review of Mätzig et al. (2009), from a total of 63 speakers with aphasia, almost 80 percent demonstrated verb deficits. Almost 60 percent of these individuals had nonfluent aphasia and around 33 percent had fluent aphasia. In contrast, about 22 percent of the individuals in the study demonstrated noun deficits, and this group consisted only of speakers with a fluent type of aphasia.

There are far fewer treatment studies of participants with fluent aphasia than of speakers with nonfluent aphasia (Edwards, 2005; Wilssens et al., 2015), further research is therefore warranted.

Functional assessment

The choice of assessment tools is essential in measuring language recovery. Meta-analyses of studies in lexical retrieval have advocated for the inclusion of other linguistic measures than single word naming (e.g. sentence production and narrative production) across different contexts (e.g. Conroy et al., 2006). Traditional aphasia assessment batteries provide limited information on verb production and the interactions among different processing levels such as those between verb processing, argument structure and sentence production (e.g. Armstrong, 2000; Prins & Bastiaanse, 2004; Rofes, Capasso, & Miceli, in press; Saffran, Berndt, & Schwartz, 1989). This has resulted in an increasing awareness that traditional formal aphasia tests may not be sensitive enough to assess language impairments and recovery in speakers with aphasia (Marini, Andreetta, del Tin, & Carlomagno, 2011). Nevertheless, few studies have included investigations of discourse tasks (Marshall, Pring, & Chiat, 1998; Schneider & Thompson, 2003); thus, there is a need for studies that include such tasks into assessments of treatment efficacy.

Research questions and predictions

The objective of the present study was to investigate the effect of treatment targeting verb production in sentence contexts in two multilingual speakers with aphasia. An important aim was to optimise the possibility of treatment gains and treatment related transfer, rather than comparing the effect of specific treatment methods. Hence, two treatment blocks were provided: *Semantic Feature Analysis* (SFA) (e.g. Wambaugh & Ferguson, 2007) and *communication-based treatment* (e.g. Kempler & Goral, 2011). The trained verbs were expected to improve following treatment, whereas generalisation to untrained verbs was more uncertain (e.g. Webster & Whitworth, 2012). Furthermore, the focus of SFA on lexical-semantic retrieval in particular, and the focus of both the treatment methods on verb production in sentence contexts, allowed us to predict improvement of lexical access, semantics and syntax. The treatments were provided at the lemma level, and it is anticipated that this would add to the possibility of improvement in semantics and in syntax in both the

treated and the untreated language of the participants. Given previous findings of positive effects on discourse production following verb treatment both in monolingual and in multilingual aphasia (e.g. Bastiaanse et al., 2006; Goral et al., 2012; Wambaugh, Mauszycki, & Wright, 2014), one of the aims of the study was improvement in discourse. Due to the presumably shared conceptual networks between the languages of multilingual individuals, transfer to the same linguistic levels in the untreated languages was anticipated.

The study aimed to answer the following research questions:

1) Can verb-retrieval treatment lead to improvement of trained and untrained verbs, lexical access, semantics and syntax, and of narrative production in the treated and the untreated language of multilingual speakers with aphasia?

2) Will verb-retrieval treatment in a late-acquired weaker language cause inhibition of the untreated language?

3) Will individuals with fluent and nonfluent aphasia respond to the treatments in the same way?

4) How can unstandardised assessment (e.g. narratives) complement standardised assessment tools to provide deeper insight into the language impairment and recovery in multilingual speakers with aphasia?

Method

Participants

Two multilingual speakers with aphasia participated in the study. PN is a 50-year-old, right-handed female who grew up as a simultaneous bilingual with Portuguese and Ronga[1] in Mozambique. She moved to Norway and, as an adult learned Norwegian by immersion and through language classes. She suffered a left hemisphere stroke ten months prior to the intervention, which caused a moderate nonfluent aphasia of the Broca type[2]. She reported that she used all three of her languages on a daily basis. The premorbid proficiency level was reported as high for all the languages[3]. Because of fatigue, the assessment tools for this participant were modified (shortened; Appendix 1). Based on the results of the *Bilingual Aphasia Test* (BAT) (Paradis & Libben, 1987), Norwegian was the weakest language post-stroke.

DT is a 75-year-old bilingual, right-handed female. She grew up in Scotland and spoke only English in her childhood. DT learned Latin and German at school, but she rarely used these languages in her adult life. She moved to Norway as an adult, and acquired Norwegian

by immersion. Pre-stroke, she used both English and Norwegian with her husband, and exclusively spoke English to her children and grandchildren. She sustained a left hemisphere stroke that caused fluent aphasia of the Wernicke type, about 18 months prior to the study. This participant also experienced fatigue; hence, the assessment tools were modified. English was her strongest language both prior to, and following the stroke.

Procedures

Each participant received a total of 40–50 hours of treatment. The two different treatment protocols were administered sequentially in an intensive schedule with 20–25 hours each, amounting to approximately 10 hours a week. The order of the treatments was the same for the participants. Each treatment block lasted for 2–3 weeks with a break of two weeks with no treatment in between. The period between post-treatment and follow-up was 13–17 weeks and during this period, no treatment was provided. Both treatment protocols focused on production of verbs in sentence contexts. The treatments consisted of *communication-based treatment* (e.g. Kempler & Goral, 2011), followed by *Semantic Feature Analysis* (SFA) (Wambaugh & Ferguson, 2007), and were provided in Norwegian, a late-acquired language for both of the participants. A trained SLT, with extensive experience from aphasia therapy, conducted the therapy for the participants. Consent was obtained from both participants prior to the study, and the Norwegian Social Science Data Service (NSD) approved the ethical standards of the project.

The communication-based treatment involved no pre-selected verbs. The aim of the procedure was to produce complete sentences to describe different pictures, in order for the interlocutor to identify the pictures. The method has certain similarities to *Promoting Aphasics' Communication Effectiveness* (PACE) (Davis & Wilcox, 1985), including several of the four PACE principles. The SLT and the client participate equally as sender and receiver of the target stimuli, as the dynamic exchange of new information between the SLT and participant is important. The method furthermore includes natural feedback provision. Contrary to PACE, the participants were encouraged (although not constrained) to use spoken language as the means of communication. The method thus corresponds to *intensive language-action therapy*[4] (ILAT) (Difranscesco, Pulvermüller, & Mohr, 2012). The communication-based treatment includes also other principles of ILAT, namely high intensity treatment with massed practice, action-embedded language use relevant for daily life, in addition to focusing and tailoring the treatment to the individuals' communicative abilities

and needs. Different versions of ILAT and PACE have shown to be fruitful for improving language in speakers with chronic aphasia (e.g. Davis, 2005; Goral & Kempler, 2009; Kirmess & Lind, 2011; Kirmess & Maher, 2010).

Analogous with the ILAT, the communication-based treatment included duplicate picture materials, and the client and the SLT had a cardholder each so they were could not look at each other's pictures. In addition, they took turns in describing and guessing the pictures. The SLT modelled correct sentence structure, and if needed, the participants were reminded of the sentence structure being used during treatment. When sentences were produced incorrectly, they were corrected by the SLT. The participants were encouraged to produce simple, but complete sentences containing verbs. In this method, there are no wrong answers, i.e. any verb in a sentence that exchanges relevant information is accepted (Kempler & Goral, 2011). A goal is for the communication to get closer to a natural conversation, so that the ecological validity is enhanced.

The other treatment method, *Semantic Feature Analysis* (SFA) is an approach that aims at enhancing lexical retrieval by improving the access to the semantic network of the speaker (e.g. Boyle & Coelho, 1995; Wambaugh & Ferguson, 2007). The method was initially developed for (single word) noun production, where it has shown promising results in both monolingual and multilingual speakers with aphasia (e.g. Boyle, 2004, 2010; Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Edmonds & Kiran, 2006; Kiran & Edmonds, 2004; Lowell, Beeson, & Holland, 1995). SFA has also been adapted to treatment of verb retrieval in two studies of monolingual speakers (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014), and one with a multilingual speaker with aphasia (Knoph et al., in press).

The procedure was adapted from Wambaugh and colleagues (2007; 2014) (cf. also Knoph et al., in press). The semantic features used in this version of SFA were mostly related to argument structure and semantic roles. The original SFA features of *location* and *association* were maintained since they appear useful for eliciting lexical-semantic information. The features included to address semantic roles involved the *agent/experiencer* of the action, the *theme/patient*, the *purpose*, and the *instrument* (these features are expected to be relevant for eliciting lexical-semantic information as well). The semantic features were triggered by asking the following questions: 'Where does this action happen?' (location), 'What does it make you think of?' (associations), 'Who usually does this?' (agent), 'What is it done to?' (theme), 'Why does this happen?' (purpose), 'What part of the body or what tool is used to make this happen?' (instrument). Wambaugh and Ferguson (2007) point out that for

treatment of verb retrieval involving arguments and thematic roles, generalisation may be affected by the semantic relatedness of the nouns expressed in the arguments.

For PN the procedure was carried out in line with other SFA studies (e.g. Knoph et al., in press; Wambaugh & Ferguson, 2007; Wambaugh et al., 2014) in the following fashion: A picture of the target action was placed in the centre of a diagram (Appendix 2), and the participant was asked to produce a relevant verb referring to the illustration. Whether she managed to do this, or not, the SLT guided her through each of the six semantic features, one at a time. This was done by asking each of the questions above, to elicit information about each of the six semantic features. PN's responses were written down on the diagram. When she could not access an appropriate feature, the SLT would suggest a response, or either semantically or phonologically prompt a possible feature. She was then requested to name the target verb. If she could not produce the verb after naming all the features, the SLT would provide the target verb for PN to repeat it. Finally, she was asked to produce a simple sentence with the target verb. In the cases where she did not succeed in producing a correct sentence, the SLT would suggest a simple sentence, which PN repeated. Positive feedback was provided, and the next picture was presented.

Initially, this method was applied in the same way for DT as well. However, it soon became apparent that she did not fully grasp the rationale behind this method of treatment, probably due to her difficulties with auditory comprehension. She could not generate the required semantic features. Her approach was rather to describe the pictures in a relatively detailed manner. Thus, the treatment procedure was modified. Instead of requesting her to produce the six predetermined semantic features, any three relevant features produced by DT for each picture were accepted. Frequently she would produce irrelevant features, and the SLT would suggest relevant features to the pictures. She was also requested to produce the target verb and a simple sentence to describe the picture. Often, she did not succeed in producing a sentence, and the SLT would suggest a simple sentence for her to repeat. She did not always manage to repeat these sentences.

For each of the participants, the words for the SFA treatment were selected based on their individual performances on the Norwegian baselines. The verbs were selected from a shortened Norwegian version of the *Newcastle University Aphasia Treatment Resources* (NATR), comprising 50 verbs (Morris, Webster, Whitworth, & Howard, 2012). The verbs in NATR are all everyday words with high naming agreement in both the English and the Norwegian version. The verbs in the action-naming test are not matched for relevant

psycholinguistic variables, like frequency, imageability, and number of syllables. However, an analysis of the verbs did not reveal great differences between the verbs. Verbs that were produced correctly at the baselines were not included in the treatment set. PN was able to produce 26 verbs spontaneously twice or thrice in the baselines. The remaining 24 verbs were selected for training. A supplementary set of 22 verbs were included for treatment, to yield a larger practice set of 46 verbs. However, only the 24 targeted items were tested before and after each treatment block. Additionally 20 verbs were selected as untrained controls. DT did not produce any verbs at all three baselines, and only eight verbs were named twice. For her, 30 verbs were selected for treatment, while 20 were chosen to serve as untrained controls.

Pre-treatment measures and outcome measures

Preceding the intervention, multiple baselines were conducted in all the languages where assessment materials were available for both participants. The baselines consisted of an action-naming test where the aim was to produce a simple sentence for each of the 50 pictures. Pictures depicting actions from the English version of the NATR were used for assessing English and Portuguese. The verbs from the English version of the NATR were translated into Portuguese by a professional interpreter, as there is no Portuguese version of these resources (Morris, Webster, Whitworth, & Howard, 2009), and the Norwegian version was used for Norwegian (Morris et al., 2012). In addition, a personal narrative with a different topic was collected each time (see below). The baselines were conducted thrice for each participant. Pre- and post-treatment measures included a modified version of the BAT (Paradis & Libben, 1987) (Appendix 1), the action-naming test, and a personal narrative, and were conducted in all languages of the participants. This paper reports on three measurement points: before and following treatment, and at follow-up. Two types of control measures, one related and the other unrelated were collected weekly during the treatment blocks to ascertain experimental control and to assess the effects of treatment and possible generalisation. These were collected in the language of treatment, and comprised naming of 20 untrained verbs and a non-word repetition task (Kay, Coltheart, & Lesser, 2009). For the narrative elicitation, the participants produced personal narratives about a movie they had seen or a book they had read, or a happy moment or a vacation. They were encouraged to tell a different story at each measurement point, so that they did not practice telling the same story every time. The test sessions including the narratives were recorded on audio- and videotape.

Prior to the treatment, measures of social validation were conducted, to ensure clinical significance. The husbands of the participants completed a measure of functional communication, the Norwegian version of the *Communicative effectiveness index* (CETI) (Lomas et al., 2006). In addition, the Norwegian version of the *Stroke and Aphasia Quality of Life Scale* (SALK-39) was conducted (Berg, Haaland-Johansen, & Hilari, 2010), to better understand the impact of the aphasia on the participants' life. Highly proficient speakers of each language administered all the assessments, and the first author was present during a majority of the assessments.

Analysis

The *McNemar test* was used to test the statistical significance on the BAT and on the action-naming test. This is a non-parametric alternative to the t-test, and it is commonly used to measure changes in participants' scores on, for instance, language tests (Field, Miles, & Field, 2012).

For the narratives, the target category for treatment (verbs; types and tokens) and one class of untreated lexical elements (nouns; types and tokens) were analysed. This was done to investigate whether there was a direct treatment gain for verbs and, if a possible treatment effect would transfer to other grammatical categories not directly targeted in the treatment. For discourse analysis, the total number of words produced (including false starts and repetitions) and the number of utterances was counted, and a calculation of the speech rate (words per minute) was performed. In addition, to investigate whether the narratives improved in terms of content, the number of correct information units (CIUs) was counted. This is a measure of content production in discourse which comprises words that are "accurate, relevant and informative relative to the eliciting stimuli" (Nicholas & Brookshire, 1993, p. 340). In addition, the percentage of words in the sample that conveyed appropriate information was calculated. This measure has good ecological validity, as changes in CIU measures of information content are perceived even by naïve listeners in some studies (Jacobs, 2001; Ross & Wertz, 1999).

Effect size was calculated to compare the pre- and post-intervention scores. The Busk and Serlin's d_1 (1992) is based on within-case variation, and the calculation is done by subtracting the average pre-treatment from the average post-treatment values and dividing them by the standard deviation of the pre-treatment measures. To calculate the standard deviation at least two measurement points pre-intervention are necessary; hence, effect size

was calculated for the narrative measures and the action-naming tests (where multiple baselines were obtained). Effect sizes greater than one were taken as significant (e.g. Goral & Kempler, 2009; Goral et al., 2013; Knoph et al., in press).

For the CETI, a change in scores of 12 percent from one measurement point to the next was considered clinically significant (Lomas et al., 1989). The analysis of the SALK-39 was based on the English norms of the test, since this measure does not have Norwegian norms (Hilari, Byng, Lamping, & Smith, 2003). A score was considered significant if it changed more than one standard deviation under or above the mean (Berg et al., 2010).

Reliability

The BAT subtests were scored by the test administrators and the first author in cooperation, in line with the standards given in Paradis and Libben (1987). Furthermore, Paradis and Libben (1987, p. 213) allocate each of the BAT subtests to one or more linguistic levels, which allows for the measurement of performance at different linguistic levels, including semantics, syntax and lexical access. To ensure the reliability of the testing, the first author briefed the test administrators about conducting the tests and about communicating with people with aphasia. The responses on the action-naming test were transcribed orthographically and if they contained the target verb (in any form) were scored as correct. The narratives were also transcribed orthographically, checked by another listener for transcription reliability, and then coded. Interrater reliability of the coding was checked for 30 percent of the narratives, and the interrater agreement for scoring of the different variables varied between 87 percent and 99 percent.

Results

Results from the formal measures (the BAT and the action-naming test) and from the narratives in the treated and the untreated languages, pre-post treatment and at follow up are presented below. Measures of social validation for each of the participants will be presented at the end of this section.

Standardised test (BAT)

PN's total BAT scores in the treated language (Norwegian) increased significantly post-treatment (p = .003), along with the scores in semantics (p = .026) and lexical access (p = .013). The results for semantics and lexical access were maintained at follow-up (semantics: p

= .043, lexical access: p = .045). For the untreated Portuguese, an increase in the total scores was found post-treatment (p = .007), although this was not maintained. BAT results did not show significant cross-linguistic transfer to Portuguese for any of the measured linguistic levels.

DT's total BAT scores showed significant gains in the treated language (Norwegian) (p = .034), in semantics (p = .043) and in lexical access (p < .001), with maintenance for semantics (p = .026) and lexical access (p < .001). However, no significant transfer to the untreated English was found (see Table 1).

Table 1. Performance (in %) at different linguistic levels pre- and post-treatment for PN and DT, measured by the Bilingual Aphasia Test (BAT)

	Pre-treatment	**Post-treatment**	**Follow-up**	**Pre-treatment**	**Post-treatment**	**Follow-up**
P1	**Portuguese (L1)**			**Norwegian (L3)**		
Semantics (N = 4)	72 %	88 %	88 %	60 %	**88 %***	**88 %***
Syntax (N = 3)	83 %	93 %	89 %	75 %	84 %	72 %
Lexical access (N = 4)	85 %	93 %	90 %	70 %	**90 %***	**88 %***
Total scores	84 %	**94 %****	91 %	76 %	**89 %****	82 %
P2	**English (L1)**			**Norwegian (L2)**		
Semantics (N = 4)	56 %	80 %	72 %	44 %	**76 %***	**80 %***
Syntax (N = 3)	55 %	60 %	48 %	57 %	58 %	51 %
Lexical access (N = 4)	70 %	90 %	85 %	45 %	**83 %*****	**88 % *****
Total scores	64 %	72 %	67 %	57 %	**70 %***	69 %

Note. N = number of subtests in the modified BAT that measure the performance at a respective linguistic level. Each subtest contains between 5 and 35 items (Paradis & Libben, 1987).
Significant effects are in bold.
*** p < .001; ** p < .01; * p < .05

Action-naming test

On the action-naming test PN showed an improvement of the verbs in Norwegian (p < .001) following both treatment blocks, this was maintained at follow-up (p = .044) (see Table 2). The effect scores for Norwegian were significant both at post-test (d_1 = 11.35), and at follow-up (d_1 = 10.69). Cross-linguistic transfer to Portuguese verbs was apparent post-treatments (p = .034), however, this was not maintained at follow-up. The effect scores were significant for Portuguese, as well, both at post-test (d_1 = 3.33), and at follow-up (d_1 = 3.00).

DT showed an improvement of the Norwegian verbs (p = .009), but this was not significant at follow-up. The effect scores for Norwegian were significant at post-test (d_1 = 3.44), and despite a decrease at follow-up, they were still significantly better (d_1 = 1.06).

McNemar results showed no significant improvement for the English verbs. Nevertheless, a significant effect score was found post-treatments (d_1 = 1.28), however this was significantly decreased at follow-up (d_1 = -1.12).

Table 2. Action-naming test results for PN and DT, pre- and post-treatment (percentage accuracy and effect size)

	Pre-treatment	**Post-treatment**	**Effect-size (post-test)**	**Follow-up**	**Effect-size (follow-up)**
PN (Portuguese-Norwegian)					
Portuguese	70 %	**90 % ***	**d_1 = 3.33**	88 %	**d_1 = 3.00**
Norwegian	52 %	**86 % *****	**d_1 = 11.35**	**84 %*****	**d_1 = 10.69**
DT (English-Norwegian)					
English	13 %	18 %	**d_1 = 1.28**	8 %	**d_1 = -1.12**
Norwegian	14 %	**31 % *****	**d_1 = 3.44**	20 %	**d_1 = 1.06**

Significant effects are in bold.
*** $p < .001$; ** $p < .01$; * $p < .05$

Narratives

All the results from the narratives can be found in Table 3 for PN and in Table 4 for DT.

Treated language

PN showed an increase of verb tokens (d_1 = 4.36) and of verb types (d_1 = 4.78) in the Norwegian narratives. None of these measures were maintained at follow-up. She furthermore increased the amount of noun tokens (d_1 = 1.24) and noun types (d_1 = 1.23) post-treatment, however this was not maintained at follow-up. Analyses of PN's quality of the discourse in Norwegian showed an increase in the total number of words post-treatment (d_1 = 3.06) and in speech rate (d_1 = 3.94). Moreover, there was an increase in the total number of CIUs post-treatment (d_1 = 3.62). None of the other measures changed significantly, and no follow-up effects were found.

DT showed an increase in verb types only post-treatment (d_1 = 1.00), and no changes in the noun production. At the discourse level DT produced more words per minute (d_1 = 4.26), which was maintained (d_1 = 3.56). The number of CIUs increased post-treatment (d_1 =1.79), but this was not maintained at follow-up. None of the other measures changed significantly in any direction.

Table 3. Narrative results for PN in Portuguese (L1) and Norwegian (L3), with effect sizes

Narrative		**Portuguese (L1)**					**Norwegian (L3)**				
		Pre-treatment (mean)	**Post-treatment**	**Effect size**	**Follow-up**	**Effect size (follow-up)**	**Pre-treatment (mean)**	**Post-treatment**	**Effect size**	**Follow-up**	**Effect size (follow-up)**
Lexical variables	**Verb tokens**	9.80 (3.77)	57	**d_1 = 12.53**	33	**d_1 = 6.16**	27 (8.04)	62	**d_1 = 4.35**	25	d_1 = 0.25
	Verb types	9.20 (3.77)	52	**d_1 = 11.36**	32	**d_1 = 6.05**	25 (6.48)	56	**d_1 = 4.78**	24	d_1 = -0.15
	Noun tokens	12.80 (5.12)	60	**d_1 = 9.22**	43	**d_1 = 5.90**	30 (10.52)	43	**d_1 = 1.24**	32	d_1 = 0.19
	Noun types	12.60 (5.03)	57	**d_1 = 8.83**	43	**d_1 = 6.04**	29 (10.58)	42	**d_1 = 1.23**	32	d_1 = 0.28
Discourse variables	**Total words**	55.40 (22.42)	322	**d_1 = 11.89**	190	**d_1 = 6.00**	170.5 (49.92)	323	**d_1 = 3.06**	167	d_1 = -0.68
	Words/ minute	8.38 (2.51)	20,50	**d_1 = 4,84**	19.66	**d_1 = 1.44**	11.54 (1.73)	18.37	**d_1 = 3.94**	14.90	**d_1 = 1.94**
	Number of utterances	17	57	**d_1 = 4.35**	39	**d_1 = 2.41**	59	79	d_1 = 0.89	64	d_1 = 0.22
	CIUs	41.00 (17.13)	192	**d_1 = 8.81**	130	**d_1 = 5.20**	93.75 (27.99)	195	**d_1 = 3.62**	85	d_1 = -0.31
	CIUs/total verbal units	75%	60%	**-15%**	68%	-7%	55%	60%	5%	51%	-4%

Significant effects are in bold

Untreated languages (cross-linguistic transfer)

PN's amount of verbs increased for Portuguese narratives in tokens as well as types post-treatment (verb-tokens: d_1 = 12.53, verb-types: d_1 = 11.36). This was maintained at follow-up (verb-tokens: d_1 = 6.16, verb-types: d_1 = 6.05). A great increase of noun tokens (d_1 = 9.22) and noun-types (d_1 = 8.83) was evident for PN in Portuguese. The increase was found also at follow-up (noun-tokens: d_1 = 5.90, noun-types: d_1 = 6.04). At the discourse level, PN produced more words in Portuguese post-treatment (d_1 = 11.89), and an increase in words per minute was found (d_1 = 4.84). There was an increase in the number of utterances (d_1 = 4.35) and in the number of CIUs (d_1 = 8.81); however, the percentage of CIUs decreased with 15 percent. All these changes remained at their high levels at follow-up, and in the amount of words that were CIUs, the decrease diminished (-7%).

DT also improved both in verb tokens (d_1 = 1.37) and verb types in English post-treatment (d_1 = 1.13). This was not maintained at follow-up. No improvement in noun production was found in English. The discourse of DT also improved, with an increased number of utterances (d_1 = 1.25), which was maintained at follow-up (d_1 = 1.01). The total number of words and the amount of words per minute did not change post-treatment, but an increase was evident at follow-up (total words: d_1 = 1.20; words/minute: d_1 = 1.81). Finally, a considerable increase of CIUs was found post-treatment (d_1 = 4.26), and this was maintained at follow-up (d_1 =1.23). A small, insignificant decrease of the percentage of CIUs was apparent post-treatment, this continued to decrease to a significant level at follow-up (-16 %).

Table 4. Narrative results for DT in English (L1) and Norwegian (L2), with effect sizes

Narrative		English (L1)					Norwegian (L2)				
		Pre-treatment (mean)	**Post-treatment**	**Effect size**	**Follow-up**	**Effect size (follow-up)**	**Pre-treatment (mean)**	**Post-treatment**	**Effect size**	**Follow-up**	**Effect size (follow-up)**
Lexical variables	**Verb tokens**	44 (13.63)	63	**d_1 = 1.37**	55	d_1 = 0.78	55 (24.64)	77	d_1 = 0.89	62	d_1 = 0.28
	Verb types	39 (14.74)	56	**d_1 = 1.13**	49	d_1 = 0.66	48 (22.91)	71	**d_1 = 1.00**	56	d_1 = 0.35
	Noun tokens	15 (7.23)	18	d_1 = 0.37	19	d_1 = 0.51	11.30 (7.51)	16	d_1 = 0.62	16	d_1 = 0.62
	Noun types	15 (7.00)	13	d_1 = -0.29	18	d_1 = 0.43	10.67 (6.51)	13	d_1 = 0.82	13	d_1 = 0.36
Discourse variables	**Total words**	187 (58.73)	245	d_1 = 0.99	257	**d_1 = 1.20**	335 (99.63)	391	d_1 = 0.56	360	d_1 = 0.25
	Words/minute	28.55	28.82	d_1 = 0.06	37.61	**d_1 = 1.81**	17.00	30.60	d_1 = **4.26**	28.4	**d_1 = 3.56**
	Number of utterances	27	42	**d_1 = 1.25**	39	**d_1 = 1.01**	81	90	d_1 = 0.53	81	d_1 = -0.02
	CIUs	104	124	**d_1 = 4.26**	110	**d_1 = 1.23**	57	177	d_1 = **1.79**	129	d_1 = 0.84
	CIUs/total verbal units	59 %	51 %	8 %	43 %	**-16 %**	24 %	45 %	**16 %**	36 %	12 %

Significant effects are in bold

The control measures (untrained verbs and nonword repetition) were stable throughout the intervention, and fluctuated less than 15 percent between the measurement points, for both participants. Thus, no improvement was found for these measures.

Social validation

Unfortunately, PN's husband did not complete the CETI pre-treatment; hence, PN's CETI-results will not be reported. The husband however reported post-treatment that apart from her slow speech rate, she was 'almost like before' when speaking Portuguese. He experienced her Norwegian to have improved, although she still had word retrieval impairments. The result of PN's SALK-39 showed that the physical score decreased significantly with 1.41 points (SD = 0.98). The other scores changed slightly in both directions, however not significantly.

DT's CETI-scores changed significantly in a positive direction on several of the questions; however, with no significant increase of the total scores. Important items like *Getting somebody's attention*, *Answering yes and no appropriately*, *Communicating her emotions*, *Starting a conversation with people who are not in close family* and *Describing and discussing something in depth* increased with 13–65 percent. This was supported by the written comments on the CETI from her husband. He stated that she had approached and initiated communication with strangers on several occasions after starting with speech and language therapy. An additional interesting issue is that he experienced that she had become a better listener than before. The SALK-39 scores showed no significant changes.

Discussion

This study investigated treatment of verb production in sentence contexts in two multilingual speakers with fluent and nonfluent aphasia. The findings are discussed in relation to the four research questions presented above.

Therapy effects in the treated language

Overall, the participants responded positively to the treatments. At the lexical level, following both treatment blocks, the participants improved their verb production, and for both participants this increase was maintained several months after the treatment had ended.

Furthermore, both participants improved in their standardised test-results, indicating that the effects of the treatments were not only item specific. As anticipated, the lexical-semantic focus of the treatments promoted gains in semantics and in lexical access for both

participants. This improvement was maintained, suggesting a long lasting improvement in the word-finding abilities of the participants. A generalisation to syntax following the treatments was predicted, but not confirmed. This may partially be explained by the three subtests of the BAT (simple and semi-complex commands, complex commands and syntactic comprehension) assessing comprehension of syntax, rather than production. Specific syntactic measures were not analysed from the narratives, this is an option for future analysis. For DT, the SFA-treatment was a challenge, often resulting in production of three single words associated with the picture, without the following sentence production. Hence, she did not get much practice in sentence production from this treatment. This could also partly add to the lack of improvement in the syntactic domain for her.

In narrative production, PN showed an extensive improvement, both at the lexical level and at the discourse level. It is apparent that the treatments not only improved the number and the variety of words from the trained word class, but also improved noun production. This may be explained by the nature of the treatments. When producing verbs in complete sentences the verb is paired with nouns. Moreover, some of the features of the SFA-treatment trigger argument structure and noun production. In line with results of prior studies of verb production in sentence contexts in monolingual aphasia, PN produced longer narratives post-treatment, and she did so more efficiently, with a larger number of words per minute (e.g. Bastiaanse et al., 2006; Fink, Schwartz, Saffran, & L., 1992; Schneider & Thompson, 2003). PN's sentences were also more informative post-treatment, indicating that not only did she produce more words, but also the words she used were correct in the context.

DT also showed improvements in the narratives, although to a lesser extent than PN. As shown by Mätzig et al. (2009), noun retrieval impairments are found in speakers with fluent aphasia. Hence, the lack of improvement of nouns may be attributed to the aphasia type. While verbs were 20 percent of the total amount of the produced words in her narratives on average, only four percent of the total number of words were nouns. The fact that DT's nouns did not improve may also be interpreted in relation to DT's lack of ability to produce complete sentences in one of the treatment blocks. This dissociation between verbs and nouns stresses the importance of including assessment tools that evaluate the performance on both nouns and verbs (Rofes et al., in press). Even though the treatment did not directly target noun retrieval, according to the above proposal on the nature of the verb, an improvement in noun production was anticipated. Furthermore, the verb production became more diverse, and she

additionally increased her speech rate. Her sentences were also more informative post-treatment.

Comparable results as the ones we found for PN and DT in the present study have been found in previous studies of verb retrieval with SFA (e.g. Knoph et al., in press; Wambaugh & Ferguson, 2007) and of communication-based treatment (Altman et al., 2012), indicating that treatment of verbs in sentence contexts may generalise to discourse production. In addition, the implementation of semantic feature generation as a strategy for the person with aphasia may have been beneficial for improving the discourse (Wambaugh et al., 2014).

The treatment focused on the lemma, in that the verbs were treated in sentence contexts. The lemma is considered to contain information necessary for grammatical encoding in the particular language (de Bot, 1992, 2004; Levelt, 1989). It may therefore be assumed that when treating verbs at the lemma level, this will strengthen the semantics (cf. the improved informativeness for both participants). Thus, the treatment of verbs at the lemma level in the present study may also have contributed to the findings. With reference to the specific nature and role of the verb, it may be assumed that training verbs is especially important in order to enhance connected speech production.

Transfer to untreated languages

Cross-linguistic transfer is an overarching goal in treatment of multilingual speakers with aphasia. Clinically, this is important since there is often a lack of SLTs speaking the language combination of their clients. This is also of interest theoretically. If therapy gains in one language generalises to an untreated language, this implies that the two languages share structures and representations (Goral et al., 2010).

At the lexical level, transfer to Portuguese was found for PN. Transfer was evident in the action-naming test, and both verbs and nouns improved extensively in the Portuguese narratives following treatment, both in amount, and in variety. The maintenance effect for Portuguese was considerable for all the lexical variables, indicating that her word-finding abilities improved also in the untreated language. However, this was not supported by her BAT-results. Only the overall scores of the Portuguese BAT showed significant, although non-lasting improvements. The difference in the results for the different assessment tools will be discussed below. Given that generalisation to untrained verbs has been found to be challenging in monolingual speakers (e.g. Wambaugh et al., 2014; Webster & Whitworth, 2012), and cross-linguistic transfer may be difficult to accomplish in multilinguals (Ansaldo

& Ghazi Saidi, 2014; Faroqi-Shah et al., 2010; Kohnert, 2009) these findings are promising. Furthermore, these findings are in keeping with Goral et al. (2012), where cross-linguistic transfer effects in action naming was found.

At the discourse level PN showed great improvements, and all these improvements had lasting effects in Portuguese. It seemed, however that the increased number of words came at the expense of the percentage of words that were CIUs, but this decrease was not lasting. The findings of significant improvements on nearly all discourse measures in the untreated language indicate that the communication skills in Portuguese improved substantially. Improvements in discourse have been found for some participants in SFA-studies in monolinguals (Wambaugh & Ferguson, 2007; Wambaugh et al., 2014) and in one multilingual speaker with aphasia (Knoph et al., in press). Also communication-based treatment has shown to improve discourse in monolingual aphasia (Kempler & Goral, 2011) and in multilingual aphasia (Altman et al., 2012). This furthermore supports the suggestions of treating verbs in sentence contexts (Bastiaanse et al., 2006; Links et al., 2010), indicating that this may be fruitful for cross-linguistic transfer.

DT also showed treatment-related transfer to verbs in the untreated language, English, although these improvements were not maintained. As opposed to PN, DT did not improve in noun production, reflecting her noun retrieval impairments in the treated language. Improvements in the English discourse for DT were found. The narratives in this language showed an increased amount of utterances and improved content of her sentences (both with lasting results). This infers that the treatments in sentence contexts did affect the discourse in the untreated language, as well. Even if the amount of words produced did not entirely reach significance immediately post-treatment, this effect increased and was significant at follow-up, as was the speech rate. The results in this study are therefore congruent with the findings of Altman et al. (2012) and support the proposal that treatments targeting sentence generation, without necessarily practicing specific items, can lead to positive carryover outcome to connected language production.

Current models of lexical access assume that the search for words is semantically driven (Hall, 2011), therefore semantic treatment is often a preferred approach in treating word-retrieval difficulties in speakers with aphasia (Peach & Reuter, 2010). Several models of multilingual language processing argue that unbalanced bilinguals access the conceptual store through the L1 lexicon (cf. Kroll & Stewart, 1994; Pavlenko, 2009). This way, treatment gains especially on the lexical-semantic level in the L2 may transfer to the active, but

untreated L1 lexicon through the conceptual store. An inspection of the participants' BAT-results provides support for this organisation. The two participants learned Norwegian as adults; therefore, their Norwegian (L2) lexica were presumably sparser than their respective L1 lexica. By examining the BAT results, the Norwegian scores were lower on average than the L1 scores. Thus, one can assume that for each of these speakers the connections between their lexica and conceptual store were stronger for L1 than L2, and therefore each participant accessed the concepts through their L1 lexicon. An additional support for this is the finding of improvement in the number of CIUs in the untreated languages for both participants. This confirms the assumed shared representation for languages of multilingual speakers, as proposed by several models of multilingual language processing (e.g. Kroll & Stewart, 1994; Pavlenko, 2009).

As pointed out previously, it may be beneficial to treat words at the lemma level to increase the possibility of cross-linguistic transfer. Since the lemma presumably contains information on semantic, as well as syntactic properties, improvements at this level may therefore spread, not only to the semantic and syntactic levels, but can also activate lemmas of untreated languages, as de Bot (2004) argues. The retrieval of the verb lemma, along with the access of the conceptual store through L1 is suggested as an interpretation of the cross-linguistic transfer found in this study.

Inhibition of the untreated language

Inhibition, or deterioration, of the untreated languages of multilinguals when provided with therapy in only one language is a highly undesirable effect of treatment. Thus, this study specifically investigated such negative outcome. Such inhibition has been reported, especially when treatment has been administered in the postmorbidly weakest language, as in the present study (Goral, 2012; Goral et al., 2013). A decrease in the assessment results in the untreated language would be interpreted as inhibition. From the results of the formal testing and from the narrative production, no inhibitory effect was detected for any of the participants in the present study. At one single measure there was a decrease in the Portuguese results for PN, namely on the percentage of words that were CIUs. This outcome should be read in the light of the considerable increase of words produced post-treatment. Even if the amount of CIUs decreased, the change was not considered to be large enough compared to the number of words. Moreover, this decrease did not last, and was insignificant four months post-treatment. DT also showed negative effects on one measure. This was a slight, although significant

decrease in the English action-naming test 13 weeks following treatment (it is worth remembering that the English verbs had improved significantly post-treatment). Undoubtedly, it is difficult to ascertain exactly what happened between these measurement points. The results of this study are inconsistent with the results of Goral and colleagues (2012; 2013) and suggest no inhibition of the untreated languages of the two participants, following treatment in a weaker language (cf. also Knoph et al., in press for similar results in a quadrilingual speaker with aphasia).

Differences between aphasia type

The participants in the present study suffered from nonfluent (PN) and fluent aphasia (DT), respectively. Although individual participants cannot be compared directly, the results may contribute to the limited caseload of verb-treatment studies in nonfluent and fluent aphasia. As noted, there were great differences in the extent to which the participants were able to implement the SFA treatment. DT's inability to identify and produce the required semantic features in the SFA may reflect an unawareness of the implications of her language deficits, which is not uncommon in Wernicke's aphasia (Heilman, 1991). Nevertheless, the formal assessment results did not reveal substantial differences between the participants, apart from generally poorer results for DT. In the narratives, however, there were differences between the performances, especially in verb- and noun production (cf. above). This finding is congruent with previous findings where noun deficits have been associated with fluent aphasia in particular (Mätzig et al., 2009), whereas verb deficits have been found for both groups. This may further explain why the treatments improved only PN's noun production. Regardless of DT's challenges with the original SFA procedure, improvements of verb production especially in the treated languages were found, thus showing a clear treatment effect. Moreover, the treatment may have strengthened the semantic network, with an improvement at the lexical level and in the number of CIUs as a consequence. Additionally, communication-based treatment has previously resulted in improvement of discourse production in multilingual speakers with aphasia (Altman et al., 2012). Thus, the overall improvement may be interpreted as a combined effect of both treatments.

Formal versus functional assessment

A proposed by for instance Marini et al. (2011), formal aphasia tests may not be sensitive enough to assess language impairments and recovery in speakers with aphasia. The included

BAT-subtests mainly assess comprehension, and since the present study focused on verb production in sentence context and it was assumed that a treatment gain could generalise to discourse, an inclusion of narrative assessment was reasonable. In addition, this inclusion enhances the ecological validity of the study.

For both participants the discourse assessment unveiled aspects that were not detectable in the formal testing, especially at the discourse level, but also in terms of lexical access, especially in the untreated languages. The action-naming test assessed verbs in complete sentences, but was not a sufficient measure in terms of discourse. Whereas the action-naming test showed no generalisation to untrained verbs, in the Norwegian narratives an increase of verb types and tokens was found for PN and in verb tokens for DT. In addition, great gains in discourse production were identified by collecting and analysing narrative productions, gains that could not be detected by the BAT-results. Also regarding transfer effects to the untreated languages, the narratives complemented the BAT results for both participants. While no improvement in lexical access was found in PN's L1 (Portuguese) nor in DT's L1 (English), they both produced a significantly higher number of verb types and tokens in their L1 narratives. Correspondingly, they both showed great increases in CIUs in the discourse production, although the BAT showed no improvement in semantics. The findings imply an improvement of word finding abilities in the untreated languages that was not detectable from the formal assessments.

Thus, these outcomes support the views of other researchers, that formal testing alone may not be sufficient for identifying language recovery in speakers with aphasia (e.g. Marini et al., 2011). The difference in the results of the formal tests and in the narratives underlines the importance of including functional assessment tools for assessing language recovery in multilingual aphasia.

Conclusions

This study did not aim to contrast the two treatment protocols. We therefore cannot decide their individual contribution to the results, only the cumulative effect of both treatments. The above-presented results suggest that verb retrieval treatment provided in sentence contexts in a late-learned weaker language may be propitious, not only for monolingual speakers with aphasia, but also for multilingual speakers with fluent and nonfluent aphasia. This was demonstrated at the lexical level and in discourse production, in the treated as well as in the

untreated languages. Finally, the treatment did not lead to an unwanted inhibition of the untreated language. This is of great importance for clinicians, as well as researchers.

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Declaration of interest

There are no conflicts of interest.

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Footnotes

[1] Ronga is a Bantu language spoken mainly in Mozambique. Assessment of this language is not included, as neither the Bilingual Aphasia Test nor the action-naming test exist in this language.

[2] For both participants, assessment of aphasia type and severity is based on the Bilingual Aphasia Test (Paradis & Libben, 1987) and clinical judgement, since the BAT does not provide information on aphasia type.

[3] Information on the language use and the proficiency level of each of the languages was obtained with the *Language Use Questionnaire* (Muñoz, Marquardt, & Copeland, 1999) and part A of the BAT (Paradis & Libben, 1987) for both participants.

[4] Also referred to as *constraint-induced language therapy* (CILT) or *constraint-induced aphasia therapy* (CIAT) (e.g. Berthier et al., 2009; Pulvermüller & Berthier, 2008).

OVERVIEW OF SUBTESTS ON THE SHORT FORM OF THE BILINGUAL APHASIA TEST

Part B

Language background. Items 4–17

Pointing. Items 23–32

Commands. Items 33–47

Syntactic Comprehension. Items 66–70, 71–76, 81–88, 111–114, 125–128, 137, 140, 142, 143, 145, 148, 150, 151

Semantic Categories. Items 125–157

Synonyms. Items 158–162

Antonyms. Items 163–172

Verbal Fluency. Items 263–266 (phonological fluency). In addition was one task of semantic fluency added, due to the focus of the treatment

Naming. Items 269–288

Sentence Construction. Items 289–313

Picture Description. Items 344–346

Listening Comprehension. Items 362–366

Appendix 2. SFA diagram

HVEM GJØR DETTE VANLIGVIS? *Who does this usually?* _____	HVA BLIR DET GJORT MED? *What/who is it done to/with?* _____	HVOR SKJER DETTE VANLIGVIS? *Where does this usually happen?* _____
	MÅLBILDE *Picture of target word*	
HVORFOR SKJER DET (MENINGEN)? *Why does it happen?* _____	HVILKEN DEL AV KROPPEN/HVILKET VERKTØY? *Which part of the body/What tool is used?* _____	HVA FÅR DET DEG TIL Å TENKE PÅ? *What does it make you think of?* _____

English translation in italics.