Word-finding difficulties in left hemisphere stroke, multiple sclerosis and Parkinson's disease

– differences in symptom occurrence and effects of anomia treatment

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ABSTRACT

Word-finding difficulties, or anomia, are a common symptom in various conditions affecting the brain, such as stroke, multiple sclerosis (MS) or Parkinson's disease (PD). The aim of this thesis is twofold: (i) to increase our knowledge about the similarities and dissimilarities between the word-finding difficulties associated with different kinds of neurological conditions, and (ii) to evaluate treatment effects of anomia treatment using a method called semantic feature analysis (SFA).

Word-finding ability was assessed by means of a comprehensive test battery to describe and compare signs of anomia, in relation to various health aspects within the International Classification of Functioning, Disability and Health (ICF), in 87 participants with left-hemisphere stroke, MS or PD (in Study I), and to evaluate changes in outcome measures after SFA treatment (in Studies II–IV). Three participants with stroke (Study II) and two participants with MS (Study IV) participated in multiple-baseline across-subjects single-case experimental-design studies, and seventeen participants with stroke participated in a randomized controlled trial (Study III).

Findings from *Study I* revealed similarities in terms of reduced fluency, delayed response times and difficulties supplying sufficiently informative content when re-telling cartoon plots. Most participants reported experiencing a negative impact on their communicative participation and quality of life. Participants with anomia after stroke differed from those with MS or PD in that they typically had more extensive anomia, although there were overlaps between the groups. However, the degree of anomia as assessed in formal tests did not always correlate with the degree of self-perceived communicative difficulties in everyday life.

Findings from the three intervention studies (*Studies II–IV*) showed that participants with stroke found the trained items used in SFA treatment significantly easier to retrieve after the treatment, but that these effects were primarily limited to the trained words and that similar treatment effects could be achieved using another type of anomia treatment as well. No treatment effects were apparent in participants with MS who had mild anomia. Moreover, the findings confirmed those from previous studies, namely that generalization effects on untrained items, effects on connected speech and improvements to self-reported communicative participation and quality of life are difficult to achieve; only minor (statistically non-significant) treatment effects on communicative activity and participation were found. *In conclusion*, anomia of various degrees in stroke, MS and PD may lead to similar consequences for everyday communication and self-perceived communicative participation. Anomia treatment focused solely on improving single-word retrieval may not be sufficient to yield effects on the activity and participation in everyday communicative situations.

Keywords: anomia, word-finding difficulties, ICF, assessment, self-reports, naming, everyday communication, semantic feature analysis, SFA, treatment, stroke, multiple sclerosis, Parkinson's disease

SAMMANFATTNING PÅ SVENSKA

Vikten av att kunna kommunicera, uttrycka önskningar, förhoppningar, behov, önskemål, åsikter och förmaningar är odiskutabel. Att kunna kommunicera och att göra sig förstådd genom ord underlättar det mesta i vår vardag, i kontakten med andra människor genom möten, telefonsamtal eller meddelanden. Vi använder också ord för att reflektera över saker och för att utveckla oss själva. Vi sätter ord på våra tankar.

Men för många människor kan kommunikationsförmågan plötsligt förändras på grund av sjukdom. Tre av de vanligaste förvärvade sjukdomarna som drabbar hjärnan och påverkar kommunikationsförmågan är stroke, Parkinsons sjukdom (PS) och multipel skleros (MS). Denna avhandling jämför hur svårigheter att hitta ord kan visa sig hos människor efter en sådan sjukdom, och om ordfinnandeförmågan kan förbättras genom träning med en behandlingsmetod som kallas Semantic feature analysis (SFA). Sammanlagt deltog 90 personer som själva upplevde svårigheter att hitta orden (anomi) i de fyra delstudierna. Av dem hade 44 personer haft en vänstersidig stroke, 27 hade MS och 19 hade PS. Deras förmåga att hitta ord undersöktes med hjälp av ett omfattande undersökningsmaterial. Uppgifterna i materialet prövade förmågan att hitta såväl enstaka ord som att formulera sig i sammanhängande tal. Deltagarnas egna upplevelser av sina svårigheter undersöktes också, liksom deras kommunikationspartners upplevelser av svårigheterna. Tjugo av personerna med stroke och olika svårighetsgrader av anomi (i delstudie II och III) och två personer med MS och milda svårigheter att hitta orden (i delstudie IV) deltog dessutom i anomibehandling.

Resultaten från delstudie I visade att vissa av tecknen på försämrad ordfinnandeförmåga var likartade hos de flesta av deltagarna, oavsett vilken bakomliggande sjukdom eller hjärnskada de hade. Det tog längre tid att hitta orden och det som uttrycktes kunde bli mindre informativt, exempelvis genom att vissa ord inte nämndes alls eller byttes ut mot andra ord än de som avsågs. Det framkom också att den som har svårt att hitta orden kan uppleva det som väldigt besvärande, oavsett om en lyssnare tycker att svårigheterna är stora eller små. Svårigheter att hitta orden kan minska graden av aktivitet och delaktighet i olika kommunikativa situationer och påverka livskvaliteten negativt.

Det fanns också stora skillnader. Personerna med stroke hade ofta större svårigheter att hitta ord än personerna med PS eller MS. Orden kunde också drabbas på fler sätt efter en stroke. Hos personer med PS eller MS var det vanligaste – och ofta enda påtagliga – symtomet att de bytte ut ord. Hos

personer med stroke kunde orden dessutom ofta fattas helt, eller produceras på ett sätt som inte var avsett, t.ex. genom att vissa bokstäver föll bort eller blev utbytta.

Resultaten från delstudierna II och III visade att träning att hitta orden kan hjälpa. De ord som tränades blev oftast lättare att få fram för deltagarna som hade haft en stroke. Deltagarna i studie III fick likvärdiga resultat oavsett om de hade tränat med SFA-metoden eller om de hade fått en annan träning. Men anomibehandlingen fungerade inte för alla och det var svårt att överföra framstegen till andra situationer utanför träningen. Personerna med MS i delstudie IV fick inga behandlingseffekter av SFA-träningen. Det behövs mer forskning för att hitta effektivare behandlingsmetoder mot anomi av olika svårighetsgrader och för att få behandlingseffekter som kan förbättra vardagskommunikationen. Eftersom fungerande kommunikation är en så viktig del av livet, och eftersom svårigheter att kommunicera kan få stora negativa konsekvenser, är det viktigt att alla som upplever besvärande svårigheter att hitta orden kan få en logopedisk undersökning och hjälp att hantera sina svårigheter.

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

I. Kristensson, J., Longoni, F., Östberg, P., Rödseth Smith, S., Åke, S., & Saldert, C. Anomia in left hemisphere stroke, multiple sclerosis and Parkinson's disease – a comparative study. Manuscript.

II. Kristensson, J., Behrns, I., & Saldert, C. (2015). Effects on communication from intensive treatment with semantic feature analysis in aphasia. Aphasiology, 29:4, 466–487, doi: 10.1080/02687038.2014.973359

III. Kristensson, J., Saldert, C., Östberg, P., Rödseth Smith, S., Åke, S., & Longoni, F. Naming vs. non-naming treatment in aphasia in a group setting – a randomized controlled trial. Manuscript.

IV. Kristensson, J., Longoni, F., Östberg, P., Åke, S., Rödseth Smith, S., & Saldert, C. (2021). Evaluation of treatment effects of semantic feature analysis on mild anomia in multiple sclerosis. Aphasiology, Published online May 2021, doi: 10.1080/02687038.2021.1900535

CONTENT

ABBREVIATIONS

A-NING	Aphasia assessment ("Neurolingvistisk afasiundersökning")
BNT	Boston Naming Test
CarerCOAST	Carer Communication Outcome after Stroke
COAST	Communication Outcome after Stroke
COSEF	Complex Oral Semantic Verbal Fluency
CPIB	Communicative Participation Bank (short form)
ICF	International Classification of Functioning, Disability and Health
MAS	Mild anomia in stroke
MoCA	Montreal Cognitive Assessment
MS	Multiple sclerosis
MSAS	Moderate-to-severe anomia in stroke
NGA	Norwegian Basic Aphasia Assessment ("Norsk grunntest for afasi")
OANB	Object and Action Naming Battery
PD	Parkinson's disease
PND	Percentage of non-overlapping data
QoL	Quality of life
SAQOL-39	Stroke and Aphasia Quality of Life Scale-39
SASCI-Q	The Sahlgrenska Self-reported Cognitive Impairment Questionnaire
SFA	Semantic feature analysis
SLT/SLP	Speech and language therapist / Speech-language pathologist
TMT	Trail Making Test

INTRODUCTION

Anomia, from *a-* (without) and *nomen* (name), implies the inability to name things. Anomia is the well-established term used for various degrees of pathological word-finding difficulties (Goodglass & Wingfield, 1997; Laine & Martin, 2013). Other terms with the same or a similar meaning are *dysnomia* (which may signal a milder deficit than total absence) and *verbal amnesia*, which implies that the word has been forgotten so that the lexical store is reduced. The term “anomia”, or “word-finding difficulties”, usually refers to the inability or impaired ability to access and retrieve the right word from a largely intact lexical store. In this thesis, the terms “anomia” and “word-finding difficulties” are used in that sense and treated as synonyms.

WORD-FINDING ABILITY

Most theories concerning word retrieval, for example Dell (1986) or Levelt (1992), describe the process as beginning with the activation of semantic information, for example when a person looks at an object. Such an event activates a set of semantic features and related concepts, creating a selection of possible alternatives from which a word is chosen. In the next step, the phonological features of that word are activated, followed by articulatory planning and execution, resulting in the verbalization of the word. However, theories differ in terms of the number and characteristics of the stages involved in the process, the timing and direction of information flows, and the influence of extrinsic factors. Further, some theories are based on speech samples collected from healthy speakers while others build on errors made in disordered speech.

Two of the most cited theories were developed by Levelt and colleagues (Levelt et al., 1999; Levelt, 1992; Roelofs, 2004) and by Dell and colleagues (Dell, 1986; Dell et al., 2004; Dell & O'Seaghdha, 1992; Dell et al., 1997). The former theory draws mainly upon speech samples from healthy speakers while the latter theory is mainly informed by errors made by speakers with aphasia.

Based on chronometric studies of lexical retrieval, Levelt et al. (1999) have proposed a system where information flow is unidirectional through discrete serial stages. The process begins with conceptual preparation, leading to the selection of a lexical lemma from the mental lexicon. Then the word is encoded morphologically, phonologically and phonetically, before finally being articulated.

By contrast, the interactive two-step model of lexical access (Dell et al., 1997) involves a bidirectional information flow. First, activation spreads in a network of semantic features and the word receiving the highest level of activation is selected. Second, the selected word triggers phonological encoding. Activation keeps spreading to all words that share the same phonemes, until finally the most activated segments are selected and the word is produced. Information flows freely through the levels of the lexical network, although the impact of semantics is stronger at the beginning of the process and that of phonology is stronger towards the end. This means that at the word-selection stage (step one), phonological involvement may favour alternatives sharing the same phonemes as the target.

This latter model has successfully explained various errors made by people with aphasia, predominantly in confrontation naming tasks. For example, errors resulting in real words that are semantically related or unrelated to the target word but are phonologically similar to it, such as “rat” or “mat” for “cat”, indicate that the information flow is bidirectional and that the system is interactive (Dell et al., 1997; Foygel & Dell, 2000; Schwartz, 2014). Such overt naming errors have been extensively studied, while omissions and non-responses – which lack an overt, analysable representation – are less well explored (Chen et al., 2019). However, it has been suggested that omissions are caused by insufficient activation of semantic information: when the activation of the semantic features, or of the lexical-semantic connections, is too weak, no word at all is retrieved (Chen et al., 2019; Dell et al., 2004; Lambon Ralph et al., 2001).

WORD-FINDING DIFFICULTIES

Anomia occurs as a symptom of various kinds of brain damage induced by neurological disease or injury. It is present as a persistent symptom in essentially all sub-types of aphasia after left hemisphere stroke as well as in traumatic brain injury (Goodglass & Wingfield, 1997). Further, anomia occurs in progressive neurodegenerative diseases, such as multiple sclerosis (MS) (Murdoch & Theodoros, 2000; Sepulcre et al., 2011; Tallberg & Bergendal, 2009) and Parkinson’s disease (PD) (Berg et al., 2003; Cotelli et al., 2007; Miller et al., 2006; Péran et al., 2009). Stroke, MS and PD are three of the most common acquired neurological conditions in the world today, and they all lead to life-long disability. In 2020, there were about 23,000 reported cases of stroke, 14,500 of PD and 13,500 of MS in the Swedish health-care system (National Board of Health and Welfare (Socialstyrelsen), 2021).

People with stroke, PD or MS are often referred to speech and language therapists (SLTs) because of their communication difficulties. In stroke, those difficulties are usually regarded as language difficulties (aphasia) or motor-speech difficulties (dysarthria) – or, most commonly, as a combination of both (Mitchell et al., 2021). By contrast, in people with PD or MS, only the motor-speech problems are typically addressed. Despite the fact that word-finding difficulties are among the most frequent self-reported problems with speech and communication in PD and MS, anomia is most likely underdiagnosed in connection with those conditions (Johansson et al., 2021; Miller, 2017; Murdoch & Theodoros, 2000; Rao, 1986; Schalling et al., 2017). More so than in the case of stroke, opinions differ as regards whether anomia in PD and MS is to be considered a language-specific deficit or a reflection of general cognitive impairment, particularly executive dysfunctions (Faroqi-Shah & Gehman, 2021; Filley, 2012; Gilmore et al., 2019; Monastero et al., 2018). It is most likely that specific language functions are indeed impaired, but it must also be kept in mind that language abilities are embedded in cognition and are dependent on executive functions, such as sustained attention, attention switching, inhibition, working memory and processing speed (Code, 2018; Davis, 2012; Miller, 2017). Hence cognition and language can be considered as inseparably interconnected – and any problem with either or both may result in communication difficulties. Moreover, where language and motor speech problems coexist, this naturally makes communication difficulties worse (Saldert & Bauer, 2017). However, the relationship between language and cognition, or between speech and language, is beyond the scope of this thesis. Instead, this thesis aims to fill a knowledge gap when it comes to whether the manifestations and consequences of word-finding difficulties differ across people with MS, PD and stroke, and also whether semantic feature analysis (SFA) is effective in treating anomia.

In the present thesis, anomia and the corresponding communication difficulties will be discussed in relation to the components of the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001), a bio-psycho-social framework for describing the interaction of health aspects in people. See Figure 1 for a schematic overview of the interactions between the components of the ICF. In this thesis, the *health condition* is left hemisphere stroke, Parkinson's disease or multiple sclerosis. Structural damage to the brain, which is due to these conditions, causes problems retrieving words (*body functions and structure*). Those word-finding difficulties may hinder certain *activities* and *participation* in various situations, as the anomia can prevent people from effectively conveying their needs, thoughts and wishes and from participating in everyday

communication (Cruice et al., 2006, 2010; Hilari et al., 2012). *Environmental* and *personal factors* may hinder or facilitate the other components.

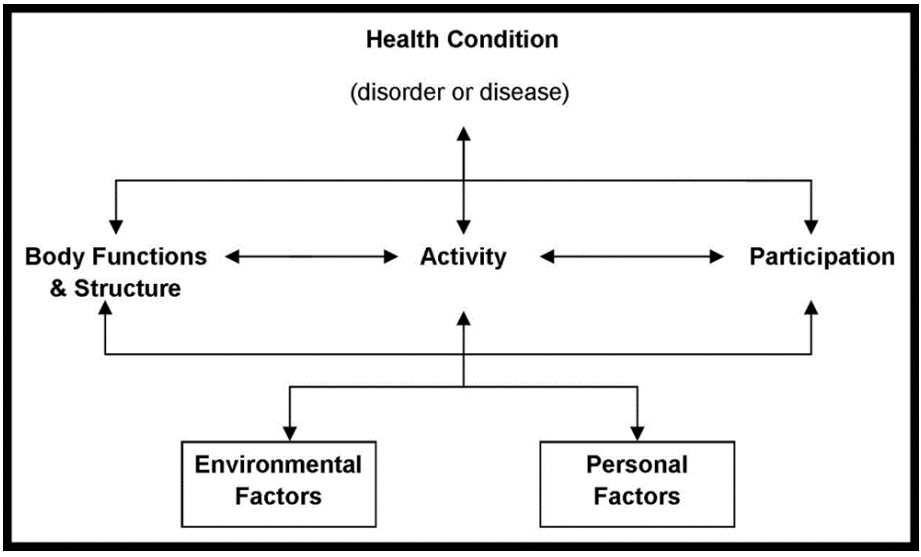

Figure 1. International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2001). Figure reproduced with the permission of the World Health Organization (WHO).

Thus, both the frequency of occurrence and the qualitative aspects of anomia differ between individuals owing to the dynamic interaction of several factors, including linguistic aspects of language use, co-morbidity, personal coping strategies, situational factors and the size and location of the brain damage.

Accurate and efficient word-retrieval is a complex process, demanding interaction among broad neural networks and involving several cortical and sub-cortical regions along with their interconnecting pathways. In a review on language areas investigated in fMRI and PET studies (Price, 2012), some of the regions verified as particularly important in word retrieval are the left middle and superior frontal gyrus, posterior regions in the middle and inferior left temporal lobe and – in more demanding tasks – the superior temporal gyrus. Additionally, the anterior cingulate is involved in the suppression of incorrect responses. Further, the white-matter tracts equivalent to the anterior and posterior arcuate fasciculus, the inferior longitudinal fasciculus and the internal capsule have been found to be involved in word retrieval (Alyahya et al., 2018). This explains why brain pathology – such as cortical lesions,

neurodegeneration, inflammatory activity or MS plaques – affecting the areas of the brain involved in language processing, including the connecting white-matter paths, may cause communication difficulties in stroke, MS and PD (Altmann & Troche, 2011; Goodglass & Wingfield, 1997; Renauld et al., 2016).

It is well known that both the location of brain damage in stroke and the type of aphasia can lead to differences in individuals' ability to name nouns and verbs (Alyahya et al., 2018; Benetello et al., 2016; Conroy et al., 2006; Goodglass & Wingfield, 1997; Pashek & Tompkins, 2002). However, the results from the few previous studies regarding affected word classes (parts of speech) in progressive disease have been inconclusive or contradictory (Cotelli et al., 2007; Kambanaros et al., 2016; Péran et al., 2009). Moreover, overlapping neural correlates for the retrieval of both nouns and verbs have been found in participants with aphasia. Using principal-component analysis on neuro-psychological test profiles and MRI data, Alyahya et al. (2018) identified the angular gyrus, the posterior supra-marginal gyrus, the superior lateral occipital cortex, the posterior middle and inferior temporal gyri, the temporal fusiform cortex, the anterior middle temporal gyrus and temporal pole and the posterior cingulate gyrus as involved in the left hemisphere. Further, although the authors identified frontal areas associated with verb naming exclusively, the correlation between noun naming and verb naming was strong, which suggests that the underlying supporting process may be shared at least to some extent (Alyahya et al., 2018). Similarly, Delikishkina et al. (2020) found dissociated activation in the lateral occipito-temporal, parietal and left inferior frontal cortices during naming of nouns and verbs in healthy subjects, while training-related effects for both nouns and verbs manifested themselves as decreased activation of the left posterior inferior frontal gyrus and anterior insula.

ASSESSING WORD-FINDING DIFFICULTIES

Typically, word retrieval (which is viewed as a *body function* in the ICF model) is assessed using tasks that involve confrontation naming (picture naming) in both research and clinical settings. There are many validated and reliable, easily administered picture-naming tests that are widely used to detect anomia and to track treatment effects (Brady et al., 2016; Laine & Martin, 2013). The material usually consists of pictures of objects, which are intended to elicit nouns. However, some materials aim to elicit words belonging to other word classes, typically verbs.

Because of linguistic and cultural differences between countries and language groups, it is often necessary to collect language-specific reference data for norms. However, only a few confrontation-naming test materials in Swedish or with Swedish norms are available. One well-known internationally used material is the Boston Naming Test (BNT) (Kaplan et al., 1983), which contains 60 pictures of objects intended to elicit nouns with increasing difficulty. Tallberg (2005) has provided Swedish norms and an adapted order of difficulty for the words in the BNT; note that difficulty here relates largely to frequency in that low-frequency words tend to be harder to retrieve than high-frequency ones (Masterson & Druks, 1998).

When the studies included in the present thesis began, there were no internationally known test materials assessing both noun and verb confrontation naming in Swedish. One elaborate material used internationally is the Object and Action Naming Battery (Druks & Masterson, 2000), which contains 160 pictures eliciting nouns and 102 pictures eliciting verbs. Information about aspects known to affect confrontation naming, such as frequency of use, familiarity and age of acquisition, is available for each English item (Masterson & Druks, 1998), but the corresponding information for Swedish was lacking.

Apart from calculating a test score for overall naming accuracy, additional analysis of the responses given may be performed to detect milder difficulties or to reveal error patterns. Unimpaired speakers typically name pictures correctly and rapidly. A response time exceeding 2000 milliseconds suggests that there is a problem of some kind in the word-retrieval process, and measuring response times makes it possible to detect even mild anomia (De Dios Pérez et al., 2019; Galletta & Goral, 2018; Sotiropoulou Drosopoulou, 2016). Further, qualitative analysis of any incorrect responses may be used to make inferences about the underlying processes and about the nature of the word-retrieval deficits (Chen et al., 2019; Dell et al., 1997; Lethlean & Murdoch, 1994; Tallberg & Bergendal, 2009).

Besides confrontation naming, another way of assessing single-word retrieval is to use verbal-fluency tasks. The most commonly used tasks measure phonological or semantic oral verbal fluency. They involve asking the participant to name as many words as possible of a certain type in one minute. In a common phonological task, referred to as “FAS”, the participant has to name words beginning with a certain letter, namely F, A or S (Benton & Hamsher, 1978). In the most common semantic tasks, all words must belong to a certain semantic category: animals (Lezak et al., 1995) or verbs (Piatt et al., 1999). Apart from language functions, verbal fluency tasks

require adequate processing speed and executive functions, which have been attributed to frontal cortical regions (Aita et al., 2019; Tallberg et al., 2008). A recent attempt to develop an instrument capable of detecting subtler difficulties, by placing even higher demands on semantic and lexical retrieval and on executive functions, is the Complex Oral Semantic Verbal Fluency (COSEF) task (Bauer & Saldert, 2019), where words must meet two conditions to count as correct responses. Concretely, all words in the first part of COSEF must refer to objects that are both round and flat (like "plate") while those in the second part must refer to objects that are both long and sharp (like "spear"). There are established Swedish verbal-fluency norms for FAS, Animals and Verbs (Tallberg et al., 2008) and for COSEF (Bauer & Saldert, 2019).

However, both confrontation-naming and verbal-fluency tasks target single words in isolation. By contrast, natural communication generally consists of longer units of language: phrases, sentences, narratives, etc. Although there is a strong relationship between confrontation naming and word retrieval in connected speech, additional measures may be necessary to capture more aspects of everyday communication (Fergadiotis et al., 2019; Herbert et al., 2008; Mayer & Murray, 2010; Richardson et al., 2018) and to shed light on the aspects of word-finding ability that pertain to communicative *activity* and *participation* in the ICF sense. However, this may be complicated. To begin with, there is no doubt that assessing connected speech is a more challenging and time-consuming task than scoring single-word tests. What is more, there is typically some degree of uncertainty associated with connected-speech assessment, since without a pre-specified target word it can be difficult to decide whether a given response is correct or not.

One accommodation frequently used in SLT assessment and research alike is to use a thematic picture to elicit connected speech. Such a picture will typically show a scene where several things are happening simultaneously, so as to yield multi-word descriptions rather than one-word utterances. This enables some control over content, which makes it easier to assess the accuracy and relevance of the spoken output. However, a "frozen-moment" picture necessarily lacks the dynamic aspects of actions, which makes it more difficult to depict verbs than nouns. One way around this problem is to use moving pictures to elicit verbs and connected speech (Blankestijn-Wilmsen et al., 2017). However, moving pictures involving many simultaneous events may give rise to uncertainty regarding participants' focus. For this reason, moving pictures without distracting details may be preferable.

However, assessment materials developed to resemble everyday communicative situations may be even more appropriate to use when evaluating generalization effects to everyday communication ability. One material in wide international use is the Amsterdam–Nijmegen Everyday Language Test (ANELT) (Blomert et al., 1994). For example, changes in ANELT scores are used as a primary outcome measure in the development of the international population registry for aphasia after stroke (I-PRAISE) (Ali et al., 2021). The ANELT has a Swedish version and accompanying psychometric data (Laska et al., 2007). Within the ICF framework, the ANELT can be viewed as reflecting the *activity* component, as the participant is asked to express what he or she would say in various everyday situations.

The highest ecological validity of all of course belongs to analyses of what is actually expressed in real everyday situations, and samples of natural conversation in all likelihood provide the most accurate insights about a person's communicative ability. Even so, there is a lack of consensus about what and how to measure when it comes to everyday communication. What is more, the collection and analysis of natural-conversation data can be a highly problematic and time-consuming task, which is doubtless part of the reason for the infrequent use of such data (Doedens & Meteyard, 2020).

However, if you cannot actually listen in, you can always ask. It is obviously the case that people's own opinions and experiences constitute an invaluable source of information about their communication abilities, activity and participation in everyday situations. Such self-reports and "patient-reported outcome measures" are receiving growing attention (Doyle et al., 2013; El-Wahsh et al., 2020; Hilari et al., 2016; Johansson et al., 2021). In most cases, the information is collected using questionnaires and rating scales. However, people with communicative deficits may have difficulties filling in such forms. Complicated wording, lengthy texts and requests for elaborate written answers may all affect the comprehension of the questions and hamper the production of the responses. To counteract this, certain adaptation measures can be taken. For example, pictures can be used, the wording can be made easier to understand, and alternative ways of responding can be offered. Examples of questionnaires that make it easier for people with communicative difficulties to express their opinions include the Communicative Participation Item Bank (CPIB) (Baylor et al., 2013), the Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39) (Hilari et al., 2003) and the Communication Outcome after Stroke (COAST) scale (Long et al., 2008). In the latter case, there is also a version of the COAST scale which is addressed to a communication partner of the person with a communication deficit: the CarerCOAST (Long et al., 2009). Since it has been found that

there can be considerable discrepancies between self-reports, reports by a communication partner and scores on formal assessment tasks (de Jong-Hagelstein et al., 2012; Doyle et al., 2013; Johansson et al., 2021; Klugman & Ross, 2002; Schalling et al., 2017; Sonder et al., 2012), it would be motivated to combine all of those data-collection tools.

As discussed above, different assessment tasks involving the naming of single words and the production of connected speech place different demands on word-retrieval ability. Confrontation naming requires *convergent* semantic processing skills in that a specific single word (or a synonym) is expected. By contrast, oral verbal-fluency tasks require *divergent* semantic processing skills in that as many similar words as possible are to be produced (Piatt et al., 1999). Further, tasks involving narratives, re-telling or natural conversation add the need to organize words into well-formed phrases and sentences as well as the need to choose words that are appropriate for the specific context (Arnott et al., 1997; Fergadiotis & Wright, 2016). For this reason, the word-finding difficulties revealed by assessment tasks targeting single words may not be the same as those revealed by connected speech. On a similar note, self-reports may uncover difficulties that do not manifest themselves in clinical routine assessment (El-Wahsh et al., 2020; Johansson et al., 2021; Schalling et al., 2017). For this reason, a combination of results from the various assessment materials mentioned above is probably required to provide a comprehensive picture (reflecting the ICF components of *body functions and structure*, *activity* and *participation*) of a person's ability to communicate and to find the right words.

TREATING WORD-FINDING DIFFICULTIES

Several studies have shown word-retrieval treatment to be effective (Brady et al., 2016; Harvey et al., 2020; Nickels, 2002; Thomas et al., 2020). In particular, structured and multi-modal treatment methods, comprising several components, have resulted in treatment effects (Nickels, 2002). Various elements may contribute to treatment gains, and it is not yet fully explored what treatment elements contribute the most to treatment effects (Brady et al., 2016). For example, participants' naming ability may improve because they engage in a great deal of verbal production and self-generate features (Evans et al., 2021; Gravier et al., 2018), or because they are presented with auditory and visual stimuli (Choe & Stanton, 2011; Heath et al., 2015). In particular, it has been found that the use of written cues in treatment may enhance treatment effects (Sze et al., 2021). Writing is often used in re-organizational and compensatory treatment approaches, where a comparatively unimpaired

writing ability may be helpful to those whose naming is impaired. For example, treatment methods based on written cueing hierarchies have resulted in improved naming ability (Beeson et al., 2013; Conroy et al., 2009a; Wright et al., 2008).

Moreover, the optimal amount of training has yet to be defined, although high-intensive treatment is generally considered more effective than low-intensive treatment, as long as it is tolerable to the participant (Brady et al., 2016; Wisenburn & Mahoney, 2009). However, some researchers have found distributed treatment to be more favourable than intensive treatment (Dignam et al., 2015).

When it comes to treatment focus, studies of anomia treatment have mainly targeted nouns, while fewer have targeted verbs or both nouns and verbs. Treatment effects on verbs have been found to be smaller than those on nouns (Webster & Whitworth, 2012). Most anomia-treatment methods are impairment-based in that they aim to improve word retrieval and have the ultimate goal of improving everyday communication. However, common outcome measures, such as naming ability in confrontation-naming tasks, reflect (dis)ability (or the *body function* component in the ICF) in relation to an activity which is actually quite uncommon in everyday communication. Although some studies have reported generalization effects to the activity and participation aspects from treatment targeting body-function components (Barthel et al., 2008; Irwin et al., 2002; Meier et al., 2017; Webster et al., 2015), the results regarding such effects are still inconclusive.

One method for which treatment effects have been reported in people with stroke and traumatic brain injuries is semantic feature analysis (SFA) (Massaro & Tompkins, 1994). Reviews of this method are presented in Efstratiadou et al. (2018); Maddy et al. (2014), and Quique et al. (2019) includes a meta-analysis of treatment outcomes of SFA. In summary, there is evidence of treatment effects of SFA regarding improved word-retrieval ability for treated items and, to a lesser extent, for untreated items. Generalization effects have tended to be larger for items related to the treatment items than for unrelated items. In the review by Efstratiadou et al. (2018) including 21 studies and 55 participants, 82 per cent of the participants gained effects for treated items. Those effects were maintained in 58 per cent of the participants, but generalization effects were present only in 40 per cent of the participants. Participants with more severe aphasia gained less treatment effects – for both treated and untreated items – than participants with moderate or mild aphasia. Similarly, people with Wernicke's, mixed or global aphasia were less likely to gain generalization or

maintenance effects than participants who presented with other types of aphasia (Efstratiadou et al., 2018; Quique et al., 2019).

SFA is based on the theory of spreading activation (Collins & Loftus, 1975), in which words are organized in semantic networks. This theory posits that, as a person is searching for a word, activation spreads across a network to interlinked nodes sharing the same features. When the features of a specific word reach a sufficient level of activity referred to as the threshold for production, retrieval of that word is more likely to occur. This is similar to the interactive two-step model of lexical access proposed by Dell and colleagues (Dell, 1986; Dell et al., 1997). The SFA method uses a systematic structure to cue semantic features for a target word. It is claimed that this procedure increases semantic specificity and strengthens connections in the semantic network.

SFA treatment procedures have been described for nouns (Boyle & Coehlo, 1995) and for verbs (Wambaugh & Ferguson, 2007). Concretely, a chart with empty frames is placed in front of the participant. Above each frame is a heading indicating a feature. The features for objects (nouns) are “Category”, “Use”, “Action”, “Properties”, “Location” and “Association”. Those for actions (verbs) are “Subject”, “Purpose”, “Body part or tool used”, “Description”, “Location” and “Association”. Then a picture is placed in the middle of the chart and the participant is asked to name it – independently if possible, but otherwise by repeating after the SLT. In either case, the participant is then asked to name the semantic features of the word represented by the picture, in the established order. If unable to do so, the participant is presented with spoken and written options and asked to choose the correct feature among them. As adequate features are produced, they are written in the corresponding frames. Finally, the features are summarized and then the participant is asked to name (or repeat) the target word again. An example summary is the following: “This is a technical device that I use when I write or browse the Internet. It stores information and it has a screen and a keyboard. It sits on my desk in my study. I think of e-mails and anti-spyware. It is … a computer.” This procedure is repeated for different words. See Figure 2 for an example of the charts used in SFA.

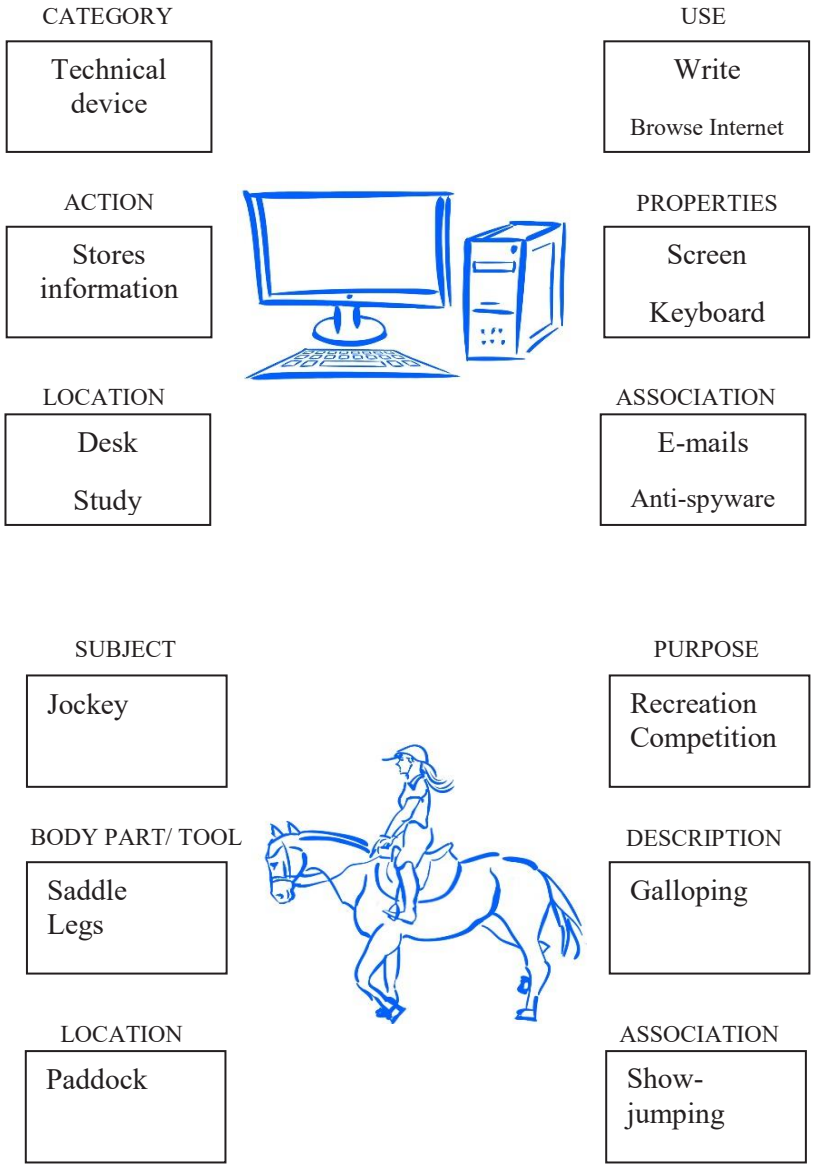

Figure 2. Charts used in semantic feature analysis (SFA) for nouns/objects (top) and verbs/actions (bottom). Illustrations by Bjarne Kristensson.

Different intensities, dosages and treatment-delivery conditions for SFA have been tried, with similar treatment effects (Efstratiadou et al., 2018). In addition, various adjustments have been made to the original SFA treatment protocol, such as using fewer features or adding elements such as writing. For instance, Hashimoto and Frome (2011) showed that improved naming ability could be achieved using only three features: naming the category, properties and association of words was sufficient to achieve treatment gains. They suggested that the exclusion of features less likely to prompt a specific word made it possible to focus on the more distinguishing, salient features. The less distinguishing features excluded were those shared with many other words, such as location (e.g., "at a farm") and those deemed irrelevant for some words, such as action (e.g., for "flower").

The repeated practice of listing semantic features in a specific order may be important to automatize word-finding processing (Falconer & Antonucci, 2012; Peach & Reuter, 2010; Wambaugh & Ferguson, 2007). Further, the structured repeated naming of semantic features may contribute to the acquisition of a general word-finding strategy (Boyle, 2010), which could make the SFA useful as a self-cueing method in cases of word-finding difficulties in everyday communication. Hence the SFA treatment may yield effects on word retrieval linked to the ICF aspects of body function and (communicative) activity and participation.

Most studies have applied SFA as an individual treatment, but findings from a few studies suggest that delivering SFA in a group setting is possible and can have positive results on discourse outcome measures, such as improved verbal productivity, higher information content and/or greater efficacy in connected speech (Antonucci, 2009; Efstratiadou et al., 2019; Falconer & Antonucci, 2012; Kladouchou et al., 2017).

Additionally, a group setting may provide opportunities for natural two-way communication, collaboration and positive reinforcement among peers (Antonucci, 2009; DeDe et al., 2019; Elman & Bernstein-Ellis, 1999; Falconer & Antonucci, 2012; Peach & Reuter, 2009; Simmons-Mackie et al., 2007), offering a possibility to further promote treatment outcomes associated with activity and participation. A systematic review by Lanyon et al. (2013) showed that treatment effects on targeted language processes could in fact be achieved by group treatment. Moreover, it has been found that participating in a group may benefit social networks and improve quality of life (Hilari et al., 2016; Wilson et al., 2021).

AIMS

The overall aim of this thesis was to increase our knowledge about anomia and anomia treatment effects in different neurological diseases and conditions, in two ways: first, by exploring quantitative and qualitative aspects of anomia in participants with left hemisphere stroke, multiple sclerosis (MS) or Parkinson's disease (PD); and, second, by evaluating treatment outcomes of treatment with semantic feature analysis (SFA) in stroke and MS regarding confrontation naming of both nouns and verbs as well as everyday communication ability as rated in formal assessments and by the participants themselves.

The specific aims of each of the four studies included in this thesis were the following:

I. To explore and compare quantitative and qualitative symptoms of word-retrieval difficulties in left-hemisphere stroke, multiple sclerosis (MS) or Parkinson's disease (PD).

II. To evaluate whether SFA treatment can increase naming ability, increase the ability to participate in conversation and lead to positive changes in everyday communication, as perceived by the participants themselves and by their significant others.

III. To evaluate group treatment effects of a naming treatment (modified SFA) as compared with a non-naming treatment, in participants with stroke.

IV. To evaluate the treatment effects of SFA on mild anomia in MS.

METHODS

PARTICIPANTS

Ninety participants with self-perceived anomia participated in the studies within this thesis. All participants in Studies III and IV were also included in Study I. Inclusion criteria were:

- subjectively experiencing anomia;
- diagnosed with left-hemisphere stroke, multiple sclerosis (MS) or Parkinson's disease (PD);
- (for participants with stroke) a minimum of 6 months post-stroke and a documented unilateral left-hemisphere lesion location;
- no other known neurological illness;
- no indication of dementia in medical records;
- unimpaired or only mildly impaired auditory comprehension;
- unimpaired or corrected hearing and vision;
- absence of apraxia of speech or dysarthria affecting language assessment;
- Swedish as a native language.

Table 1. Overview of participants in Studies I–IV

Study	Study design	n	Diagnosis	Age in years	Gender	Years of education	Years post-diagnosis
I	Cross-sectional	87	Stroke (*n*=41) PD (*n*=19) MS (*n*=27)	53–88 53–83 30–72	20♀21♂ 8♀ 11♂ 23♀ 4♂	7–25 6–18 9–19	1–32 1–33 2–32
II	Single-case experimental	3	Stroke	54–71	1♀ 2♂	N/A	2–5
III	Randomized controlled trial	17	Stroke	56–87	6♀ 11♂	8–18	2–21
IV	Single-case experimental	2	MS	40–74	1♀ 1♂	14–17	20–28

Initially, 110 participants were recruited to Study I. Of those, 23 were excluded for not meeting the inclusion criteria: 3 had right-hemisphere stroke or bilateral lesions, 14 had pre-existing neurological conditions, 3 did not

have Swedish as a native language and 3 had severe dysarthria or apraxia of speech considerably affecting their intelligibility. Eventually, Study I included 87 participants with mild to severe anomia. Of those, 41 had stroke, 27 had MS and 19 had PD. Of the participants with MS, 10 had relapsing-remitting MS and 17 had progressive MS. Information about the lesion location in the participants with MS or PD was unavailable, although the involvement of basal ganglia was presupposed in the case of PD. The most common lesion location for the participants with stroke was the arteria cerebri media (n=28). Further, 6 participants with stroke had frontal lesions, 3 had posterior ones, and 4 had multiple or unspecified left-hemisphere lesions. The participants with stroke were divided into two groups according to their level of anomia, as assessed using the OANB. Those whose accuracy scores were below 83 per cent (n=19) made up the "moderate-to-severe anomia after stroke" (MSAS) group while the others (n=22) constitute the "mild anomia after stroke" (MAS) group.

Studies II and III included participants (3 in Study II and 17 in Study III; those 17 were also included in Study I) with mild to severe aphasia after stroke. Each of them had a communication partner (most commonly a spouse) who filled in questionnaires about the participant's communicative effectiveness after the stroke and about his or her own quality of life.

Finally, Study IV included two participants with MS and mild anomia (also included in Study I). A third participant was initially included but dropped out midway and was thus not included in Study IV (only in Study I).

ETHICAL CONSIDERATIONS

The four studies were given ethical approval by the Regional Ethical Review Board of Gothenburg, Sweden (case numbers 622-12 and 506-16). Special attention was devoted to ensuring that the participants comprehended the information they were given about the studies before they were asked to give their written consent to participate. Oral and written information was provided to all participants. An aphasia-friendly version with additional picture support was used. Participants in the non-naming treatment group in Study III were offered SFA treatment after the study was completed.

RESEARCH QUESTIONS

The overall research questions for each study were the following:

Study I. What quantitative and qualitative similarities and differences are there when comparing symptoms of anomia, in formal assessments and as perceived by the participants themselves, in groups of participants with stroke, PD or MS?

Study II. Are there any treatment effects of intensive SFA single-words treatment as reflected in formal assessment of naming and of everyday communication, and in self-reports on everyday communication ability?

Study III. Is a modified SFA group treatment more effective in improving naming in formal assessments, and in improving self-reported communicative participation and health-related quality of life, than an anomia group treatment not focusing on verbal production?

Study IV. Does SFA treatment have effects on word-retrieval ability in mild anomia in MS, and does it provide a useful strategy when encountering anomia in everyday communication?

ASSESSMENT MATERIAL

To obtain a comprehensive picture of the participants' word-retrieval (dis)ability and of its effects on their health in relation to the ICF components of body function and (communicative) activity and participation, a large battery of assessment tasks was used. The aims were to capture difficulties of various degrees and in various settings as well as to assess any changes after treatment.

In Study I, the assessment instruments were used to describe and compare word-retrieval ability within and between participants with different underlying neurogenic conditions.

In Studies II–IV, the assessment instruments were used to capture changes in word-retrieval ability within and between participants after treatment.

Assessment instruments and methods used in each study

Study	I	II	III	IV
Confrontation naming				
OANB[a]	☑	☑	☑	☑
BNT[b]	☑		☑	☑
Treatment items[c]		☑	☑	☑
Word fluency				
FAS [d]	☑		☑	☑
Animals[e]	☑		☑	☑
Verbs[f]	☑		☑	☑
COSEF[g]	☑			☑
Connected speech				
Re-telling[h]	☑		☑	☑
Conversation		☑		
ANELT[i]			☑	
Self-reports				
COAST[j]		☑		
CarerCOAST[k]	☑	☑	☑	
CPIB [l]	☑		☑	☑
SAQOL-39[m]	☑		☑	
SASCI-Q[n]	☑			☑
Study-specific scales	☑		☑	☑

Notes: [a]Object and Action Naming Battery (Druks & Masterson, 2000; Masterson & Druks, 1998). [b]Boston Naming Test (Kaplan et al., 1983). [c]Items used in treatment. [d]Benton and Hamsher (1978). [e]Lezak et al. (1995). [f]Piatt et al. (1999). [g]Complex oral semantic fluency (Bauer & Saldert, 2019). [h]Re-telling of the plot in Lineman cartoons (Cavandoli, 2007). [i]Amsterdam–Nijmegen Everyday Language Test (Blomert et al., 1994). [j]Communication outcome after stroke (Long et al., 2008). [k]Communication outcome after stroke – carer's perspective (Long et al., 2009) [l]Communicative Participation Item Bank (CPIB) (Baylor et al., 2013). [m]Stroke and Aphasia Quality of Life scale-39 (Hilari et al., 2003). [n]Sahlgrenska Academy Self-reported Cognitive Impairment Questionnaire (Eckerström et al., 2013).

Besides the language-assessment tasks, Studies I, III and IV also included assessment of other functions and skills that could potentially influence communication ability. Executive functions were assessed using the design-fluency task of the Delis–Kaplan Executive Function System (DKEF-S) (Delis et al., 2001), the Trail Making Test (TMT) (Reitan & Wolfson, 1985) and the number-repetition task in the Clinical Evaluation of Language Fundamentals, fourth edition (CELF-4) (Semel et al., 2003). Additionally, participants with PD and MS were assessed using the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005). Overall, the results indicated that most participants with stroke or PD had some kind of executive dysfunction while about 70 per cent of the participants with MS scored within the normal range for healthy subjects. Finally, the participants were

also screened for motor-speech deficits (Hartelius, 2015) to ensure that their intelligibility would be sufficient for a reliable analysis of the assessment results.

Since there is inherent interaction among the various components of the ICF framework, all results could be considered as referring to the use of a *body function* (word retrieval) for naming or re-telling (b16710: Expression of spoken language) during the *activity* of conveying spoken information to a listener (d330: Speaking) while *participating* in an assessment situation (d740: Formal relationships). However, the various tasks will also be specifically considered as reflecting the ICF aspects to different degrees. Performance on the confrontation-naming and verbal-fluency tasks is deemed to mainly reflect the *body-function* aspect, while the connected-speech tasks (re-telling, conversation and the ANELT), which resemble everyday communication, and the self-reports on everyday communication ability and communicative participation are deemed to mainly reflect the *activity* and *participation* aspects.

MEASURES MAINLY REFLECTING BODY FUNCTION

CONFRONTATION NAMING

It is well known that commonly used formal assessment tasks, such as confrontation-naming tasks, can reliably reveal anomia in participants with moderate or severe word-finding difficulties (e.g., Druks & Masterson, 2000; Kaplan et al., 1983). Various picture-naming tests are valid and reliable instruments. Impaired accuracy is typically evident from test scores, and test norms commonly relate scores to those of unimpaired speakers. In the present thesis, confrontation-naming tasks involving both nouns and verbs were used in all four studies, and the ability to name depicted nouns and verbs correctly was one of the main outcome measures in Studies II–IV. In all four studies, a selection of pictures representing high-frequency words from the OANB (Druks & Masterson, 2000) was used. In Studies I, III and IV, those pictures were supplemented by a selection of 20 low-frequency nouns from the BNT (Kaplan et al., 1983). That selection was based on the highest level of difficulty in the Swedish version of the BNT (Tallberg, 2005). The norms for the full Swedish version of the BNT (Tallberg, 2005) are 47.58 ±4.15 (79% accuracy). No reference norms exist for the 20-item short form of the BNT used here, but those items were correctly named by 17–88 per cent of the non-brain damaged participants (n=111) in Tallberg (2005).

Within the OANB selection, three comparable sets were constructed, each containing 20 nouns and 20 verbs. There were two reasons for this. First, in

Study I there was a need to present material that would be suitable for participants with varying degrees of anomia, so as to ensure that there would be a sufficient number of items to capture even mild anomia while participants with severe anomia should be spared the agony of trying in vain to name an excessive number of items. The other reason for creating three comparable sets was that this would enable repeated measures in the intervention-related Studies III and IV while avoiding learning effects. It was expected that three sets of 20 nouns and 20 verbs each would meet both of these requirements. Together, the three sets yielded 60 nouns and 60 verbs, which was deemed likely to be a sufficient number for the analysis of confrontation-naming ability even in mild anomia.

The three OANB sets were matched for frequency of occurrence, age of acquisition, visual complexity, word length and phonological complexity; in addition, accuracy data were collected from individuals without brain damage (Andersson & Larsfelt, 2013; Hellberg & Kroon, 2015; Torinsson & Åke, 2017). The reference data collected (n=110) yielded an average total score of 118.6 (SD 1.6) correct responses out of 120 (range: 111–120), meaning 98.8% accuracy. For nouns, the average score was 59.5 out of 60 (99.2%, range 56–60); and for verbs, it was 59.2 out of 60 (98.7%; range 52–60) (Torinsson & Åke, 2017).

Normative data on response time were also collected (Dei Campielisi, 2021). The mean response time in the reference data (n=25) was 1.1 (SD 0.2) seconds per correctly named item; range: 0.8–1.6 seconds. For nouns, the mean response time was 1.0 (SD 0.2, range: 0.6–1.7); and for verbs it was 1.1 (SD 0.2, range: 0.9–1.5) (Dei Campielisi, 2021). These findings are well in line with those of previous studies, according to which a typical response time in adults without brain damage does not exceed 2 seconds (De Dios Pérez, 2017; De Dios Pérez et al., 2019; Galletta & Goral, 2018).

In Studies II–IV, pictures representing the treated words were also used. In Study II, those were pictures from Everyday Life Activities (Stark, 1992, 1995; Stark, 1998) and ColorCards® (Speechmark Publishing Ltd.), and in Studies III and IV they were pictures from *Communicate InPrint* (2007) and Papunet (2018).

SINGLE WORD FLUENCY

Both phonological (FAS) and semantic (Animals and Verbs) oral verbal fluency was assessed in Studies I, III and IV. In Study IV, word fluency was used as a control task, given that it is closely linked to executive functions

and overall cognitive ability. In Studies I and IV, the Complex Oral Semantic Verbal Fluency Task (COSEF) (Bauer & Saldert, 2019) was used to detect even minor difficulties, or changes over time, in the participants.

Swedish norms for people with more than 12 years of formal education are the following: for FAS, 49.0 ±13.3 for 30–64-year-olds and 45.2 ±10.1 for those above 65 years of age; for Animals, 27.1 ±5.4 (<65 years) and 20.6 ±5.7 (>65 years); and for Verbs, 22.3 ±6.4 (<65) and 19.4 ±5.6 (>65) (Tallberg et al., 2008). The overall Swedish norm for COSEF is 16.95 (SD = 5.58) (Bauer & Saldert, 2019). For people with more than 13 years of formal education, the norms are 19.46 (SD = 5.55) for 30–64-year-olds, 16.72 (SD = 3.30) for 65–74-year-olds and 18.20 (SD = 5.12) for people over 75 years of age.

MEASURES REFLECTING ACTIVITY AND PARTICIPATION

CONNECTED SPEECH

Speech material from informal conversations between the participant and the SLT (the author of the present thesis) was used in Study II, while recordings of participants' re-telling of the plot of a motion picture were used in Studies I, III and IV.

The overall aim was to elicit both nouns and verbs in connected speech, so as to enable assessment of word-retrieval ability with a close resemblance to the requirements placed on this ability in everyday communication, but while preserving study control. This proved to be challenging in Study II, where the influence from a conversation partner or from aspects such as topic selection could not be ruled out as potentially affecting the outcome. For this reason, it was decided that the subsequent studies would use a material that allowed more reliable comparisons: Lineman cartoons (Cavandoli, 2007), which were chosen because of the absence of distracting sub-events or multiple objects appearing simultaneously. In the Lineman cartoons, a stick-figure character is involved in events with limited details, such as meeting an animal, finding an object or engaging in a sports activity. Because only contours are shown, the concept illustrated sometimes becomes clear only after a while. The Lineman has a very expressive body language but rarely speaks in an intelligible way, using mainly nonsense language. In fact, the absence of possibly prompting language was another reason for selecting this cartoon. Graceful permission to use the cartoons for research purposes was given by the copyright owners, Quipos®.

Several sets of the cartoons were created. This enabled the material to be used for repeated measures while limiting any learning effects from seeing the same cartoon for the second or third time. Three sets (A, B and C) were used in Studies I and III, and twelve sets were used in Study IV. The sets were designed to be similar with regard to semantic content, concreteness and the level of difficulty associated with describing them. The A–C sets were assessed for comparability in terms of the numbers of nouns and verbs elicited both in a group of participants with anomia (n=10) and in a reference group of healthy individuals (n=36). All three sets proved to be comparable with regard to the number of verbs elicited. Sets A and C were comparable in the number of nouns elicited while Set B elicited slightly more nouns than the other two sets (Fleischer & Lindström, 2018).

EVERYDAY COMMUNICATION

The Swedish version of the Amsterdam–Nijmegen Everyday Language Test (ANELT) (Blomert et al., 1994) was used to assess treatment outcome regarding everyday communication in Study III. One of the two subsets of ANELT (with ten items each) was administered and scored in accordance with the original guidelines, with scoring ranges of 1–5 points on two scales: A (Understandability) and B (Intelligibility).

Initially, the Scenario Test (van der Meulen et al., 2010) was included in the test battery. This is considered a valid instrument for capturing everyday communication abilities in people with aphasia after stroke (Doedens & Meteyard, 2020) and it had the highest consensus in the Core Outcome Set (COS) ROMA report (Wallace et al., 2019). However, it was excluded from the test battery used in the present studies owing to ceiling effects noted during data collection.

SELF-REPORTS

Various self-reports were collected in all four studies to gain insight into aspects of the participants' own perception of their communicative activity, participation and quality of life. For this purpose, the Swedish versions of the established instruments listed below were used alongside some study-specific scales. Picture support was available for all materials.

The Swedish version of the general short form of the Communicative Participation Item Bank (CPIB) (Baylor et al., 2013) was used in Studies I, III and IV. The questions refer to ten situations, for which respondents are asked to rate how much their condition interferes with their communicative

participation on an average day. Example item: “Does your condition interfere with asking questions in a conversation?”

The participants with stroke in Studies I and III filled in the Swedish version of the Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39) (Hilari et al., 2003). That instrument consists of 39 items, to be answered on a scale from “yes, definitely” (1) to “no, definitely not” (5). The items are divided into four sub-domains: physique, communication, psycho-social and energy. Example item: “In the past week or so, did you feel tired most of the time?”

In Study II, the participants with stroke also filled in the Communication Outcome after Stroke (COAST) scale (Long et al., 2008), and their communication partners filled in the CarerCOAST (Long et al., 2009) scale. CarerCOAST was also used in Studies I and III. In each instrument, 20 questions related to communicative effectiveness and quality of life, such as “In the past week or so, how well could [you/your significant other] follow a change of subject in a conversation?”, are rated on a scale from “unable to do it” (0) to “very well” (4).

Participants with PD or MS in Studies I and IV filled in the Sahlgrenska Academy Self-Reported Cognitive Impairment Questionnaire (SASCI-Q) (Eckerström et al., 2013), which contains questions about physique, psycho-social aspects, energy, communication, planning and executing activities, memory and concentration. The questions are answered by means of ratings using various scales as well as by means of free text.

Several study-specific rating scales were used to collect self-ratings from the participants with regard to their own perception of the frequency of word-finding difficulties, the level of their difficulties and their own performance during assessments (Studies I, III and IV). Such scales were also used to capture potentially confounding factors such as poor general health, or “having a bad day”. The scales, ranging from 0 to 10, were presented visually and read aloud. Overall, ratings closer to 0 represented “less” (less severe problems or difficulties, or less success in the tasks), while ratings towards 10 represented “more”. Additionally, in Study IV, the participants rated the frequency of anomia and the related level of nuisance (on a scale from 0 to 4) on a daily basis, by sending a mobile-phone message to the treating SLT (the author of the present thesis). Ratings towards 0 represented a lower frequency and less bother, while a 4 represented “on numerous occasions” or “significant nuisance”.

TREATMENT MATERIAL

As in the process of selecting assessment instruments, many aspects were considered when treatment items were being selected. Some factors are known to enhance generalization effects, including the diversity of the semantic properties of the items, the existence of shared properties between treated and untreated items, and the presence of atypical treatment items (Gilmore et al., 2020; Kiran, 2008; Kiran et al., 2011; Quique et al., 2019). There is a lack of agreement as regards the optimal number of treatment items: a small number may be preferable for some participants (Coelho et al., 2000; Soni et al., 2012), while a large number has been advocated for others (Thomas et al., 2020). To this should be added that, in the case of SFA, multiple occurrences of self-produced features may increase the possibility of long-lasting treatment effects (Evans et al., 2021; Gravier et al., 2018). Further, based on what is known about the importance of patient participation and involvement in decision-making throughout rehabilitation and care (Kristensen et al., 2016; Lawton et al., 2018; Rosewilliam et al., 2011; Sit et al., 2016), letting participants choose their own treatment material may be preferable. Although treatment effects on treated items may then not generalize into everyday communication (Mayer & Murray, 2010; Palmer et al., 2019), using items of personal relevance to a participant may enhance his or her motivation to complete what may be a demanding treatment (Cherney et al., 2015; Daumuller & Goldenberg, 2010; Lee, 2010; Marshall & Freed, 2006; McKelvey, 2007; Nickels, 2002). Finally, it has been recommended that treatment should include not only nouns but also verbs (Caley et al., 2017; Herbert et al., 2008; Hickin et al., 2020; Webster & Whitworth, 2012), given the importance and usefulness of both nouns and verbs in sentence production and in everyday communication. Against the background of the above, it was decided to use both nouns and verbs as treatment items in all three intervention studies (Studies II–IV). In the selection of words, efforts were made to include items (both verbs and nouns) that were of personal relevance to participants as well as representing various levels of frequency of occurrence, different word length and different phonological and semantic features, all of which are known to potentially affect the ability to retrieve words (Masterson & Druks, 1998).

In Study II, the treatment items were different for each session, meaning that each item was used only once per participant. All items were selected by the SLT, who aimed to include a variety of words that would presumably be useful in everyday communication. However, this procedure might have caused the items used to be of less personal relevance to the individual

participants. For this reason, it was decided to involve the participants in the selection of treatment items in the subsequent studies.

In Study III, all treatment items used were chosen, without restrictions, by the participants. This yielded a variety of items of diverse typicality, imageability, frequency of occurrence, age of acquisition, length and complexity. However, the increase in relevance came at the cost of less research control over the aspects included for the individual participants. Moreover, the participant-chosen items were occasionally difficult to illustrate in a clear and unambiguous manner.

In Study IV, the participants chose the treatment items from among a pre-prepared set. This enabled the design of a matched set of untreated items for comparisons and for control of repeated measures.

PROCEDURES AND DATA ANALYSIS

ASSESSMENT PROCEDURES

All participants in Studies III and IV were also included in the descriptive cross-sectional study (Study I), meaning that the assessment battery was administered to all participants (n=87) who were included in Studies I, III and IV. To counteract any order effects, the assessment tasks were administered in two different orders within the diagnosis groups, with a change in order for each participant. Detailed written administration instructions were followed, to ensure that all assessments were carried out alike. Assessments took place in a quiet room at the University of Gothenburg, Sweden, at an SLT clinic, on the premises of a patients' organization or in the participant's home.

Studies II and IV were multiple-baseline single-case experimental-design (SCED) studies where the treatment outcomes were assessed repeatedly throughout the study. Study III was a randomized controlled trial (RCT) where assessments took place once before treatment, once immediately after treatment and once at a follow-up session 10–12 weeks after treatment.

The scoring of confrontation naming, word fluency and re-telling ability was performed by assessors different from the test administrator, blinded with regard to the group allocation of the participants and to the timing of the recordings. Two or three assessors first trained until they were able to reach consensus, following written guidelines for each measurement, and then 30

per cent of the material (in Studies I, III and IV; in Study II: 25% and 33%) was randomly selected for intra- and inter-rater reliability measurements; see the Reliability section below.

CONFRONTATION NAMING

The confrontation-naming tasks in Studies I, III and IV were presented as Power Point slide shows, with kind permission from the copyright owners: Druks and Masterson regarding OANB, and Pro-Ed regarding BNT. The participant looked at one picture at a time and tried to name it, by answering the question "What is this?" (for nouns) or "What is he/she doing?" (for verbs). In Studies I–III, the time limit was set to 20 seconds while in Study IV it was 10 seconds. When the time was up, the slides changed automatically. The test administrator also changed slides manually if a participant gave a definitive (correct or incorrect) response before the time was up. A click sound accompanied each slide transition; the click sounds were used for subsequent measurement of response time. In Study II, the items were sheets of paper inserted in binders and presented manually. The treated items in Study III were also presented manually, using the same stack of cards that had been used in the treatment sessions. Preliminary scoring was made by the administrator during the assessment, to decide whether or not to continue with an additional set in the OANB confrontation-naming task and whether or not to administer the COSEF task. The administration of the OANB was stopped when a participant failed to correctly name five or more of the items of either word class in a set of 20 nouns and 20 verbs. To participants who successfully named more than 15 nouns *or* 15 verbs in a set, another set was administered, and so on, up to a total of 60 nouns and 60 verbs in the three different sets. The COSEF was administered in Study I to those participants who continued with a second (or third) set of the OANB: this was the case for 2 out of 19 in the group of participants with stroke and moderate-to-severe anomia (MSAS), 20 out of 22 in the group of participants with stroke and mild anomia (MAS), 18 out of 19 in the PD group and all 27 participants with MS.

Accuracy in confrontation naming was scored in all four studies. In Studies I, III and IV, additional scoring of the response time was made for all correct responses. A response was considered correct when the target word, or a pre-determined synonym, was produced within the set time limit (20 seconds in Studies I, II and III, and 10 seconds in Study IV). Self-corrections (made in time) were accepted as correct responses. To avoid an excessive negative impact from the presence of mild dysarthria or apraxia of speech on the assessment of accuracy in word retrieval, a single phonological error was

noted as an inaccurate response but accepted as correct, if the target word was otherwise fully understandable. In Studies I, III and IV, inaccurate responses were categorized as (a) No response or abandoned attempt, (b) Multiple phonological paraphasias or neologism, (c) Related semantic paraphasia, (d) Unrelated semantic paraphasia, (e) Adequate circumlocution or association, (f) Inadequate circumlocution or association, and (g) Visual misinterpretation.

RE-TELLING ABILITY

To assess participants' re-telling ability, they were asked to account for the plot in Lineman cartoons to such a level of detail that someone who had not seen the cartoon could understand what happened. The cartoons were presented in ten-second segments, in order to avoid the negative impact on re-telling ability that might be exerted by a heavy memory load. In Study I, the re-telling task was used as a basis for describing and comparing re-telling ability in participants with stroke, MS or PD. In Studies III and IV, this task was used to assess treatment effects on connected speech after SFA treatment.

The recordings of the re-telling task were analysed using two different methods: main-concept analysis (MCA) (Kong, 2009; Nicholas & Brookshire, 1993b, 1995) in Studies I and III, and correct information unit (CIU) analysis (Nicholas & Brookshire, 1993a) in Study IV.

MCA assesses the presence or absence of a pre-determined set of main concepts that reflect the gist of the story. The pieces of information most important for conveying the content were identified through screening of recordings of a reference group of people without known brain damage (n=36) performing the re-telling task. Concepts that were verbalized by more than 70 per cent of the reference participants were formulated as phrases, or "main concepts" (MC), such as "The Lineman meets a horse". Then recordings were rated with respect to each MC as "accurate and complete" (AC), "accurate but incomplete" (AI), "incorrect" (IN) or "absent" (AB) (Kong, 2009; Nicholas & Brookshire, 1993b, 1995).

While identification of the MCs required a great deal of preparation, the actual performance of the MCA analysis was found to be less demanding. The MCA method proved appropriate for analysing audio recordings, and it was used in Studies I and III. As a rule, only one or two playbacks were required to complete the analysis, and inter-rater reliability proved to be good. Moreover, the MCA method proved capable of distinguishing between

participants with anomia and a reference group of people without known brain damage (Front & Johansson von Braun, 2021). Note that, in the analysis of the recordings, the exact wording was unimportant, as long as the message was delivered in an accurate and complete manner. Thus, for the example mentioned above, "The Lineman meets a horse", responses such as "The Lineman encounters/finds/discovers/sees a horse" would all be accepted as an accurate and complete (AC) main concept, while "A horse there" would be considered as accurate but incomplete (AI), and "The Lineman meets a dog" as incorrect (IN). Finally, if nothing intelligible was mentioned about the concept, it would have been marked as absent (AB). An AC gave 3 points, an AI gave 2 points, an IN gave 1 point and an AB gave 0 points, in accordance with the recommendations in Kong (2009). The results were presented as a total score and scores for each type, all expressed as percentages, which permitted comparison between sets, groups and participants. In the reference group, the mean total MC score was 87.2%, with 82.7% AC, 5.7% AI, 2.0% IN and 9.6% AB (Front & Johansson von Braun, 2021).

In Study IV, the treatment effects on word-finding ability – and ultimately on the ability to effectively convey relevant information in connected speech – were evaluated. Since this was an SCED study with repeated measures, there was a need for multiple sets of cartoons to avoid learning effects. Since main concepts for the additional sets were unavailable, MCA could not be used. It was decided instead to use transcription, because a method sensitive enough to detect changes within participants with very mild anomia was required. While producing transcriptions is a notoriously time-consuming task, doing so may still be worthwhile, especially in research, since transcriptions may offer considerable analytical advantages over recordings. The method of analysis chosen was correct information unit (CIU) analysis (Nicholas & Brookshire, 1993a). This method was considered appropriate for the study because it can be used for essentially all connected speech, as long as the anticipated content is known to the assessor. In CIU analysis, any word that is accurate, relevant and informative in its context is regarded as a "correct information unit" or CIU. The total number of words and the total number of CIUs in a narration were counted, and the narration was timed. This yielded several measures of the informativeness and efficiency of verbal production: words per minute, percentage of CIUs (%CIU) and CIUs per minute (CIU/min) (Nicholas & Brookshire, 1993a). Reference data from 27 participants without brain damage were collected: 145 words per minute, 72% CIU and 104 CIU/min (De Geer et al., Manuscript in preparation). It should be noted that the CIU method proved to present an advantage over MCA in that it allowed intuitively more logical scoring where utterances

were relevant to the content but could not be deemed to reflect "main concepts". Further, the CIU method was found to favour elaborate descriptions over less substantial ones, which contributes information that might be useful for an even more thorough analysis of aspects such as content density.

PARTICIPATION IN CONVERSATION

In Study II, the Measurement of Participation in Conversation (MPC) (Kagan et al., 2004) was used to rate social *interaction* and the *transaction of information in a conversation* on a nine-step Likert scale with half-point intervals where 0 corresponds to "no participation" and 4 corresponds to "full participation". The speech-characteristics rating scale from Norsk grunntest for afasi (Norwegian Basic Aphasia Assessment, NGA) (Reinvang & Engvik, 1980) was used to assess articulation and the occurrence of complex (semantic) paraphasias, hesitation, phonological paraphasias, visible effort, stereotypies and self-corrections on a seven-step scale with half-point intervals ranging from 0 (normal/not impaired) to 3 (severely impaired).

SELF-REPORTS

All established questionnaires and self-report forms were administered and scored in accordance with the available manuals and instructions. The responses on the study-specific scales were translated into points. A marking in between two scale steps was rated as half a point above the lower of the steps.

TREATMENT PROCEDURES

In Study II, 20 one-hour individual SFA treatment sessions were delivered three to five times a week to three participants with stroke. The original features for nouns and verbs were used, as described in Coelho et al. (2000) and Wambaugh and Ferguson (2007).

In Study III, 20 one-hour sessions were delivered in five sub-groups of 3–5 participants with stroke, three times a week for two hours at a time, with a half-hour midway break. The participants (also included in Study I) were randomly assigned to participate in a "naming" group or a "non-naming" group. In the naming group (n=9), a modified version of SFA was used, where some features were excluded on account of being too general or inapplicable to some words (Hashimoto & Frome, 2011). In the non-naming

group (n=8), a mix of exercises other than naming was used, such as copying writing, reading aloud and auditory comprehension tasks.

In Study IV, the original SFA features were used in 20 one-hour individual SFA treatment sessions, delivered (on average) twice a week to two participants with MS (from Study I).

All treatment was delivered by the author of this thesis, except that treatment in one of the naming sub-groups was delivered by a research assistant (also an SLT).

STATISTICAL ANALYSIS

Although the studies included in this thesis draw upon data from a fair number of participants, the numbers were still relatively small and the data were rarely normally distributed. For these reasons, only non-parametric statistical-analysis methods were used. Nominal data were analysed by means of Pearson's chi-square or Fisher's exact test for between-groups comparisons. The two-tailed Mann–Whitney U test was used for between-group comparisons, and the two-tailed related-samples Wilcoxon signed-rank test for within-group comparisons of ordinal or interval-scaled data. Two-tailed Spearman's rank correlations or Eta correlation coefficients were used to examine any relationship between outcome measures and between test results and demographic factors.

Treatment effects in Study II were calculated by means of d-index, based on results from the baseline phase and the last measurements in the intervention phase, and interpreted as representing a small ($\geq$2.6), medium (2.7–3.9) or large ($\geq$5.8) effect size (Beeson & Egnor, 2006; Beeson & Robey, 2006). In Study III, the effect size, calculated as $r=Z/\sqrt{N}$, was interpreted in accordance with Cohen's recommendations as small ($\geq$.1), medium ($\geq$.3) or large ($\geq$.5) (Fritz et al., 2012). In Study IV, the treatment effects were calculated using the percentage of non-overlapping data (PND), by dividing the number of post-baseline data points exceeding the highest point in the baseline phase with the total number of post-baseline data points (Scruggs et al., 1987). Treatment was considered very effective (PND$\geq$90%), effective (PND=71–89%) or ineffective or questionable (PND$\leq$70%) (Scruggs et al., 1988).

Since all four studies included in this thesis aimed to capture multiple aspects of word-retrieval ability, they all contained multiple comparisons. For this reason, the results were adjusted by means of the Bonferroni correction for multiple comparisons.

RELIABILITY

Inter-rater reliability was calculated on 30 per cent of randomly selected material for each measurement in Studies I, III and IV. The two-way mixed, single-measure, absolute-agreement intraclass correlation coefficient (ICC) was considered to be acceptable above .70, good above .80 and excellent above .90 (Cicchetti, 1994). Agreement in terms of Cohen's kappa was considered slight when <.20, fair at .21–.40, moderate at .41–.60, substantial at .61–.80 and almost perfect at .81–1 (Landis & Koch, 1977).

For accuracy of confrontation naming, inter-rater reliability was excellent: OANB: ICC=.97; 95% CI [.96, .97] and BNT: ICC=.93; 95% CI [.92, .93]. Likewise, it was excellent for response time within 0.1 seconds: ICC=.98; 95% CI [.98, .98] and for oral verbal fluency (FAS: ICC=.99; 95% CI [.99, 1.0], Animals: ICC=.99; 95% CI [.99, 1.0], Verbs: ICC=.99; 95% CI [.99, 1.0], COSEF: ICC=.99; 95% CI [.99, 1.0]).

Inter-rater agreement was good for the main-concept analysis (MCA) ICC=.89; 95% CI [.87, .90] and for CIUs (90% point-to-point agreement). As regards the ANELT, it was good for the A scale (Understandability): ICC=.85; 95% CI [.78, .90] but – similarly to the original reliability data (Blomert et al., 1994) – not quite acceptable for the B scale (Intelligibility): ICC=.69; 95% CI [.54, .80].

In Study II, inter-rater reliability was calculated on 33 per cent of the confrontation-naming tasks and 25 per cent of the recorded conversations. Inter-rater reliability for naming was substantial: κ=.70. For both the MPC measure and for the NGA speech characteristics, inter-rater reliability was excellent: ICC=.90; 95% CI [.81, .95] and [.85, .93], respectively.

RESULTS

In this section, results will be presented in turn for each separate measure of word-retrieval ability explored in this thesis: confrontation-naming ability, word fluency, connected speech and self-reports. In each section, the descriptive and comparative data from Study I will be presented first, followed where applicable by treatment-effect results from Studies II, III and IV. This is done to enable comparison between groups – that is, participants with moderate-to-severe anomia after stroke (MSAS), participants with mild anomia after stroke (MAS), participants with (mild) anomia and multiple sclerosis (MS) and participants with (mild) anomia and Parkinson's disease

(PD) – with regard to assessment results and treatment effects pertaining to various aspects of communication in relation to the relevant ICF components (body function, activity and participation).

MEASURES REFLECTING BODY FUNCTION

CONFRONTATION NAMING – ACCURACY

Unsurprisingly, accuracy in naming significantly distinguished the three groups of participants with less severe anomia from the MSAS group: $p<.001$, regardless of the word class or frequency of occurrence of target items. The MSAS group's mean accuracy score for the OANB was 48% and that for the BNT was 8%. Results from the three groups of participants with mild anomia overlapped; the only significant difference was found between the MS and MAS groups ($p=.016$ for OANB items and $p=.022$ for BNT items). Hence the results overlapped between the MSAS and MAS groups, between the PD and MAS groups, and between the PD and MS groups. The mean accuracy score for the OANB was 93% in both the MAS and the PD groups, and 98% in the MS group. For the BNT items, the mean scores were 43%, 55% and 62% for the MAS, PD and MS groups, respectively.

Within-group comparisons revealed that accuracy in naming was significantly lower for low-frequency than high-frequency items: $p<.001$ in all groups. Further, accuracy in naming was significantly lower for verbs than for nouns in the MSAS group ($p=.031$), the PD group ($p=.004$) and the MS group ($p=.005$). However, there was no significant difference between correctly named verbs and nouns in the MAS group ($p=.084$).

Analysis of the inadequate responses in the confrontation-naming tasks in Study I revealed that "no response or abandoned attempt" was common in the stroke groups. The proportion of this category was significantly larger in the MSAS group than in the PD group ($p=.018$) and the MS group ($p=.006$). Similarly, the proportion of "multiple phonological paraphasias or neologisms" was significantly larger in the stroke groups than in the other groups: MSAS vs. MS ($p=.025$), and MAS vs. both PD ($p=.035$) and MS ($p=.014$). The most common type of inadequate response in both the MS and PD groups was "related semantic paraphasias", which were common in both stroke groups as well, while "unrelated semantic paraphasias" was a relatively uncommon category in all four groups. Finally, the proportion of "visual misinterpretation" was highest in the PD group.

TREATMENT EFFECTS ON NAMING ACCURACY

Treatment effects on confrontation-naming accuracy for treated items were found in Study III, where the participants (n=17) had anomia of various degrees after left hemisphere stroke. The treatment effects on naming accuracy were similar for participants in both treatment groups: the one that specifically targeted verbal naming (using modified SFA) and the one that refrained from doing so (instead using mixed treatment tasks): p=.011 and p=.017, respectively. In the naming group, the treatment effect on accuracy was larger for trained verbs (p=.017, Z=2.395) than for trained nouns (p=.058), but no such difference was found for the non-naming group.

By contrast, no corresponding treatment effects of SFA on confrontation-naming accuracy for treated items was found in Study II or IV, which both had a single-case experimental design (SCED). In Study II, none of the participants (n=3) with aphasia after stroke improved their confrontation-naming ability. The participants (n=2) in Study IV, who had MS and mild anomia, both had high accuracy scores even in the baseline assessments, and the percentage of non-overlapping data (PND) after treatment was zero.

The treatment effects in Study III were not maintained at a follow-up assessment ten weeks after the end of treatment, and no generalization effects to confrontation-naming accuracy for untrained items were found in any of the studies.

CONFRONTATION NAMING – SPEED

The response time (RT) for all correct responses in the confrontation-naming tasks was measured in Studies I, III and IV. In Study I, a prolonged response time (>2 seconds) was found to be a distinguishing feature shared by participants with self-reported anomia, regardless of aetiology. However, in the PD and MS groups, prolonged RTs were evident only for the low-frequency BNT items (M=3.4 s and M=3.5 s, respectively). In fact, there was no significant difference (p=.367) in BNT RT among the four groups; mean BNT RT was 4.1 s for both stroke groups. However, the stroke groups also had prolonged RTs for high-frequency items (M=4.4 s in the MSAS group and M=2.6 s in the MAS group).

Similarly to the accuracy results, the MSAS group had a significantly longer RT (p<.001) for the OANB items than the PD and MS groups, but the results overlapped between the groups and the only other significant difference was found between the MAS and MS groups (p=.004).

TREATMENT EFFECTS ON NAMING SPEED

In Study III, no statistically significant treatment effect on RT remained after corrections for multiple comparisons had been made. However, mean RT decreased somewhat after treatment in the group that targeted naming, from 3.7 s to 2.8 s per item in the OANB (p=.021, Z=2.310) – but only from 4.1 s to 3.7 s per item in the BNT (p=.515, Z=.652). In the group not targeting naming, mean OANB RT decreased from 4.0 s to 3.5 s, while mean BNT RT increased from 5.4 s to 6.5 s (p=.735, Z=.388) – mostly due to an increased range (3.2–8.1 s before treatment but 1.7–19.9 s after it). Note that any responses given after the 20-second time limit were considered incorrect and are thus not included in the RT analysis. Hence these results must be considered with caution.

For one of the two participants with MS in Study IV, RT decreased progressively during the course of the SCED study, for repeatedly measured items, both treated and untreated. This result was therefore not interpreted as an effect of the SFA treatment but as a result of repeated measurements.

VERBAL FLUENCY

Scores on oral verbal fluency tasks were not used as outcome measures in any of the intervention studies, but they were used in Study I for within- and between-group comparison and in Studies III and IV as a background variable. In addition, word fluency was used as a control task in Study IV because it requires verbal responses and is closely linked to executive functions and to overall cognitive ability.

All groups in Study I had an impaired oral verbal fluency relative to Swedish test norms (Tallberg et al., 2008), although both stroke groups had a more severely impaired fluency than the PD and MS groups. There were no significant differences between the MAS and the MSAS groups, except in the Animals task (p=.029). As expected, the MSAS group scored significantly lower (p<.001) on all tasks than the PD and MS groups. Likewise, there was a significant difference (p<.001) between the MAS and MS groups for all tasks. Compared with the PD group, the MAS group scored significantly lower on the FAS (p<.001) and Verbs (p=.015) tasks. There were no significant differences between the PD and MS groups for any of the verbal fluency tasks.

The mean score on the FAS task was 5.7 in the MSAS group, 13.6 in the MAS group, 37.7 in the PD group and 34.9 in the MS group. The mean

scores for Animals were 3.7 (MSAS), 10.7 (MAS), 17.2 (PD) and 20.2 (MS), those for Verbs were 2.2 (MSAS), 7.1 (MAS), 14.2 (PD) and 15.4 (MS), and those for COSEF were 2.5 (MSAS), 7.1 (MAS), 11.9 (PD) and 14.6 (MS). It should be noted that only two of the MSAS participants performed the COSEF task.

Comparison between phonological and semantic fluency within each group revealed the same pattern as that observed for people without known brain damage (Tallberg et al., 2008). Accordingly, scores on the (semantic) Animals task were higher than those on the (phonological) FAS task in the MSAS group (p=.044), in the MAS and MS groups (both p<.001) and in the PD group (p=.009). Scores on the (semantic) Verbs task were significantly higher than those on the FAS task in the MAS group (p=.007) and the MS group (p=.001), but not in the other two groups.

In Study IV, one of the participants scored below test norms on all verbal fluency control tasks but reached the cut-off for the COSEF task (Bauer & Saldert, 2019) during the study. The other participant's results gradually increased to well within the test norms for all the verbal fluency tasks. This was interpreted as an effect of repeated exposure and familiarization with the tasks.

MEASURES REFLECTING ACTIVITY AND PARTICIPATION

CONNECTED SPEECH – RE-TELLING ABILITY

Connected speech samples were analysed in all the studies, with a view to exploring components relating to communicative activity and participation alongside those relating to body function. In Studies I, III and IV, the participants were shown Lineman cartoon clips (Cavandoli, 2007) and asked to re-tell their plot. Main concept analysis (MCA) (Kong, 2009; Nicholas & Brookshire, 1993b) was used in Studies I and III while correct information unit (CIU) analysis (Nicholas & Brookshire, 1993a) was used in Study IV.

All four groups in Study I scored below the reference mean total score of 87.2% main concepts (MCs) (Front & Johansson von Braun, 2021). The groups' mean scores were 22.0% (MSAS), 53.1% (MAS), 69.6% (PD) and 78.6% (MS). The MSAS group scored significantly lower than the MAS group (p=.008) and than the PD and MS groups (p<.001 in both cases).

Further, the MAS group had a significantly lower mean MC score than the MS group (p=.003).

The distribution across response types in the reference group was 82.7% accurate and complete (AC), 5.7% accurate but incomplete (AI), 2.0% incorrect (IN) and 9.6% absent (AB) (Front & Johansson von Braun, 2021). The corresponding proportions in the MSAS group were 10.1% AC, 13.3% AI, 9.0% IN and 67.6% AB. In the MAS group, the proportions were 43.6% AC, 17.6% AI, 7.5% IN and 33.5% AB. In the PD group, the corresponding proportions were 60.1% AC, 9.1% AI, 4.9% IN and 24.6% AB. The proportions in the MS group were 67% AC, 13.4% AI, 5.1% IN and 15.1% AB.

TREATMENT EFFECTS ON RE-TELLING ABILITY

In Study III, no treatment effects on re-telling ability were evident in either group. The mean MC score in the naming group, whose members were treated with modified SFA, was 37.7% before treatment (A1), 42.1% (p=.374) immediately after treatment (A2) and 43.9% (p=.484) at the follow-up session (A3). In the non-naming group, whose members were treated with mixed treatment tasks such as auditory comprehension tasks and copying writing, the mean MC score at A1 was 25.2%, that at A2 was 24.6% (p>1) and that at A3 was 33.6% (p=.208).

Likewise, there were no treatment effects on re-telling ability in either participant in Study IV.

CONNECTED SPEECH – CONVERSATION

TREATMENT EFFECTS ON PARTICIPATION IN CONVERSATION

In Study II, samples of natural conversation were collected and analysed using the Measure of Participation in Conversation (MPC) (Kagan et al., 2004) as well as rating of speech characteristics from the NGA (Reinvang & Engvik, 1980). Although no treatment effects on confrontation-naming ability were present, there were tendencies (albeit no statistically significant differences) towards improvement in the ability to participate in conversation in two of the participants. The effect sizes (d-index) ranged from 0.65 to 0.76 on the MPC Interaction scale and from -0.75 to 1.69 on the MPC Transaction scale. Similarly, regarding qualitative aspects of speech, there were tendencies towards an increase in self-corrections for two participants, and

towards a decrease in paraphasias for one participant, but no statistically significant improvements were evident. The only characteristic that showed a small effect (d=2.58) was an (undesirable) increase in the amount of semantic paraphasias in the speech samples from one of the participants.

EVERYDAY COMMUNICATION

TREATMENT EFFECTS ON EVERYDAY COMMUNICATION

In Study III, there were no generalization effects in either group to everyday communication as assessed using one of the two sub-parts of the Swedish version of the Amsterdam–Nijmegen Everyday Language Test (ANELT) (Blomert et al., 1994) either immediately after treatment or at the follow-up, as compared with the situation before the treatment. Out of a maximum score of 50 points, the naming group had mean scores of 30.3 on scale A (Understandability) and 45.8 on scale B (Intelligibility) before treatment and 29.0 (p=.497) and 46.2 (p>1), respectively, after treatment. The non-naming group had mean scores of 24.3 (A) and 47.5 (B) before treatment and 22.0 (p=.339) and 43.0 (p=.357), respectively, after treatment.

SELF-REPORTS

In Study I, no statistically significant difference (p=.099) was found among the four groups in their ratings of self-perceived communicative participation in the Communicative Participation Item Bank (CPIB) (Baylor et al., 2013). Each group contained not only participants who rated their condition as interfering to an extreme extent with their communicative participation in everyday situations, but also participants who rated that interference as only slight.

TREATMENT EFFECTS ON SELF-PERCEIVED COMMUNICATIVE ABILITY, COMMUNICATIVE PARTICIPATION AND QUALITY OF LIFE

In Study II, one of the participants rated his self-perceived everyday communication higher on the COAST scale after treatment, despite a lack of measurable improvement to naming ability. Moreover, there was a difference of approximately 30 percentage points between that participant's own (higher) ratings and those of his communication partner. The other two participants' ratings were slightly lower after treatment, by 1.3 and 7.5 percentage points, respectively. Ratings by two of the communication

partners changed slightly (by 2.5 percentage points) while the third increased considerably (by 30 percentage points).

In Study III, despite significant improvements to confrontation-naming ability, there were no statistically significant differences within or between the groups with regard to self-reported communicative participation or quality of life on any of the assessment points, after Bonferroni corrections had been made. The mean ratings on the General Short Form of the Communicative Participation Item Bank (Baylor et al., 2013) in the naming group were 12.3 before treatment, 12.6 (p=.677) after treatment and 12.4 (p>1) at follow-up ten weeks after treatment. The corresponding ratings in the non-naming group were 9.3, 9.4 (p=.248) and 11.1 (p=.235), respectively. Note that a higher rating (out of a maximum of 30) corresponds to less impact on self-perceived communicative participation. Hence both groups experienced a considerable, and persistent, negative impact on their communicative participation. Likewise, both groups reported a relatively unchanged negative impact on their quality of life, as measured using the Stroke and Aphasia Quality of Life Scale-39 (Hilari et al., 2003). On a scale from 0 to 5, where 5 corresponds to "no problem", the total mean in the naming group was 3.4 both before and after treatment (p=.407). At the follow-up session, however, it was 3.9 (p=.043), but this difference was not statistically significant after Bonferroni corrections for multiple comparisons. The mean rating in the non-naming group was consistently 3.7 before treatment, after treatment (p=.271) and at follow-up (p=.484).

Another important finding in Study III was the substantial negative impact on quality of life reported by the communication partners (most often spouses). They rated their own quality of life using the Communication Outcome After Stroke, Carer's perspective (Carer-COAST) (Long et al., 2009), where scores are presented as percentages and higher scores signal better quality of life. On average, the significant others reported 56.6% for their own quality of life in the naming group and 57.5% in the non-naming group. These ratings did not change significantly after treatment or at the follow-up session, in either group.

In Study IV, both participants typically reported experiencing bothersome word-finding difficulties on a daily basis. However, the ratings remained rather stable throughout the study and no treatment effects were evident (PND=0%).

SUMMARY OF RESULTS

In summary, and in the light of the overall research questions, the results showed the following:

Study I. What quantitative and qualitative similarities and differences are there when comparing symptoms of anomia, in formal assessment and as perceived by the participants themselves, in groups of participants with stroke, PD or MS?

There were quantitative differences in anomia symptoms between participants presenting with left hemisphere stroke, MS and PD, respectively, in that stroke typically led to greater word-retrieval difficulties. However, there were individuals with PD or MS who exhibited anomia symptoms to the same extent as individuals with stroke did. Qualitatively, the participants displayed similar symptoms of anomia in terms of delayed responses, impaired verbal fluency and reduced information content. However, the participants with stroke exhibited a wider variety of symptoms, for example phonological errors, than the other groups. The groups of participants with PD or MS made predominantly semantic substitutions. Finally, scores on formal assessments did not correspond well with the level of difficulties experienced by the participants themselves, and all groups reported reduced communicative participation.

Study II. Are there any treatment effects of intensive SFA single-words treatment as reflected in formal assessment of naming and of everyday communication, and in self-reports on everyday communication ability?

Only minor treatment effects were evident. Two out of three participants showed a tendency towards an increased ability to participate in conversation and towards a slight increase in qualitative speech aspects, despite an unaltered naming ability.

Study III. Is a modified SFA group treatment more effective in improving naming in formal assessments, and in improving self-reported communicative participation and health-related quality of life, than an anomia group treatment not focusing on verbal production?

Both the modified SFA treatment in the naming group and the mixed treatment in the non-naming group yielded treatment effects on treated items. Neither method yielded any statistically significant generalization or maintenance effects.

Study IV. Does SFA treatment have effects on word-retrieval ability in mild anomia in MS, and does it provide a useful strategy when encountering anomia in everyday communication?

SFA was not effective either in improving mild anomia in MS in the two participants or in serving as a useful word-finding strategy in everyday communication.

DISCUSSION

This thesis aimed to describe and compare signs of anomia within and between groups of participants with either left hemisphere stroke, Parkinson's disease (PD) or multiple sclerosis (MS) as well as to explore treatment effects of anomia treatment using semantic feature analysis (SFA). The thesis adds knowledge about how anomia may manifest itself in different health conditions, and about the treatment effects of anomia therapy, delivered individually and as group treatment, in participants with various degrees of anomia and either stroke or MS.

In summary, the symptoms of anomia were found to overlap among participants with stroke, PD and MS. Anomia manifested itself as reduced fluency and limited information conveyance across all groups, but there were some significant differences between them. In formal assessment tasks, the participants with moderate-to-severe anomia after stroke generally exhibited extensive signs of anomia, both quantitative and qualitative ones, while the difficulties in most participants with PD or MS were only partly revealed. Even so, the self-reports on reduced communicative participation were comparable between the groups. Hence the degree of anomia established through formal assessment does not necessarily reflect the degree of self-perceived difficulties in everyday communication.

Anomia treatment using SFA improved confrontation naming ability on treated items in participants with stroke, but similar effects were gained using another treatment approach as well. Further, only minor and statistically non-significant long-lasting treatment effects and generalization effects to untrained items or to everyday communication skills were found, both according to formal assessment and according to participants' own ratings. For participants with MS and anomia, no treatment effects of SFA treatment were found.

As expected, confrontation-naming tasks detected anomia in most participants in Studies I, II and III. However, in Study I, where participants presented with different degrees of anomia, their performance on confrontation-naming tests was highly divergent – in fact ranging from 0 to 100 per cent accuracy for naming of common objects and activities. This corroborates previous findings that confrontation-naming tasks may not be sensitive enough to capture mild anomia if only naming-accuracy scores are considered (De Dios Pérez et al., 2019; Hunting-Pompon et al., 2011; Macoir et al., 2021); if response times are also considered, the sensitivity of such tasks may improve (see below).

Although results overlapped across participants with different aetiologies, post-stroke anomia often led to more severe confrontation-naming difficulties than PD or MS, indicating that stroke-induced brain injuries affect the underlying word-retrieval processes to a larger extent. The low scores for confrontation-naming accuracy in the group of participants with stroke and moderate-to-severe anomia diverged very strongly from those of the other groups. It is of course the case that large and multiple brain lesions, as well as lesions in structures crucial for verbal production, can result in larger disturbances. When it comes to the *body functions and structures* aspect of the ICF framework, lesion size and location of lesions in stroke commonly affect language skills more unfavourably in stroke than in PD or MS. However, one somewhat surprising result from the present studies was the wide range of naming difficulties detectable in the PD and MS groups. Although most participants in those groups had results within test norms, it was evident from the confrontation-naming tasks that some of them had marked word-finding difficulties, especially for low-frequency words.

Findings in Study I suggest, in particular, that PD can lead to greater naming difficulties than has been apparent in previous research. In fact, the confrontation-naming ability of the PD group in Study I was comparable to that displayed by the group of participants with mild post-stroke anomia. These findings support the need to consider having an SLT perform a language assessment in addition to the assessments of speech and swallowing, as advocated, for example, in Saldert and Bauer (2017) and Schalling et al. (2017).

When people with self-perceived difficulties perform within test norms in formal assessment, additional tasks and measurements are required. In this thesis, measurements of response time, verbal fluency and information density successfully detected mild anomia. What is more, analysing not just the numbers but also the nature of adequate and inadequate responses may

deepen our understanding of how anomia may manifest itself in different individuals. In this context it may be noted that many of the participants in Study I had relatively greater difficulties producing verbs than nouns. This finding is well in line with those of previous studies discussing the noun–verb dissociation in neurological conditions such as stroke, PD and MS (Benetello et al., 2016; Kambanaros et al., 2016; Smith et al., 2018). However, other participants, particularly those with mild post-stroke anomia, had similar naming difficulties for nouns as for verbs, suggesting that there is indeed considerable variability among individuals regarding word-class dissociation (Conroy et al., 2009b).

Another noteworthy finding in Study I was that semantic inaccuracies predominated in the PD and MS groups, while both semantic and phonological inaccuracies were common in the stroke groups. Again, this suggests that the language-processing system is more affected by the – generally more extensive – size and location of the underlying brain damage in stroke than in PD or MS. However, it is certainly the case that multiple, large and deep brain structures may be damaged in PD and MS as well, and this provides a possible explanation for the occurrence of similar concurrent phonological and semantic inaccuracy in those conditions. Moreover, since neural networks important in language processing involve various grey-matter brain regions and their white-matter connections (McKinnon et al., 2018), lesions of various sizes and locations may potentially affect the relevant processes. It has been suggested that impaired prefrontal executive functions, commonly associated with white-matter lesions, may affect the ability to retrieve words in fluency tasks in MS, and that slower cognitive functions result in ineffective lexical-retrieval processing (Tallberg & Bergendal, 2009). Similarly, it has been suggested that damage to basal ganglia in PD disrupts the cortical connections, affecting information transmission between language areas (Altmann & Troche, 2011). Consequently, cortical and sub-cortical damage due to stroke, MS or PD may lead to slower and ineffective cognitive functions, including language functions, commonly resulting in reduced information content and reduced fluency in verbal output. According to the semantic-phonological model (Foygel & Dell, 2000), which is based on the interactive two-step theory of lexical access (Dell et al., 1997), the weight of the lexical-semantic and/or lexical-phonological connections may become reduced in a damaged system, resulting in errors that are semantic and/or phonological in nature.

Results from Study III showed that accuracy in single word confrontation naming, a measure reflecting word-retrieval function, can be improved with treatment, even in participants who have had chronic aphasia for many years.

In this context, it is noteworthy that the results of Study III suggest that gains in naming ability can be accomplished without targeting of naming in treatment. Both groups in that study improved their confrontation-naming ability for treated items, even though only one of them practised verbal naming. The other group instead trained their items in a mix of exercises, but never by naming or independently producing the items in any other way. Despite this difference in treatment content, both groups significantly improved their verbal naming ability. This can be interpreted as meaning that overt naming practice may not be crucial for gains in naming ability, but that activation of supporting adjacent processes may be as effective. A further tentative conclusion is that participating in a group may have had a beneficial effect on treatment outcomes, in both groups. In fact, having the opportunity to communicate with a group of peers can benefit communicative activity and participation (Antonucci, 2009; DeDe et al., 2019; Elman & Bernstein-Ellis, 1999; Falconer & Antonucci, 2012; Peach & Reuter, 2009; Simmons-Mackie et al., 2007) and could thus possibly promote treatment outcomes. In other words, participants' use of their word-retrieval function together with peers in activities resembling everyday communication may have enhanced the treatment gains they obtained.

In Study I, oral verbal fluency tasks proved capable of detecting anomia of various degrees. Participants with moderate or severe anomia typically had significant difficulties producing more than a few correct responses in those tasks. Many of them were clearly frustrated and spontaneously commented on how time pressure was stressful and obstructive when they were attempting tasks such as verbal fluency ones. However, similar reactions were also apparent in participants with less difficulties, indicating that verbal fluency tasks are very demanding – and that the environmental factor of time pressure involved in such tasks may be part of the reason for this. Indeed, when asked about their word-finding difficulties, most participants mentioned experiencing a reduction in speed in everyday communication. This was confirmed by the prolonged response times observed in the assessment of confrontation naming in Studies I, III and IV – reduced speed in confrontation naming was evident even in the participants with high scores for naming accuracy. In fact, one of the main findings in Study I was that response times for low-frequency items was increased by a similar amount in all four groups of participants, despite large differences in accuracy scores. It is inarguable that the temporal aspect is important in speech production for real-time communication. Inaccurate timing as well as reduced speed and fluency may affect the perceived quality of an otherwise adequate production, which may impede activity and participation. In a study by Wallace et al. (2017), being able to "keep up" in conversations was identified as one of the

most important treatment outcomes by the 39 participants with aphasia and their family members who were included in that study.

Results from the intervention-related Studies III and IV indicate that response times can be reduced with practice. However, in Study III, the reductions obtained were not statistically significant after Bonferroni adjustments. In Study IV, the reduction in response time was similar for all repeatedly measured items – that is, for trained and untrained items alike. For this reason, that reduction was interpreted as a result of repeated exposure rather than as a treatment effect of the SFA treatment. Correspondingly, the increasing verbal fluency evident in Study IV was presumably a consequence of cumulative familiarity with the task, due to repeated measurements. However, even though the improvements were thus unlikely to result from the SFA treatment, those findings may be seen as encouraging indications that improvements can be achieved through practice, even in chronic or progressive disease. In this context, it should be noted that targeting both accuracy and speed in anomia treatment can be more effective than targeting accuracy only. In a study by Conroy et al. (2018), a treatment method combining speed and accuracy proved more effective in improving and maintaining effects on both accuracy and speed in naming, as well as yielding generalization effects to connected speech. The possibility that treatment may influence response times, with generalization effects to communicative activity and participation, deserves further investigation.

Another common denominator of most people participating in the studies included in this thesis, regardless of aetiology, was a reduced content density in connected speech. In Studies I and III, content density was assessed using main-concept analysis (MCA), which provided a qualitative overview of speech production that clearly highlighted the density of the information content conveyed. The measure of whether information was present, sufficient, lacking or absent was based on the proportion of accurate and complete utterances to incomplete, inaccurate or absent ones. The findings from MCA analysis in Study I showed that the reduction of information density in the participants' re-telling output was qualitatively similar although quantitatively different. No statistically significant treatment effects on re-telling ability were evident in Study III in either group, meaning that the participants' increased naming ability was not evident in their performance on the connected-speech task. Since their improved naming ability was limited to treated items, it is possible that the word-retrieval function did not improve to such an extent that it affected word-retrieval ability in other situations. Moreover, results from Study IV suggest that the treatment effects on confrontation naming were affected by the degree of

anomia. It should be noted that the participants with MS and mild anomia had very high accuracy scores to begin with, meaning that there was little room for improvement. This caused a ceiling effect which rendered the measurement of accuracy in confrontation naming inadequate. In Study IV, correct information unit (CIU) analysis was deemed to be sensitive enough to detect changes in re-telling ability even in the participants with mild anomia, but no such treatment effects were evident. Since the participants did not seem to use SFA as a strategy when encountering word-finding difficulties, the lack of a treatment effect on re-telling might be partly influenced by personal factors contributing to an unwillingness or inability to use the strategy. However, it is more likely that the usefulness of SFA as a strategy in everyday communication, and in the activity of performing the re-telling task, was insufficient, meaning that it failed to further boost participants' only slightly impaired word-finding ability.

At a general level, it can be noted that the findings resulting from the formal assessments performed in this thesis support the existing recommendations to include both single-word and connected-speech tasks when evaluating word-finding difficulties in individuals with anomia, as different tasks may reveal different deficits (Fergadiotis et al., 2019; Herbert et al., 2008; Mayer & Murray, 2010; Richardson et al., 2018).

Although statistically significant treatment effects on naming were found in Study III, the overall results from the three intervention studies were unsatisfactory. Only minor treatment effects of SFA were found on communicative activity and participation (in Study II) and on quality of life (Study III). In Study II, the two participants with non-fluent aphasia both exhibited slightly positive trends towards an improved ability after treatment to participate in conversation and to make adequate self-corrections. These findings may indicate that the participants had become better aware of their own verbal production and possibly better able to adjust an undesirable output. This would reflect an increased influence of personal factors on the word-retrieval function and on communicative activity and participation. Similarly, a combination of greater awareness and an unsatisfactory ability to amend verbal output may have contributed to the slight, temporary drop seen in one participant's ratings of self-perceived communicative effectiveness immediately after treatment. Another possible explanation for this is that participants need time to implement any improvements, resulting in a delayed treatment effect; this is supported by the fact that the ratings for communicative confidence and satisfying social interactions had increased at the follow-up session 10–12 weeks after the end of treatment.

The lack of substantial generalization effects, although unsurprising, gives cause for concern, and the pressing issue of how to attain long-lasting generalization effects from SFA and other kinds of anomia treatment remains unsolved (Brady et al., 2016; Efstratiadou et al., 2018; Maddy et al., 2014; Nickels, 2002). The ultimate goal of anomia treatment is to increase the ability to retrieve any desired word effortlessly, accurately, timely and rapidly. It is conceivable that an improved word retrieval ability will in turn enhance self-perceived communicative skills, participation and, ultimately, quality of life. However, as discussed in Efstratiadou et al. (2019), other treatment elements, such as tasks where the word-finding ability is used with explicit communicative intent, may be crucial for obtaining generalization effects. Treatment methods such as those used in Studies II–IV, which focus on improving the body function (i.e., word-retrieval ability) and lack explicit communicative intent, may not be sufficient to achieve effects on everyday communication, activity and participation. Further, it could also be the case that the treatment items used did not have enough personal relevance (Study II), distinctive visual interpretability (Study III) or difficulty (Study IV) to yield maintenance and generalization effects. Finally, the assessment instruments and analysis methods used may not have been sensitive enough to detect any and all possible changes in activity and participation.

As concluded in Study I, self-perceived difficulties may have serious consequences for a person's communicative participation, regardless of his or her performance on formal assessment tasks. Noteworthy findings in Study I were that no significant differences were seen across the four groups of participants regarding reduced communicative participation, and that all groups reported negative consequences on their everyday communication and quality of life. The participants' ratings indicate that anomia may add to feelings of self-consciousness and result in apprehension to engage in communicative situations. The findings in Study I show that even mild anomia can result in significant communication difficulties. Communication difficulties can lead to reduced participation in various social situations, decreased employability, lowered self-confidence and the need for an increased effort when communicating (Cavanaugh & Haley, 2020). Considering these consequences, it is apparent that, to enable clinical confirmation of self-perceived difficulties, there is a need for assessment methods and materials that are sufficiently sensitive to detect even mild anomia. For this reason, it is important to ask questions about anomia and other communication difficulties, and to use a range of instruments to assess any difficulties.

Another important finding in Study I was the discrepancy between self-reported communication difficulties and those revealed by formal assessment. This highlights the need to ask the person concerned about his or her own experience. It should be noted that some participants claimed to experience *less* difficulty, while others claimed to experience considerably greater difficulties, than their test scores indicated. While this is in line with previous studies (El-Wahsh et al., 2020; Klugman & Ross, 2002; Schalling et al., 2017), it is something that deserves more attention both in future research and in clinical management.

One reason for these discrepancies could be that changes in an ability are more noticeable to the person directly concerned than to those around him or her. An abrupt change, such as after a stroke, might be more noticeable than slowly developing difficulties, such as in PD or MS. However, minor impairments and slow deterioration may be equally troubling when they affect key abilities. On the other hand, even substantial deficits may be overshadowed by other, co-occurring symptoms (Johansson et al., 2021; Schalling et al., 2017). Further, it may be easier to compensate for evolving difficulties in progressive diseases such as PD and MS than for the sudden loss of functions due to stroke (Thiel et al., 2006), in line with the compensation known to happen in normal aging (Manenti et al., 2013). In addition, besides any difficulties caused by the underlying condition itself, the perception of communicative difficulties may also be affected by other environmental and personal factors, such as personality traits, pain, coping strategies, communicative demands and social support (Northcott et al., 2016; Yorkston et al., 2014), given that satisfactory communication requires the interaction of multiple factors. For example, supporting behaviour on the part of communication partners may facilitate successful communication, while overbearing, derogatory or impatient attitudes may serve as barriers (Eadie et al., 2006).

Finally, it should be stressed that inter-personal interaction in the presence of communication difficulties may be equally challenging for everyone involved, which was reflected in the ratings made by communication partners in Studies I, II and III. In Study II, this was particularly evident in the case of the participant with fluent aphasia, whose communication partner's ratings were considerably lower than his own. Similarly, in Studies I and III, some of the ratings by communication partners indicated that the communication partner's quality of life was severely affected. The impact that a family member's health condition may have on a caregiver is recognized as "third-party disability" within the ICF classification (WHO, 2001). A previous study by Berg et al. (2005) showed that depression was relatively more

common in caregivers than in stroke survivors themselves. Similarly, caregivers of people with PD or MS have been reported to have impaired physical and mental health relative to population norms for quality of life (Peters et al., 2013). This means that communication partners may not have the resources they would need to be supportive. Previous studies discuss the importance of addressing third-party disability due to family members' communication disabilities (Grawburg et al., 2013; Mach et al., 2021) and conclude that family-centred interventions may improve both the treatment outcomes and the well-being of the person with a neurological condition (Threats, 2010; Visser-Meily et al., 2006). In line with this, the findings in this thesis highlight the need to provide additional support to spouses, relatives and friends of individuals with anomia.

LIMITATIONS

In the interpretation of the findings presented in this thesis, some limitations to the research underpinning it must be considered. First, all participants had self-perceived word-finding difficulties, and most of them were recruited from patients' organizations, meaning that the results cannot be generalized to all people with left-hemisphere stroke, Parkinson's disease or multiple sclerosis. Additionally, although the number of participants may be relatively large for its field, having a larger number of participants would have enabled more extensive comparisons and would have strengthened reliability. Second, data were collected by several researchers and research assistants over a long period of time, and minor variations in test administration cannot be entirely ruled out. However, reliability calculations yielded very good results, and all test administrators followed written instructions and guidelines to ensure equivalence across assessment sessions. Third, although the test battery used was extensive, it might not have captured all aspects of word-retrieval ability as used in everyday communication. The addition of interviews and samples of real-life everyday communication could have made it possible to capture more of the communicative activity and participation aspects. In addition, the use of only part of the Boston Naming Test can be questioned, as this limited the possibility of making comparisons with test norms. Similarly, some of the rating scales used were study-specific and validity and reliability data were lacking. Further, the use of different forms to collect information about the participants' self-perceived quality of life prevented detailed comparisons across the groups in this respect. However, the CPIB was administered to all participants, as were most components of the broad test battery, which enabled extensive comparisons across groups and participants. Fourth, some participants found it difficult to suggest treatment items, and this may have caused their items to be less personally relevant than what was intended. Still, each participant approved his or her items before they were used in treatment.

What is more, it proved a challenging task to depict some of the items chosen in an unambiguous way, and in some cases this may have caused uncertainty about what the intended target word was, which may, in turn, have affected the outcome measures. However, this is unlikely to have exerted a major influence on the results, since each participant had only one or two hard-to-depict items while the rest were easy to recognize.

CONCLUSIONS AND IMPLICATIONS

Anomia-symptom occurrence differed between participants with left hemisphere stroke, multiple sclerosis (MS) and Parkinson's disease (PD) in that stroke commonly resulted in more severe anomia and in more extensive symptoms. However, there were overlaps on a continuum of anomia-symptom occurrence and manifestations, with participants with stroke generally at one end, those with PD generally in the middle, and those with MS generally at the other end. Anomia commonly manifested itself in fluency deficits and reduced information content. Naming inaccuracies were predominantly semantic in nature in participants with PD or MS. The participants with stroke additionally had phonological errors, and non-responses were common.

Implication: People with communication difficulties after stroke require extensive contacts with SLTs and other health-care professionals. It is important that those health-care professionals inquire about communication ability, including word-finding difficulties, as part of the clinical routine for people with neurological conditions. Assessment of mild anomia may need to include additional measures of speed and connected speech.

There was a discrepancy between results on clinical assessments and the level of difficulties experienced in everyday communication by the participants themselves. Anomia of various degrees can result in a self-perceived reduction of communicative participation and quality of life.

Implication: Standard assessment instruments should be supplemented with self-reports, in research as well as in clinical settings.

There were treatment effects on word retrieval, reflecting the body-function component of the ICF, from the impairment-based semantic feature analysis (SFA) treatment method in that naming ability improved for treated items in participants with stroke. However, similar effects were gained from another treatment as well. No statistically significant treatment effects were found for measures reflecting the (communicative) activity and participation aspects of

the ICF, although two participants with stroke displayed a tendency towards an increased ability to participate in conversation. Finally, no treatment effects from SFA were evident on measures reflecting body function, communicative activity or participation in the two participants with mild anomia in MS.

Implication: More research is needed regarding generalization and maintenance effects from anomia treatment and regarding effective methods for treating mild anomia. More research is also needed regarding treatment methods that focus on improving communicative activity and participation.

FUTURE PERSPECTIVES

The findings in the studies included in this thesis need to be verified in larger samples. Comparisons between larger, more homogenous groups would enhance our overall knowledge about the manifestations and consequences of anomia, and so would the inclusion of participants presenting with other neurological conditions, such as right-hemisphere stroke, bilateral stroke, dementia or traumatic brain injuries.

Although an extensive test battery was constructed and used in the studies, not all aspects of word-retrieval ability and its impact on communicative activities and participation were captured. There is a need for standardized test batteries and analysis methods appropriate for evaluating anomia of various degrees, in relation to all three ICF components of body function, communicative activity and communicative participation, as well as in relation to personal and environmental factors.

The effects of various anomia treatments need to be explored in a greater number of participants, preferably in the context of large randomized controlled trials. The findings from the present studies as well as those from previous studies are inconclusive with regard to immediate and lasting treatment effects. It remains to explore what treatment methods or elements are the most effective for improving communicative activity and participation and for gaining maintenance and generalization effects.

Above all, the findings from self-reports in this thesis – showing that both the participants, who themselves presented with a neurological condition, and their communication partners reported serious negative effects on their quality of life – highlight that more research and clinical attention are required to meet the needs of people affected by communication difficulties.

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