The Applicability and Outcome of Constraint Induced Language Therapy (CILT) in Early Aphasia Rehabilitation

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List of papers

Paper I

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Paper II

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Paper III

Kirmess, M. (Submitted). "I like to come here and do a job" - Participant experience and long-term outcomes of CILT in early aphasia rehabilitation. *International Journal of Speech-Language Pathology*. Manuscript ID TASL-2010-0104[b]

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1. Introduction

The term aphasia is defined as an acquired language and communication disorder following brain injury, which cannot be explained by sensory or motor disorders, degenerative diseases, or intellectual or psychogenic disorders (Hallowell & Chapey, 2008b; Reinvang, 1994). Brain injuries have different aetiologies such as stroke, trauma, deficits in oxygen supply, and so on; however, this study focuses solely on cerebrovascular accidents (ischemic and haemorrhagic stroke). Aphasia embraces expressive and receptive language modalities (speech, comprehension, reading, and writing) and can be expressed to different degrees. Depending on the localisation and extent of the brain injury, aphasia may interfere with other cognitive functions depending on language (Hallowell & Chapey, 2008b). Hence, aphasia covers a variety of clinical language characteristics, but the diagnostic term 'aphasia' does not define which specific language functions are affected in the person surviving a stroke.

Stroke incidence in Norway is estimated at 15,000 persons per year, making it the third most mortal illness and the dominating cause of severe disability in Norway (Helsedirektoratet, 2010). In the recently published guidelines for treatment and rehabilitation of stroke, the Norwegian Directory of Health estimates that approximately 25% of stroke survivors will experience aphasia (Helsedirektoratet, 2010, p. 127). In addition, approximately 10,000 persons live with stroke-related aphasia in Norway at any time (Becker, 2009). The Norwegian Aphasia Association (Afasiforbundet i Norge) describe slightly higher numbers in their public presentations, claiming that between three and five thousand people acquire aphasia each year. This difference may reflect the inclusion of additional aetiologies for aphasia (i.e., not solely stroke).

Language is a unique feature of being human and a central part of communication (Linell, 2009). That language concerns more than conveying information and content is addressed by Armstrong and Ferguson (2010). They (ibid) emphasize the role language plays in the reflection of interpersonal resources (i.e., the way language is adapted to different contexts, what is said to whom and how, emotions, etc.) and in the expression of discourse coherence. Hence, their (ibid) understanding of functional language reflects a 'meaning-making resource'. Consequently, a language deficit such as aphasia significantly influences the sufferer at both the intra- and interpersonal levels.

Thus, patients' longing to improve expressive language function (as expressed by many persons with newly acquired aphasia I have met during my work as a speech and language pathologist[1]) is reasonable. Despite having additional problems with comprehension, reading, and/or writing, the skill of producing meaningful utterances seems to be of particular importance for the person with aphasia and is therefore an expressed priority in the rehabilitation process. The use of alternative communication approaches seems to be more appreciated at a later stage in the rehabilitation process in line with starting to acknowledge the aphasia outcome (cf. Holland, 2010).

The Norwegian Government defines rehabilitation as a timed, planned process with stated purposes, measurements, and instruments and the aim of establishing the best possible functional outcome in order to enhance individual mastering, independence, and participation in all areas of daily living (St.meld.nr. 21, Sosial- og helsedepartement, 1998-1999). Importantly, the involvement and rights of co-determination of the person in need within a multi-professional setting are emphasised. The present thesis applies this definition of rehabilitation. Furthermore, the term aphasia rehabilitation is preferred to recovery, because full or almost full recovery after stroke is reported for only one third of persons experiencing a stroke (Helsedirektoratet, 2010) and aphasia (Pedersen, Vinter, & Olsen, 2004). Stroke mortality decreases because of improved acute treatment (e.g., thrombolysis). As a consequence, an increasing number of stroke survivors experience and live with stroke sequelae, thereby needing extended and often prolonged rehabilitation (Indredavik, Ellekjaer, & Selmer, 2008).

The terms therapy, treatment (or treatment approach), and training are often used synonymously in the literature of rehabilitation research, while the Norwegian educational perspective of aphasia rehabilitation prefers the terms teaching or tuition. These different terms and implanted definitions may have legal implications for the provision of professional

[1] The Norwegian professional title *logoped* is translated as speech and language therapist according to the Norwegian Association of Speech and Language Therapists (Norsk Logopedlag, www.http://norsklogopedlag.no). On the other hand, journals publishing aphasia studies prefer the term speech and language pathologist (SLP). For consistency, the term SLP is applied throughout this doctoral thesis.

services (e.g., therapy), may relate to different approaches concerning re-establishing or new learning, and may reflect international variation. Since the present study is grounded in a multi-disciplinary approach based on a biopsychosocial model, these listed terms are juxtaposed in this thesis. Even so, the main use of the term *treatment* in the papers is chosen to reflect the clinical rehabilitation perspective. The term or extension *program* is in this thesis applied for a specific type of treatment in a given set-up or structure. According to Hallowell and Chapey (2008a), the term *intervention* is applied to describe the process of facilitating rehabilitation in the form of professional treatments and is therefore also relevant to use for the aphasia treatment program in this study - constraint induced language therapy (CILT).

1.1 The purpose of the research study

The effectiveness of speech and language therapy for aphasia rehabilitation is regularly discussed in the research field, and the demand for treatment outcome studies is constantly growing (Hallowell & Chapey, 2008a). The updated review from the Cochrane database on the effect of speech and language therapy for aphasia covered aphasia research from 1966 to 2009 (Kelly, Brady, & Enderby, 2010). Despite the large time span, the review resulted in only 30 included intervention studies that fulfilled the requirement of being randomized control trials. Based on these rather few studies, the authors (ibid) could only infer a few indications of the effect of speech and language therapy. There was insufficient evidence to allow inferences to be drawn regarding whether one specific speech and language therapy program produces better outcomes than another. However, there was also insufficient evidence to conclude that speech and language therapy is ineffective.

In spite of this, the Cochrane review highlighted that intensive treatment studies (including constraint induced language therapy) tended to produce more promising outcomes than low-intensive speech and language interventions. Intensive treatment studies were also associated with significantly higher dropout rates. Intensive treatment refers to at least five hours of treatment per week, which Bhogal, Teasell, and Speechley (2003) reported as being the necessary number of treatment hours to produce an effective treatment outcome. The

Norwegian stroke rehabilitation guidelines for aphasia are consistent with this recommendation (Helsedirektoratet, 2010).

The insufficient evidence of the effect of speech and language therapy as reflected in the Cochrane review (Kelly et al., 2010) may be explained by factors such as methodological limitations, the large number of treatment programs, the heterogeneity of individual language problems, and the lack of relevant studies. Irwin, Pannbacker, and Lass (2008) contend that the medical gold standard of randomized control trials is not necessarily the best method to gain knowledge within human research (e.g., in the field of aphasia).

Kelly et al. (2010) summarise that as of yet, there is no universally accepted aphasia therapy program that could be efficiently applied to every person acquiring aphasia. Therefore, speech and language pathologists have to work within different approaches and methods based on each person's individual treatment plan. There are no Norwegian studies included in the Cochrane review (Kelly et al., 2010), but its relevance applies more than ever with the increasing request for effective treatment for a growing population of individuals affected by stroke (cf. Helsedirektoratet, 2010; Indredavik et al., 2008). Despite a growing research tradition for Norwegian speech and language pathologists in the field of aphasia rehabilitation, thus far, there exists only a small number of treatment publications beyond the level of master's degree thesis. This extends the need to render visible the clinical work and experience provided by Norwegian speech and language pathologists for persons with aphasia. Therefore, one of the purposes of the present study concerns the systematic documentation of a treatment outcome for aphasia in Norway.

Related to the small number of included aphasia intervention studies in the Cochrane review (Kelly et al., 2010), the authors address the even more restricted number of studies that include persons with aphasia in the first weeks and months post-stroke. Kelly et al. (2010) discuss the relevance of research results conducted within a chronic (minimum one year post-stroke, often long-term) population for the early (less than one year) clinical setting in which most speech and language pathologists meet their clients with aphasia. Linebaugh, Baron, and Corcoran (1998) even question the applicability and appropriateness of treatment procedures based on research in chronic aphasia to acute aphasia rehabilitation. Studies within the chronic population are necessary to gain important knowledge about the

effectiveness of an aphasia program beyond the influence of spontaneous recovery and, hence, play an important role in the development of new treatment approaches (cf. Paragraph 2.2). Furthermore, positive chronic treatment outcomes argue against a treatment limitation solely based on time post-onset (e.g., Moss & Nicholas, 2006), which has previously been a valid reason for terminating aphasia rehabilitation.

Importantly, Robey (1994, 1998) reported a greater aphasia treatment outcome when rehabilitation was started within the acute phase (up to four months post-onset) than without any treatment or compared to treatment at later stages. More recently and based on modern neuroscience, researchers discuss to which degree the same brain processes are active in the different phases of rehabilitation and require similar or different treatment approaches (e.g., Hillis & Heidler, 2002). Therefore, specific aphasia treatment outcome studies are warranted to explore intervention effects for the acute and early rehabilitation phases of aphasia (Cherney & Robey, 2008; Kelly et al., 2010).

The promising reported findings on intensive intervention in aphasia rehabilitation, the positive results from constraint induced language therapy in the chronic population (described in detail in the following chapter), and the demand for further exploration of interventions for early aphasia rehabilitation provide the rationale of the study presented in this doctoral thesis. Therefore, the present study covers the following research subject:

The purpose of this doctoral study is to explore the applicability and outcome of constraint induced language therapy (CILT) on verbal expressive speech in early aphasia rehabilitation.

Rehabilitation research serves the purpose of gaining knowledge for the rehabilitation process (in this case, aphasia) to determinate whether an intervention works (here, the CILT-program) and, most importantly, to make an improvement on the personal level (i.e., to enhance expressive speech production and thereby communication) (Domholdt, 2005). The determination of the outcome of an intervention involves functional assessment and performance evaluations as well as discussions of intervention issues and rehabilitation service delivery (ibid). According to these factors, the general purpose of the present study is operationalized in the following research areas:

a.) *The application of constraint induced language therapy to the Norwegian speech and language therapy context.* That is, to adapt and develop a Norwegian treatment material and protocol for intervention.

b.) *The exploration of the applicability of constraint induced language therapy in early aphasia rehabilitation in a clinical setting.* This is included in the clinical intervention study to investigate whether CILT can be carried out as early as one to four months post-stroke in a conventional hospital setting. Therefore, the effect of the treatment outcome for the person with aphasia will be explored through the assessment of language and communicative measures. Furthermore, feedback from participant evaluations is collected to gain knowledge of the participant experience of CILT.

c.) *The evaluation of the implementation of CILT in the Norwegian speech and language pathologist's working environment.* This concerns the progression of the study and feedback from speech and language pathologists.

d.) *The extension of knowledge of expressive speech production in the early aphasia rehabilitation process.* This involves the investigation of the generalizability of the treatment outcome to other language modalities and treatment stability post-intervention indicated by the follow-up measures.

The application of CILT can be understood on two different levels:

- the individual level of the physical impairment and improvement of the person with aphasia.
- the systemic level of integrating CILT into the existing forms of aphasia rehabilitation in Norway.

1.2 The composition of the thesis

This doctoral thesis is based on one intervention study. It includes the frame of the thesis and three papers presenting results for scientific publication. The relation of the frame of the thesis to the three papers reflects the process and outcome dependency of the study. In order

to collect the data presented in the papers (the outcome of the intervention on the individual level), the study required laborious preparations connected to the material, instruments, sampling, and realization of the intervention (the process). The process of the study addresses the aims of research area *a*). With reference to the length restriction of the papers in scientific journals, these processes are described in detail in the frame of the thesis to provide information for replication and to support the validity and reliability of this study. The design and progression of the study and methodological considerations are mutually dependent but are, for structural reasons, described separately in Chapters 3 and 4, respectively. The frame of the thesis also allows for an extended description of the rationale of aphasia rehabilitation in general and the theoretical background of CILT, specifically. This is provided in the second chapter.

The three papers mainly emphasize the results of the CILT intervention outcome on the individual level consistent with research areas *b* and *d*. Paper I presents the first case results of the intervention and discusses the applicability and need to adapt the CILT-program to early rehabilitation in Norway.

The general purpose of aphasia rehabilitation concerns the use of language and communication outside the speech and language pathologist's room. Therefore, expressive language should be assessed in settings that are more conducive to normal conversation in order to discuss a possible generalisation effect of the treatment (cf. Research area *d*). Nickels (2002) contends that word activation is a natural part of all communication but that generalisation of single word treatment effects to everyday communication seems to be far more limited. Therefore, Paper II concerns the analysis of oral text production based on spontaneous speech production collected from the conversational interview from the Norwegian Basic Assessment of Aphasia (NGA) (Reinvang & Engvik, 1980b).

In Paper III, the results for all participants of the CILT-program are analysed and summarized on a small-group level with an additional focus on the participant experience and long-term outcomes (cf. Research areas *b* and *d*). Because language measures are usually evaluated by the researcher, viewpoints of the participants with aphasia themselves (based on the CILT participant experience survey, see paragraph 3.4.8) and of their significant others (based on the Communicative effectiveness index, CETI) (Lomas et al.,

2006) add important knowledge of the individual experience to the outcome evaluation of the CILT-program. These aspects are introduced in Paper I and extended in Paper III.

Even though the CILT-program yields positive intervention outcomes on the individual level, in order to be of clinical relevance beyond a research setting, the treatment has to be available to the aphasia population in general (i.e., the systemic level of rehabilitation in a society). Therefore, all three papers hold implications for further clinical application of the CILT treatment. In addition, the experience from the conduction of the study in relation to the regulations of the Norwegian rehabilitation system for aphasia (cf. Research area *c*) is discussed in the frame of the thesis.

1.3 Operationalization of terms

The terms and methodology applied in this thesis reflect the interdisciplinary field of aphasia, with applications from speech and language therapy, special needs education, psychology, and neuroscience.

1.3.1 Aphasia

In the introduction, aphasia was defined as an acquired language and communication disorder (Hallowell & Chapey, 2008b). Armstrong and Ferguson (2010) address the complex relation of language and communication in aphasia and focus on functional communication as the general treatment outcome. Kelly et al. (2010) discuss the difficulty of defining functional communication and apply the term for "language or communicational skills sufficient to permit the transmission of a message via spoken, written or non-verbal modalities, or a combination of these channels" (Kelly et al., 2010, p. 5).

Aphasia research has traditionally used different aphasia types (e.g., Broca's aphasia, Wernicke's aphasia, global aphasia, and anomic aphasia) with regard to the degree of language impairments of comprehension, speech production, and repetition. The connectionist or classical aphasia syndrome classification relates aphasia types to specific areas in the injured brain (cf. Basso, 2003; Goodglass & Kaplan, 1972; Hallowell & Chapey, 2008b; Reinvang, 1985). Because of the aetiology of aphasia and individual differences in brain structure and processing, the syndrome model is insufficient for classifying all persons

with aphasia (e.g., Murray & Clark, 2006; Sundet & Engvik, 1985) and does not account for all neuro-linguistic processes recognized in modern aphasia research (e.g., Poeppel & Hickok, 2004). Consequently, leading aphasiologists continuously discuss the relevance and application of the syndromes, though thus far without reaching a consensus (Ardila, 2010; Caplan, 2003). Because the present study covers aphasia independent of the lesion site and does not include or exclude specific aphasia types, the syndrome classification was not used in participants' descriptions.

However, speech production differences according to speech fluency describe a relevant parameter of aphasic language production frequently used in case descriptions in aphasia research as well as clinical practise (e.g., Basso, 2003; Hallowell & Chapey, 2008b; Reinvang & Engvik, 1980b). Therefore, the differentiation in *fluent* and *non-fluent* aphasia is used as a case characteristic factor in this intervention study (see detailed description in paragraph 3.4.1., the Norwegian Basic Aphasia assessment).

Aphasia can also be distinguished based on the degree of spared comprehensive skills, where receptive aphasia describes difficulties with auditory or written comprehension and expressive aphasia refers to relatively well-preserved comprehension skills and deficits with language production and output (Murray & Clark, 2006). Based on this distinction, in this frame of the thesis and the papers, the term *receptive* language primarily covers comprehensive tasks, whereas *expressive* language is applied to verbal speech production. Because of the lack of Norwegian assessment material[2] at the time of the study, the origins of the deficit in the speech production process were not further assessed. That is, no distinction was made in relating the individual language deficit to the semantic system, phonological output lexicon, phonological assembly, or articulatory programming, respectively (cf. Whitworth et al., 2005). Persons with pure dysarthria and without aphasia were not included in this study (cf. Chapter 3 and sampling procedures).

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[2] The neuropsychological approach to aphasia provides a model for language processing (cf. Whitworth, Webster, & Howard, 2005), which is captured in the subtests of the Psycholinguistic Assessment of Language processing in Aphasia (PALPA) (Kay, Lesser, & Coltheart, 1992). The Norwegian version of the PALPA was not completed at the time the present study started.

Chapter 2 introduces aphasia rehabilitation, which in general consists of a multitude of theoretical traditions laying ground for a variety of treatment interventions for aphasia. According to this, in this frame of the thesis, only the most relevant aspects of aphasia rehabilitation for the CILT intervention are addressed.

1.3.2 The term constraint induced language therapy

The following provides an understanding of the different terms applied in the constraint induced research field. In general, constraint induced therapy can be understood as a therapy using constrictions to produce treatment effects. The term *constraint induced movement therapy (CIMT)* originates from research in physical therapy in stroke rehabilitation (Taub & Uswatte, 2006). Norwegian medical literature discussing this form of motor movement treatment refers to constraint induced therapy in general as 'hemningsindusert' (Dietrichs, 2007; Thommessen & Wyller, 2007).

Pulvermüller and colleagues (2001) transferred the principles of constraint induced movement therapy to aphasia rehabilitation. The treatment was initially presented as *constraint induced aphasia therapy (CIAT).* The term *CIAT* is preferable in Europe (cf. Berthier et al., 2009; Meinzer, Djundja, Barthel, Elbert, & Rockstroh, 2005). In addition, the term *constraint induced language therapy (CILT)* has been used as a synonym in the American research field (e.g., Maher et al., 2006). Because of the co-operation with Professor Maher, CILT is the term applied in English presentations of this study. For the application in the Norwegian speech and language pathologist environment, the term 'constraint induced språkterapi' (CIST) was adapted as a descriptive term.

Recently, the term *intensive language-action therapy (ILAT)* has been applied (Pulvermüller & Berthier, 2008). The authors also proposed to exchange the term *constraint* with *focussed,* thereby avoiding what is sometimes perceived as the negative loading of the term constraint.

A detailed description of the concept of CILT is presented in Chapter 2 and the CILT-program in Chapter 3.

1.3.3 Early and chronic phases in rehabilitation

Research of treatment outcomes for aphasia faces certain methodological challenges, the timing of the application of treatment being one of them. There is a lack of consensus in aphasia rehabilitation defining the terms acute, sub-acute, or early versus chronic phases. Linebaugh et al. (1998) referred to the *acute* stage as the first three months post-onset of the stroke leading to aphasia and the *chronic* stage as the time beyond three months. Robey (1994) reported studies within the first four months as acute in his 1994 meta-analysis but referred to the acute phase as the first two months and sub-acute as three to twelve months in his later research (Robey, 1998). Instead of setting a certain time limit, Holland and Fridriksson (2001) defined the acute phase as the period during which the stroke survivor relies on intensive hospital care and is readied for regular rehabilitation programs. Therefore, this phase might stretch from a few days to several months, depending on the severity of the stroke.

Several neural mechanisms are described as possible causes for variations and overlapping in the timeline of spontaneous or rapid recovery (Hillis & Heidler, 2002; Marsh & Hillis, 2006). In the acute phase (here, first *days* post-stroke), transiently impaired neural tissue is assumed to recover based on the function of the ischemic penumbra and restoration of blood flow. Within the sub-acute phase (days to months, even years), reorganization of brain structures and functions takes place until a plateau of reconstruction is reached. In addition, the growth of new neural networks according to the principles of brain plasticity is anticipated from immediately post-onset and stretches indefinitely into the chronic phase. Hence, a clear distinction of the sub-acute and chronic phases on an individual basis may be difficult. The chronic phase of rehabilitation is usually characterized by the application of alternative and compensatory strategies. For the sub-acute or early aphasia rehabilitation phase, Hillis and Heidler's (2002) model supports treatment that targets the structural and functional reorganization of the brain, consistent with the theoretical underpinnings of CILT.

The definition of the recovery phase relates closely to the methodological influence of spontaneous recovery and the inference for treatment outcome results. Goodglass (1993) defined spontaneous recovery as follows: "The patient experiences a (partial) reconstruction of his or her prior language knowledge and skills. This is true even for recovery that occurs

many months after the injury" (Goodglass, 1993, p. 9). Therefore, Pulvermüller et al. (2005) argue for the use of chronic patients, defined as at least one year post-onset, to avoid the possible confounding of spontaneous recovery.

This doctoral study focuses on the treatment applicability and outcome in the early phase of rehabilitation. To ensure a certain degree of medical stability and aphasia patterns to profit from such an intensive treatment, to allow some time to adjust to the life-changing consequences of stroke, and to avoid possible negative consequences of premature intensive intervention, a period of at least one month post-stroke and up to four months post-onset was defined as the inclusion criteria for participation in the present CILT intervention. The term *early* rehabilitation was chosen to describe the rehabilitation phase after acute care, in line with Holland and Fridriksson's (2001) understanding.

2. Theoretical framework of aphasia rehabilitation

2.1 An overview of traditional aphasia treatment approaches

Because of the lack of a general treatment effective for all persons with aphasia, aphasia rehabilitation is based on a multitude of different theories, approaches, and programmes (Kelly et al., 2010). Traditionally, two main approaches are distinguished: the impairment-based method and the consequence-based method (Martin, Thompson, & Worrall, 2008).

The *impairment-based* method is related to the medical model of the 1930s, where treatment was tailored to the linguistic *deficits* of the person with aphasia but also included a focus on retained skills and relevance for daily living (Thompson & Worrall, 2008). Luria's (1977) theory of cognitive functions working in neural networks indicated a potential for re-establishing inhibited or lost function by activation of other brain areas in the same network. He emphasized the relevance of a theoretical basis, distinction in components of skills, and repeated practise to re-organize brain function if treatment was to be successful. Luria's ideas are still relevant and partially even enforced in today's impairment-based approaches. Thompson and Worall (2008, p. 9/10) describe the following premises for modern impairment-based approaches: Normal language is fractioned in aphasia, language is not lost, but access is disturbed, and successful treatment results in functional language improvement.

Where the impairment-based treatment places aphasia on the individual level with its focus on deficits, the consequence-based model acknowledges the communicative aspect of aphasia in *social interaction*. *Consequence-based* is a new term that integrates several forms of the social approach and reflects the participation and activity level of the International Classification of Functioning, Disability and Health (ICF) model (Thompson & Worrall, 2008). The treatment outcome focuses on improved participation and reflects the relevance of environmental and personal factors.

Despite their differences, the two approaches reflect a common purpose of aphasia rehabilitation—enhancement of functional communication. Hence, integration of assessment

and treatment tools from both approaches is more normal than exceptional for many speech and language pathologists and researchers today (Thompson & Worrall, 2008). The present CILT study fits into this multi-approach model and combines assessments and instruments that relate to both the impairment-based (e.g., Norwegian Basic Aphasia Assessment, NGA) and the consequence-based (e.g., the Communicative Effectiveness Index, CETI) approaches.

In addition to the classical and most traditional aphasia rehabilitation approaches in speech and language therapy presented thus far, modern neuroscience and alternative medicine provide further options, including pharmaceutics (e.g., Greener, Enderby, & Whurr, 2010), electro-magnetic stimulation (e.g., Naeser et al., 2010), and acupuncture (e.g., Chau, Fai Cheung, Jiang, Au-Yeung, & Li, 2010).

Pharmacological treatment represents a growing field in aphasia rehabilitation, as the effectiveness of different drugs for the treatment of aphasia following stroke is explored. The Cochrane review of pharmacological treatment in aphasia covering research published prior to 2001 (Greener et al., 2010) concluded that the highest concern is the safety of the drug treatment. In sum, none of these studies could conclude that a drug treatment is more efficient than speech-language therapy. Further research is warranted to document long-term effects. However, more recent research indicates that a drug treatment combined with speech-language therapy may have a better outcome compared to either treatment alone (Berthier et al., 2009; Small & Llano, 2009).

Recently, CILT-programs have been combined with pharmaceutical or electro-stimulation treatment; hence, these studies will be referred in paragraph 2.6 on published CILT research. Other forms of treatment with limited relevance for this CILT study will not be further discussed in this frame of the thesis.

2.2 Aphasia treatment for speech production

Almost all people with aphasia experience some form of word finding difficulties (Nickels, 2002; Wisenburn & Mahoney, 2009). Since verbal expression plays an important role in

communication (as presented in the introduction), a variety of treatment approaches and programs are developed to improve verbal speech production.

In a review of therapy for naming disorders, Nickels (2002) refers to two different approaches for improving word finding difficulties. First, there is the strategic, reorganisational, and compensatory approach. In this approach, spared language processes are used to support or assist inhibited language function, for example, the use of written cues for oral word activation. In order to gain a treatment effect, such a strategy requires additional spared linguistic functions (i.e., access to initial letter, ability to convert letters to sounds, benefit from phonetic cuing), which is often not the case for persons with aphasia. The second approach concerns facilitation, repair, and reteaching techniques that improve word finding and speech production. CILT belongs to the second category of approaches, because it applies semantic and phonological treatment structures as well as explicitly avoids compensatory strategies.

Expressive speech deficits may originate in different phases of word processing, as presented, for example, in the cognitive neuropsychological model (cf. Whitworth et al., 2005). Whitworth et al. (2005) report that the majority of treatments that deal with word retrieval and speech production focus on the semantic system, the phonological output lexicon, or a combination. A distinction is made between treatments that focus on semantic and/or phonological impairments, and treatments that use semantic and/or phonological treatment tasks (Nickels, 2002; Whitworth et al., 2005). Because the present CILT study does not assess the aetiology of the individual's word finding problems (cf. Introduction), there is limited control of a possible effect according to either semantic or phonological treatments. Furthermore, Nickels (2002) concluded that the majority of persons with aphasic word finding deficits profit from a combination of semantic or phonologic treatments. In the CILT treatment, the speech and language therapist, according to individual needs and mastering of the person with aphasia, provides both semantic and phonologic support, for example, semantic prompting and phonological cueing.

The majority of language-processing models are based on the single word level (Nickels, 2002), whereas sentence production involves more complex processes (Mitchum & Berndt, 2008). Two forms of grammatical deficits, agrammatism and paragrammatism, can disturb

sentence processing in aphasia. Agrammatism occurs in non-fluent aphasia and refers to the omission of important syntactical structures, whereas paragrammatism relates to fluent aphasia and reflects an erroneous use of grammatical features (Mitchum & Berndt, 2008). Approaches for improvement on sentence production for agrammatism often concern the activation of verbs, because verbs play an important role in syntactic structure by requiring a specific number of arguments (Mitchum & Berndt, 2008; Mitchum, Greenwald, & Berndt, 2000). The present CILT study includes verb phrases, but the primary focus of word activation is nouns. However, the main target of CILT concerns the sentence level, where the treatment structure aims to establish a communicative progression from single word level to sentence level (see also paragraph 3.3, the CILT-program).

The interactional CILT setting provides relevant practical experience and repetitive attempts to produce the utterance and extended feedback, which are described features for proficient speech production outcome (Nickels, 2002; Wisenburn & Mahoney, 2009). Furthermore, Black and Chiat (2000) suggest that, for some aphasic speakers, a more constrained and structured setting facilitates greater speech production because of less load on brain processing activation of the selection of the message to convey.

Nickels (2002) concludes that despite general difficulties of predicting the outcome for speech production treatment, even small and item-specific gains may have an important impact on social participation for persons with aphasia. Therefore, word activation treatment proves to be effective at least on the individual level, consistent with clinical experience. However, generalisation of successful treatments to more functional communication is not easily established. The analyses of spontaneous speech samples can be applied to investigate the generalisation from microlinguistic levels as word finding and sentence construction to more complex oral text production. This is addressed in the studies by Conroy, Sage, and Lambon Ralph (2009) and Grande et al. (2008), and reports indicated positive results. Generalisation of the CILT intervention outcomes to spontaneous speech prodution is described in detail with theoretical references in Paper II.

Nadeau, Gonzalez Rothi, and Rosenbek (2008) address several mechanisms for generalisation to untreated materials and situations. These include, among others, the application of therapy-acquired knowledge and skills to similar features in and outside the

therapy setting as well as mechanisms acting on broader language-related functions. These mechanisms cover, for example, working memory as well as the development of the intention to use spoken language in preference to using compensatory strategies or non-use. The latter is of specific relevance for CILT intervention and will be explored extensively in paragraph 2.5.2 on learned non-use.

Best and Nickels (2000) address the difference between finding a treatment approach that indicates improvement for most persons with aphasia (that is, to have general effect) and finding a treatment that provides the best possible outcome for an individual. This concerns the predictability of treatment outcome and effectiveness.

2.3 Research strategies for the investigation of aphasia treatment outcome

As presented previously, the relevance of aphasia rehabilitation is debated because of the limited number of studies providing acknowledged evidence-based treatment outcomes (cf. Kelly et al., 2010). In general, treatment outcomes cover changes (or lack thereof) according to time, treatment, or an interaction of both (Irwin et al., 2008). Moreover, studies of research outcomes are further distinguished by efficacy (controlled research in ideal conditions), effectiveness (applied clinical studies in average conditions), or efficiency (cost effective compared to other treatments) (Irwin et al., 2008; Robey, 1998).

Robey (1998, 2004) defined a five-phase research model for aphasia treatment outcomes. Table 2-1 presents the purpose of each stage, the methodological implications for research, and suggestions for the design of the study to accomplish the purpose. In reference to the demand for evidence-based practise, the designs presented in Table 2-1 refer to the clinical trial formats to achieve relevant evidence under the condition of being blinded or masked (Irwin et al., 2008).

Table 2-1 Research model for treatment outcome studies in aphasia.

Phase	Purpose	Methodological implications	Design
1	Hypothesis development	Explore to which degree a certain treatment program is active and safe. Explore treatment intensity and duration.	Single case or small group. No control necessary. Pre-post intervention /retrospective study.
2	Refining research hypothesis	Establish standardized treatment protocol, participants' inclusion criteria. Explore patient characteristics and treatment doses.	Single case or small group.
3	Efficacy	Explore the treatment in the optimal setting under ideal conditions.	Large sample. Randomized control study.
4	Effectiveness	Explore the treatment in ordinary, clinical conditions.	Large sample. External control not usual since efficacy is proven in phase 3. Field research.
5	Efficiency	Establish cost benefits of the treatment. Explore different outcome measures, including patient and family satisfaction and quality of life.	Cost-benefit analysis.

The five-phase model presents a logical structure for aphasia research to overcome methodological criticism. However, thus far, few aphasia research studies have been developed to match or follow this proposed structure, and the present CILT study is no exception. The CILT study fits the Phase 2 description due to the methodological limitations of the small sample (N=10), the lack of a comparison group, the standardized protocols, and the study of participants' characteristics. Since the present CILT study relies on previously established positive treatment outcomes within chronic CILT research in Phase 3, in ideal research, the next step would involve clinical application for chronic aphasia to explore the effectiveness (Phase 4).

Wertz, de Riesthal, Irwin, and Ross (2009) reported a meta-analysis of aphasia studies conducted at American Veterans' Affair hospitals, applying the proposed five-phase model (cf. Robey, 1998). Results revealed a majority of Phase 1 or 2 studies, the presence of a few

Phase 3 (efficacy) studies, but no Phase 4 or 5 studies. The most critical argument for the type of studies conducted and implied in the meta-analysis concerns their limited application or exploration for clinical application. This relates to the discussion in the beginning of this thesis, to which degree studies in chronic aphasia can be generalised to the early rehabilitation stage in which most aphasia sufferers have the opportunity to receive appropriate treatment by speech and language pathologists (cf. Linebaugh et al., 1998)

Cherney et al. (2008) reviewed intensive treatment studies and CILT studies based on a structure similar to Robey's (1998) model, the ASHA level of evidence scheme. Of the final ten included studies, five applied a CILT treatment. All CILT studies reported positive outcomes on measures of language impairment (e.g., standardized tests) and, if included, on measures of communication and participation (cf. ICF model, WHO). However, none of the CILT studies covered the acute or early rehabilitation phase or was applied in a clinical setting. Of the remaining intensive treatment studies, only one was carried out in the acute phase, whereas another one concerned the level of effectiveness (i.e., clinical application).

Related to this research background, the present study focuses on the clinical application and relevance within early aphasia rehabilitation. Thereby, the present CILT study blends the research model phases of exploring a new hypothesis with clinical application. Hence, the purpose of the CILT study (to provide relevant data and gain knowledge of application for the early aphasia rehabilitation phase within a real clinical setting) targets the phase of effectiveness (Phase 4). This is also addressed in the discussion section in Papers I.

2.4 Aphasia rehabilitation in Norway

Aphasia in Norway is commonly treated by speech and language pathologists with established clinical practise and written reports describing improvement. Consistent with the previously described features of international aphasia rehabilitation, treatment programs are tailored for individual needs and, hence, cover a multitude of approaches. The intensity and duration of offered conventional speech and language therapy for aphasia varies depending on the provider. Institutional acute care and rehabilitation units with employed speech and language pathologists may offer daily treatment sessions for the period of the hospitalization,

whereas treatment consisting of two to three 45-60-minute sessions a week is considered average after discharge.

Aphasia rehabilitation in Norway follows a complex legal system relating to both the educational and the health sector (cf. Qvenild, Haukeland, Haaland-Johansen, Knoph, & Lind, 2010). Traditionally, speech-language pathologists have their professional background in special needs education[3]. Further, legal authorization for rehabilitation of language is pursuant to the Education Act (Opplæringsloven, Kunnskapsdepartementet, 1998) with §4A focussing on the specific rights for adults. Aphasia is not specifically mentioned, but the administrative regulations from the Ministry of Education and Research (Kunnskapsdepartementet, 2002) state that the law covers adults who need renewed primary education, often including special needs education rights, for reasons of illness or other physical damage. It is further described that this may include primary communication skills as well as reading and writing.

Regarding the sector of education, the county municipality is responsible for appropriate rehabilitation while the person with aphasia is hospitalized, while this obligation is transferred to local authorities after discharge (Qvenild et al., 2010). In addition, specialist health services have regional responsibilities for general stroke rehabilitation based on the Law of Patient Rights (Helse- og omsorgsdepartement, 2001). In this overlapping area of education and health rights, aphasia rehabilitation often relies on the availability of speech and language pathologists at the individual institution.

In the case of non-available speech and language therapy for the person with aphasia within his/her municipality's educational system, financial support for rehabilitation can be covered by the National Insurance Act (Folketrygdlov, Arbeidsdepartementet, 1997). This healthcare-based law requires a referral by a physician in order for patients to be reimbursed the expenses of speech and language therapy offered in private practise. The content of aphasia rehabilitation is based on individual needs and does not refer to specific amounts of treatment.

[3] In recent years, speech and language therapy studies have been offered within the field of health science at the University of Bergen.

2.5 The theoretical background of CILT

The framework of the WHO classifies health condition outcomes and function into body structures, body functions, activities, and participation (World Health Organization, 2001). A biopsychosocial approach integrates biological factors (in this case, stroke with aphasia), psychological factors (language and cognition), and social factors (participation and quality of life) of a health condition (Gracey, Evans, & Malley, 2009). The CILT intervention presented in this thesis can be defined within this theoretical frame.

Constraint induced language therapy is a behavioural approach within neurological rehabilitation and recent neuro-scientific knowledge including experience-dependent brain plasticity and the theory of learned non-use (Pulvermüller & Berthier, 2008; Taub, Uswatte, Mark, & Morris, 2006). As previously mentioned, the CILT treatment has its origin in the constraint induced movement therapy developed by Taub and colleagues (Taub & Uswatte, 2006; Taub, Uswatte, & Elbert, 2002). Hence, an important part of the theoretical background of CILT refers to research from physical therapy in stroke rehabilitation.

2.5.1 Experience-dependent brain plasticity

The term brain plasticity describes the ability of the brain to adjust and modify its functional structure in relation to environmental influences, physiological changes, and experience (i.e., use) (Pascual-Leone, Amedi, Fregni, & Merabet, 2005). Learning processes in the brain involve changes both on a micro level (i.e., synapses and neurons) as well as on a macro level (i.e., larger structures such as neurological networks and genes) (Kleim & Jones, 2008; Mark, Taub, & Morris, 2006; Marsh & Hillis, 2006). The plasticity of the brain is demonstrated in an increasing number of studies of healthy persons (e.g., Demonet, Thierry, & Cardebat, 2005), persons at different states after brain injury in general (Dietrichs, 2007; Elvsåshagen & Malt, 2008; Nudo, 2006, 2007), and aphasia sufferers in particular (e.g., Crinion & Leff, 2007; Marsh & Hillis, 2006; Saur et al., 2006; Thompson & den Ouden, 2008).

Brain structure and behaviour can be understood as a dialectical relation with mutual dependency in a lifelong perspective. However, the existence of sensitive periods for the development of specific skills as well as the need for basic or remaining neurological

potentials in order to expand or maintain brain functions have to be considered. Kleim and Jones (2008) proposed a set of principles relevant for experience-dependent brain plasticity in general rehabilitation after brain injury. The first principle ('use it or lose it') summarized the demand of function-specific activation in the brain in order to remain or extend a function or skill. Other principles referred to the impact of former experience, the timing of an intervention, and a relevant treatment format for an effective rehabilitation outcome. The CILT treatment explicitly utilizes a number of these principles in the construction of the treatment characteristics and structure (Pulvermüller et al., 2001), which is also described in Papers I and III:

- Intensity; for example, 3 hours a day/10 days
- Specificity; that is, constraint to spoken verbal expression and preventing the use of compensatory strategies such as gestures, writing, etc.
- Repetition; that is, massed practise
- Salience; that is, shaping of required responses to match individual needs; stimuli material based on communicative relevance.

Researchers and clinicians will recognize most of the proposed principles in historic and recent treatment programs for stroke rehabilitation. On the other hand, the principle of inference (that is, the activation of certain brain processes may infer with others, thereby limiting outcomes) evokes reaction. At the same time, inference constitutes one of the background hypotheses of constraint induced language therapy as described in the principle of learned non-use.

2.5.2 The theory about learned non-use

Theories of brain-plasticity indicate that re-learning a function or skill after brain injury can involve behaviour that evokes both positive and negative consequences for future development (Taub et al., 2006). A typical example is the use of compensatory strategies with a healthy body part instead of the impaired body part. Most people develop a number of compensatory strategies, either intuitively or by supervision, in order to master daily living tasks after brain injury. According to theories in experience-dependent brain plasticity, it is

assumed that the use of compensatory strategies primarily supports the activation of healthy brain functions. Consequently, impaired brain areas may receive even less stimulation and, hence, experience-dependent brain plasticity may be restricted. The process of avoiding the use of a previously existent function and thereby limiting the circle of re-activation in the respective brain areas is called learned non-use (Taub et al., 2006). Figure 2-1 illustrates possible scenarios of the development of learned non-use from the constraint induced movement therapy described by Taub et al. (2002).

Evidence from animal studies supports this theory concerning motor movement; however, generalisations to human beings have to be cautiously considered (Carter, Connor, & Dromerick, 2010; Raymer et al., 2008).

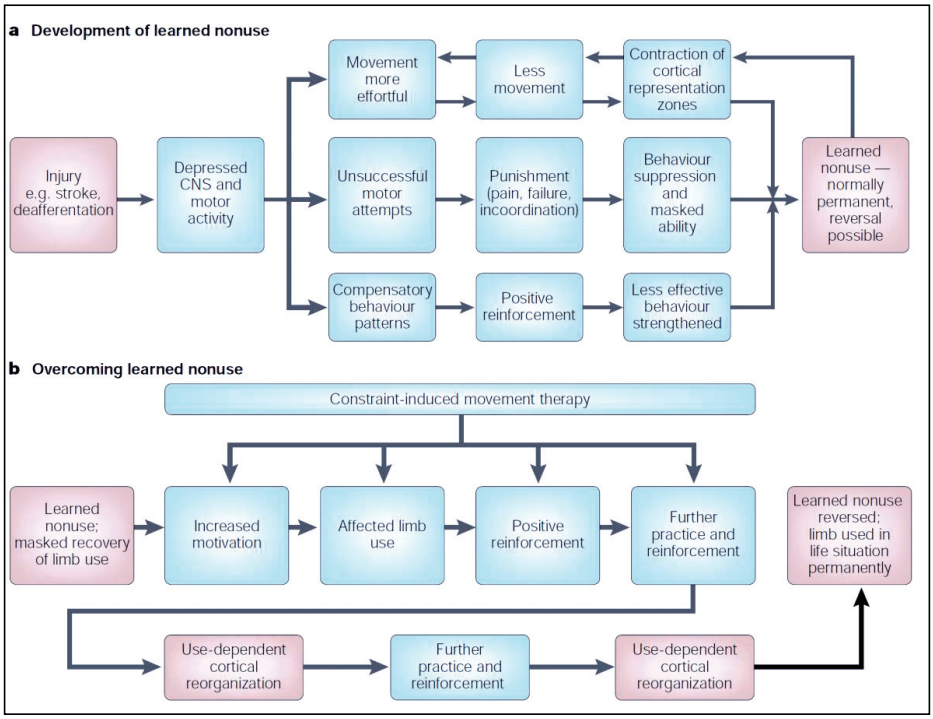

Figure 2-1 Model of learned non-use by Taub et al. (2002), printed with permission.

An important rationale for the CILT treatment concerns the application and relevance of the theory of learned non-use to aphasia rehabilitation. Pulvermüller et al. (2001) describe the concept of learned non-use for the function of expressive speech. They (ibid) assume that

word activation and production usually presents an effortful process for the person with aphasia (cf. Most people with aphasia have word finding problems). Based on Taub et al. (2006), effortful processes (here, talking) might be avoided, and the use of easier, accessible forms of compensatory strategies (e.g., gestures, writing, pointing, etc.) may be preferred.

Importantly, rehabilitation researchers, especially within the consequence-based approach, address the influence of gestures on word activation. Rose (2006) provides an overview of recent models of gesture production and their relation to language and communication. Marshall (2006) and Feyereisen (2006) refer to the differences in processing for gestures and language and investigate the rationale of gestures as a cueing or lexical priming effect for language activation. De Ruiter (2006) describes the differences between gestures facilitating arbitrary language components and gestures supporting the act of communication. Despite different viewpoints concerning the impact of gestures on language activation, there is some agreement on the compensatory impact of gestures for communication by these researchers.

While compensatory strategies are very helpful in communication itself, it is discussed to which degree they enhance or reduce word activation and production in the injured brain based on the theories of brain plasticity and experience-dependent learning. In other words, in order to increase neuronal networks in verbal expressive speech processing (e.g., by CILT), the person with aphasia is encouraged to talk and produce verbal utterances to the highest degree. In this line of argument, the two previously described aphasia rehabilitation approaches (Thompson & Worrall, 2008) are reflected, where the compensatory strategies are encompassed by the consequence-based approach, whereas the stimulation of brain processes relates to the impairment-based tradition.

However, Pulvermüller himself (Pulvermüller & Berthier, 2008; Pulvermüller et al., 2001) as well as several reviews in the CILT field (Cherney et al., 2008; Raymer et al., 2008) address the insufficient knowledge of the *degree* or *level* of mutual dependency of specific functions and brain structures related to experience-dependent learning thus far. Another open research question reflects the aspect of the time perspective; in other words, to which degree there are sensitive periods for most effective outcomes of treatment after a brain injury as well as an interaction of time and intensity (Carter et al., 2010). Research from animal studies has addressed the possible effect of premature interventions with regard to

discomfort or later complications, but these have been related to the very acute stage (within one day post-stroke) (Raymer et al., 2008; Taub, 2004).

2.5.3 The main principles for constraint induced language therapy

The development of CILT from the constraint induced movement field is reflected in the transfer and adjustment of the main principles, which are intensity, specificity, repetition, shaping, and communicative relevance. Taub (2004) based his research on the assumption that if a person did not naturally use the impaired body part, the constraint of the healthy extremity may force the use of the impaired body part. Further, he proposed that this constraint induced intervention combined with intensive mass training might induce use-dependent reorganization in the brain. Outcomes from the physical and occupational therapy field in a chronic population have been positive overall; however, there have been variations in terms of the degree of change (Taub & Uswatte, 2006).

Sterr and Saunders (2006) discussed that the intensity of the constraint induced movement therapy alone could not explain the positive outcome results, and they addressed the impact of individual adjustment through shaping, a term applied in learning psychology. Shaping relies on operant conditioned learning, where an actual response gradually transforms to the desired dimension by using positive feedback. Shaping plays a similar important role in constraint induced language therapy and implies a constant adjustment of tasks on to the individual level of mastering. Treatment elements are proposed to include an element of difficulty in order to produce a change in the activation pattern of the brain.

In the development of the CILT-program, a modified version of the constraint induced movement therapy was applied, which consisted of three treatment hours a day for a time period of 10 consecutive working days (Pulvermüller et al., 2001). The principles of intensity, massed practise, shaping, and positive feedback were continued as previously described. The responsibilities of the speech and language pathologist (or another specially trained professional) involved being a role model, shaping responses to individual needs, and providing positive feedback to ensure mastery of the task.

The challenge of CILT compared to its form in physical rehabilitation concerns the constraint of the language modality. In contrast to physical constraint induced therapy where

it is possible to physically control the use of the stronger/healthy body part, language is a "hidden/invisible" skill. Most CILT studies (see also next section) focus on improvement of expressive speech. In order to prevent the use of compensatory strategies (e.g., gestures, body language, etc.), visual barriers were arranged between the persons with aphasia and their communication partners. Thereby, any information that was exchanged had to be orally presented.

2.6 The first ten years of CILT research

Whereas constraint induced movement therapy has been studied for more than two decades (Taub & Uswatte, 2006), constraint induced language therapy presents a rather new aphasia treatment (Cherney et al., 2008), starting with Pulvermüller et al.'s seminal study from 2001. Literature searches within databases PubMed EMBASE (Ovid) and ISI Web of knowledge for key words and combinations (*CILT, CIAT*, *intensive language therapy, constraint induced AND aphasia)* resulted in a list of 52 studies (per 17 October 2010), and not all concerned a constraint induced language treatment study for aphasia.

Each of the three papers in this doctoral thesis includes a short review of CILT studies with content-specific focus for each article. Table 2-2 presents a general overview of the most relevant CILT studies for this doctoral thesis as well as their number of participants, treatment programs, and reported outcomes. It has to be noted that this list is not exhaustive for the reason of accessibility and excludes papers based on previously reported samples and data. For example, the study by Meinzer, Elbert, Djundja, Taub, and Rockstroh (2007) is not listed, because the data is based on the previously reported studies by Meinzer et al. (2005) and Pulvermüller et al. (2001).

Table 2-2 Examples of CILT studies within the chronic population.

Author	Year	N	Treatment	Behavioural outcome
Pulvermüller et al.	(2001)	17	CIAT vs. conventional SLT	Improvement for CIAT group on the Token Test[4], naming and comprehension of the AAT, and CAL
Meinzer et al.	(2005)	27	CIAT (n = 12) versus CIAT+ (n = 15) (involving homework with partner) Included written material	Improvement for both groups. Higher ratings for communication improvement and stability to follow-up within CIAT+ group
Maher et al.	(2006)	9	CILT (n = 4) versus PACE (n = 5), same intensity and material	Both groups improved on the WAB, Boston naming test, and action-naming test. Individual changes greater for CILT group.
Meinzer, Streiftau, & Rockstroh	(2007)	20	CIAT provided by experienced therapist versus trained laypersons	Highly structured CIAT can be applied by trained layperson.
Barthel, Meinzer, Djundja, & Rockstroh	(2008)	12 (39)	MOAT (modality therapy) (n = 12) compared to CIAT-group (consistent of CIAT and CIAT+ sample from Meinzer et al. (2005) (n = 27))	Improvement in language functions for both groups. MOAT better outcome for written language and perception of everyday communication.
Faroqi-Shah & Virion	(2009)	4	CILT for agrammatism	Addition of grammatical constraints did not significantly enhance functional outcome.
Goral & Kempler	(2009)	1	Adjusted CIAT for verb treatment	Increase in verb production, stable results in other language measures.
Breier et al.	(2009)	23	CILT+ MEG imaging	Improvement in language-impaired measures (WAB) for two

[4] The Token test is applied as part of the Aachener Aphasie Test (Huber, Poeck, Weniger, & Willmes, 1983).

				thirds of the participants. Participants with improvement maintained at follow-up showed increase in left temporal activation post-CILT.
Kurland, Baldwin, & Tauer	(2010)	1	CILT, followed by PACE	Improvement in naming, independent of type of treatment.

Abbreviations: CIAT = Constraint induced aphasia therapy, CILT = Constraint induced language therapy, SLT = speech and language therapy, MOAT = Model-oriented aphasia approach, MEG = magnetoencephalography, PACE = Promoting aphasics communicative effectiveness, WAB = Western Aphasia Battery, AAT = Aachener Aphasie Test, CAL = Communicative Activity Log

The purpose of the original Pulvermüller et al. (2001) study was to examine the applicability of the ideas and methods from constraint induced movement therapy to the area of language rehabilitation. An intervention study with 17 participants with chronic aphasia was carried out where the comparison group received conventional, distributed (but undefined) speech and language therapy in the same total amount of treatment hours as the intensive CILT group. The CILT intervention consisted of the previously described 10-day intensive training program with 3 to 4 hours speech and therapy daily, using a card game activity with several semantic and linguistic levels. Results showed an improvement in both groups but a significantly better outcome for the CILT group on the group level. The majority of research studies continued this degree of intensity and structure for the CILT intervention, which also forms the structure for the present study.

The Pulvermüller et al. (2001) study was criticised for applying two different treatments within two different intensity schedules (Cherney et al., 2008). Therefore, later studies investigated different treatments with the same intensity (Barthel et al., 2008; Kurland et al., 2010; Maher et al., 2006) (cf. Table 2-2). Further areas of interest in chronic CILT research included the involvement of homework (transferring the treatment outside the research setting) (Meinzer et al., 2005), the training of laypersons to conduct the treatment (cost beneficial) (Meinzer, Streiftau, et al., 2007), and CILT-programs tailored for specific linguistic features such as agrammatism (Faroqi-Shah & Virion, 2009) and verbs (Goral & Kempler, 2009).

CILT is based on principles of brain plasticity; hence, several studies apply measures of brain activation pre- and post-CILT interventions using different methods such as functional Magnetic Resonance Imaging (fMRI) (Kurland et al., 2010; Meinzer, Elbert, et al., 2007; Meinzer et al., 2004; Meinzer et al., 2006), magnetoencephalography (MEG) (Breier et al., 2009; Breier, Maher, Novak, & Papanicolaou, 2006), and event-related potential (ERP) (Pulvermüller et al., 2005). The review of functional imaging studies by Meinzer and Breitenstein (2008) covered 13 studies and a total of 57 persons with chronic aphasia with a focus on word activation treatment. The majority of studies revealed immediate treatment-induced changes of activation patterns in both hemispheres. However, the authors (ibid) requested future studies that investigate the treatment-induced brain activation patterns for other language modalities (e.g., comprehension or reading) as well as the long-term stability of the outcome. This was accomplished in a group study of chronic aphasia by Breier et al. (2009), which demonstrated differences in activation patterns in relation to behavioural changes. Persons with improvement post CILT-treatment and improvement stability at the three month follow-up showed increased left temporal activation, whereas those who did not maintain the acquired improvement showed more right hemisphere improvement. Furthermore, persons who did not make significant improvement on language measures following the CILT-treatment displayed more activation in left hemisphere parietal areas.

Recent explorative research in the CILT field concerns the use of pharmacological treatment. The Berthier et al. study (2009) combined constraint induced aphasia therapy (CIAT) with a drug treatment (Memantine) in a chronic aphasia population. Memantine is supposed to affect cortical activity and cognitive function and has been used in the treatment of Alzheimer's disease. Results showed significant improvement for both Memantine (compared to a placebo) and CIAT treatment individually. However, the combination of CILT and Memantine treatment resulted in the greatest improvement as measured on the Western Aphasia Battery (Kertesz, 1982) as well as on the Communicative Activity Log (CAL, Pulvermüller et al., 2001).

Naeser et al. (2010) studied the improvement on naming and speech for two persons with non-fluent, chronic aphasia in a treatment design combining repetitive transcranial magnetic stimulation (rTMS) and CILT. The results indicated improvement for treatment with rTMS

alone; however, significant changes in naming tasks and certain aspects of propositional speech were first achieved with the combination of rTMS and CILT.

In summary, CILT represents a rather new research area in constant development. The chronicity of CILT study participants listed in Table 2-2 ranged from minimum one year post-onset for all studies described to a maximum of twenty years post-onset as reported by Pulvermüller et al. (2001). However, expansion to the acute or early aphasia rehabilitation phase and its clinical application is still fairly unexplored (Cherney et al., 2008). The present study is therefore of important clinical relevance for gaining more knowledge about CILT and the process of early aphasia rehabilitation.

3. The design and progress of the study

The purpose of the present study, as described in the first chapter, comprises several aspects covering both the adaption and development of the CILT treatment in the Norwegian setting as well as, and more importantly, exploring the applicability of this method in the early phase of aphasia rehabilitation. Recognizing the basic role that the treatment material plays for the data presented in the three papers, this chapter describes the Norwegian CILT material in a more detailed manner than usually found in a journal article. However, the focus of this chapter is the processes involved in carrying out the intervention treatment study, including the study design, sampling, assessment battery, and ethical considerations for participation. Methodological considerations are gradually introduced in this chapter and will be discussed in detail in the next chapter.

3.1 Method

In order to explore the applicability of constraint induced language theory in early aphasia rehabilitation, a pre-test and post-test intervention study with follow-up was conducted, with a mixed method design approach (Creswell, 2009). Even so, the majority of the reported data in the three papers comprise quantitative measures on language variables. A qualitative method was applied for the evaluation of linguistic performance based on oral text production. The combination of quantitative data from standardized test, qualitative data from content analysis of more complex texts, participants' experiences and comments by significant others cover both language-impaired measures and measures of participation and activity (cf. IFC model). This is in line with previously reported research requests for functional outcome measures of aphasia rehabilitation (Cherney et al., 2008; 2010).

Integration of qualitative and quantitative data is also available on the individual test level. For example, the text analysis in Paper II contains both a quantitative assessment of the amount of nouns and verbs as well as a qualitative evaluation of the interview content. Similarly, traditionally quantitative measures of correct answers within a standardized test (for example, Psycholinguistic Assessments of Language Processing in Aphasia; PALPA) can be extended by a qualitative analysis of error patterns.

Descriptive and statistical data analyses were conducted using the Statistical Package for the Social Sciences (SPSS; Version 16) as well as Microsoft Office Excel 2007. The computer software program HyperTranscribe was employed for orthographic transcription of text samples (Norwegian Basic Aphasia Assessment or NGA; the Cookie Theft Picture), allowing transcription with looped replay of the video files. For the analysis of verbs and nouns in Paper II, node coding in the qualitative research program NVivo (Version 8) was a helpful tool for categorizing linguistic elements. The University of Oslo provided all programs for data analysis.

3.2 Sampling procedure

During the time of the PhD study, the Department of Special Needs Education did not have formal co-operation with hospitals or rehabilitation institutions for stroke patients where persons with aphasia could be invited for participating in the study. Hence, the following procedures were carried out to inform about the CILT intervention and stimulate interest among speech and language pathologists to co-operate and, through them, establish contact with persons with aphasia.

First, an informative article (translated English title: Constraint induced language therapy: An introduction) was published in the journal of the Norwegian Speech and Language Therapist Association, *Norsk Tidsskrift for Logopedi* (Kirmess, 2007), introducing the main principles of CILT and reporting available research results until 2007. In response to this published article, a number of speech and language pathologists contacted me for further information about the study. Unfortunately, in the end, none of them had the opportunity to conduct the CILT-program in their clinical practise at that time, mainly because of time (intensity) restriction and non-availability of persons with aphasia in the early rehabilitation phase.

The outline of the study was further presented to the national co-operative network of institutions interested in the field of aphasia (*Afasiforum*), established by speech and language pathologists and clinical linguists in 2005. In addition, speech and language pathologists in stroke hospitals and private practises in the day's travelling distance around the University of Oslo as well as main rehabilitation units in Bergen and Trondheim were

contacted by email containing an invitation letter and a copy of the abovementioned Norwegian article. In a period of very low informant availability, I also returned to part-time clinical work as a speech and language pathologist in a hospital in order to search for possible participants or, alternatively, to find reasons for the difficulty of recruiting persons with aphasia. In all, co-operation with five different locations across Norway was established in addition to continuous contacts with other speech and language pathologists for control persons. For purpose of depersonalization, neither persons nor institutions are referred to by name.

3.2.1 Inclusion and exclusion criteria

Descriptions of participant characteristics are frequently asked for in order to compare and generalise study results (Brookshire, 1983; Roberts, Code, & McNeil, 2003). Participants for the study were required to fulfil the following criteria in order to control for additional factors that might influence the outcome of the CILT intervention:

Inclusion criteria

- First time cortical stroke[5] in the left hemisphere
- Early aphasia rehabilitation, that is, minimum one month to four months post stroke
- Medical stability
- Mother tongue Norwegian
- Pre-morbid right handedness (reported by the treating speech and language pathologist)
- Comprehension of yes/no questions above chance level (subtest in the NGA)

[5] An exception was made for the case of DS, where a previous stroke occurrence (several years ago) did not result in any form for physical or cognitive deficit.

- The presence of stroke-related impairment (hemiparesis, apraxia of speech, perceptual and cognitive deficits) to a degree, where benefit from participating in the intervention is medical and ethically reasonable, and does not counter indicating the intervention purpose

Exclusion criteria

- Other known neurological or psychiatric diagnosis

Additional stroke-related impairments such as apraxia of speech or cognitive deficits were not excluded but were recorded for further analysis of the results. Medical status, additional impairment, vision, hearing, and other relevant pre- or post-stroke information that may influence language rehabilitation were reported by the treating speech and language pathologist on a provided information form (see Appendix A). This information was collected from medical journals (for example, stroke location), interdisciplinary reports (for example, cognitive deficits, motor apraxia), personal narratives by the person with aphasia or their significant others (for example, handedness, pervious language skills), and clinical assessment by the treating speech and language pathologist (for example, oral apraxia, dysphagia).

General stamina and attention span (clinically assessed by the treating speech and language pathologist) had to be at a realistic and reasonable level relative to the person with aphasia, for which participation was approved in this intensive treatment.

In case of insecurity about the possible participation of a person with aphasia, the treating speech and language pathologists were encouraged to discuss the individual cases with me, the project leader, who was responsible for the final decision.

3.2.2 Sampling challenges

Kelly et al. (2010) recognise the difficulty of recruiting and maintaining participants in stroke rehabilitation research. With this in mind, the inclusion criteria were set to be relatively wide and were not limited to certain aphasia types. Based on a calculated yearly incidence of three to five thousand new stroke patients with aphasia in Norway, recruiting a

group of estimated thirty persons for the CILT intervention seemed reasonable. However, clinical practise proved different for the following reasons.

Most importantly, inpatients seemed to be discharged from the acute hospitals before the time for entering the intervention study arrived (1–4 months post-onset). On the other hand, rehabilitation units would rather see clients even later on in their recovery process (i.e. ≥ 4 months post-onset). Responses from speech and language pathologists in communal services or private praxis, where the person with aphasia might be offered language therapy beyond hospitalization, reflected limitations concerning the intensity of the CILT intervention.

Further, based on feedback from the involved speech and language pathologists and personal experience, the stroke population in the hospitals had a more complex medical background (for example, multiple strokes or additional diagnosis of dementia, alcoholism, etc.) and variation of personal characteristics (for example, being a non-native speaker) than expected. This reduced the number of persons assessed for eligibility. Besides these methodologically negative factors, there was also a positive perspective observed for non-participation. Some persons with aphasia who seemed appropriate for the study in the first weeks post stroke recovered to a degree where the planned CILT intervention did not match their needs anymore and were therefore not included.

Therefore, the final study includes a convenient sample. From the available pool, ten persons with early aphasia enrolled in the CILT intervention after providing written and oral informed consent.

3.2.3 Informed consent

The Norwegian ethical guidelines for research demand information letters about the purpose and content of the study for all involved participants (De nasjonale forskningsetiske komiteer, 2000-2006). Therefore, the co-operating speech and language pathologists signed a written informed consent paper for their participation in the study.

For the persons with aphasia and their significant others, two sets of information letters were provided, acknowledging different levels of linguistic skills related to the diagnosis of

aphasia (Braunack-Mayer & Hersh, 2001): a written version and a picture supported[6] version (Appendix B provides an Norwegian example of the latter) (Penn, Frankel, Watermeyer, & Müller, 2009).

The information letters contain a short description of the CILT intervention study, including a statement that the intensity may be exhausting for some persons, time schedule, explicit information about the alternative of withdrawing at any time without specific reason, and information about data handling and saving. The consent form included separate sections providing informed consent to the general participation in the study as well as videotaping and the use of videotapes in research presentations.

In addition, information was repeated orally for persons with aphasia before the signing the informed consent. Furthermore, informed consent was also obtained from the significant other to ensure understanding of the implications and family approval for participation in such intensive treatment (Wagner, 2003).

The study is approved by the Regional Committees for Medical Research Ethics (REK, project number 2.2007.1855), and the Norwegian Social Science Data Services (NSD, project number 17167).

3.2.4 Participants

As described, recruiting participants for the study proved to be difficult despite extending the study to cover large areas of Norway. The flow of participants chart illustrates the composition of the sample (see Figure 1, originally from Paper III).

It should be noted that the number of excluded informants only covers the cases that seemed to fulfil the inclusion criteria at first contact and were therefore more specifically assessed for a possible participation. Therefore, the presented sample size (N = 17) does not reflect the total number of persons suffering from stroke with aphasia at the time, which are excluded for reasons described in the paragraph about sampling challenges.

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[6] Based on the research consent example from the Norwegian edition of the "Supported Conversation for Aphasia" material (Kagan, Winckel, & Shumway, 2003).

Retrospectively, the pre- and post-test data of one test (NGA) was available for one person who received conventional speech and language therapy. The data was evaluated for inclusion as control data. Because of the lack of additional test data or a follow-up measure, the data was considered insufficient for this study and was therefore excluded.

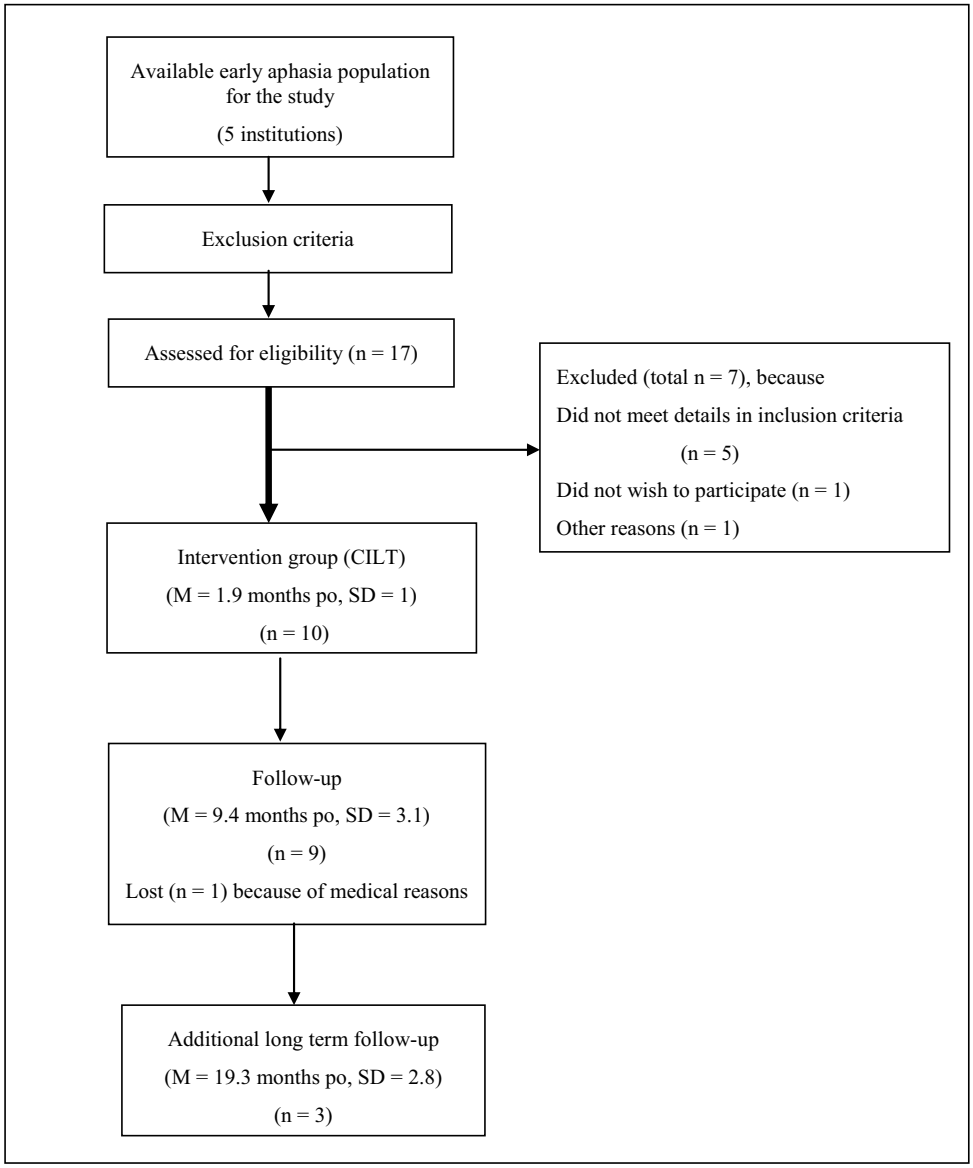

Figure 3-1Flow Chart for CILT recruitment

The final intervention group comprised ten participants. Of these ten participants, nine completed the follow-up assessment at least three months post the CILT intervention, while one person (GA) resigned from the study for medical reasons. An additional follow-up was conducted at least one year post-onset for three cases (MX, HP, and FOT) for reasons of availability within the time frame of this study. An overview of the participant characteristics (Roberts et al., 2003) is provided in Table 3-2, which is similarly presented in Paper III.

Table 3-1 Summary of case characteristics.

Case	Age	G	Edu	Stroke type	Aphasia fluency	Aphasia severity	Time w/po	Follow-up w/po	Apraxia of speech	Group	CILT hours
FOT	43	M	15	Ischemic	Non-fluent	Moderate	8	36	No	Yes	30
MX	51	M	12	Haemorrhage	Non-fluent	Mild	14	33	Yes	Yes	27
TT	54	M	15	Ischemic	Fluent	Mild	8	38	No	Yes	30
RD	55	F	11	Haemorrhage	Non-fluent	Mild	16	64	No	Yes	28
BM	59	M	12	Ischemic	Fluent	Moderate	6	33	No	Yes	30
DS	66	F	10	Ischemic	Non-fluent	Severe	10	59	Yes	Yes	25.5
PL	67	M	16	Ischemic	Fluent	Severe	9	33	Yes	Yes	30
GA	68	M	16	Haemorrhage	Non-fluent	Severe	6	NA	Yes	No	24.5
LL	78	F	7	Ischemic	Fluent	Moderate	4	48	No	No	27
HP	89	F	13	Ischemic	Non-fluent	Moderate	6	23	Yes	No	20

Abbreviations: G = Gender, Edu = Education in years, w/po = weeks post-onset

3.2.5 Individual presentation of the cases

FOT was a 43-year-old male with non-fluent aphasia and right-side hemiparesis following a left cerebral vascular accident. He received acute thrombolytic treatment as well as a hemicraniectomy prior to beginning the study. FOT's expressive language was marked by severe anomia without apraxia of speech by the time he enrolled in the study. FOT started CILT intervention eight weeks post stroke for a total of 30 hours. After CILT intervention, FOT received weekly, continued speech and language in both individual and group settings throughout the follow-up measures (both). FOT participated in two follow-ups, 6 and 20

months post CILT intervention. His further progression was influenced by medical complications in the period between the first and second follow-ups.

MX, a 51-year-old man, survived an intracerebral haemorrhage in the left hemisphere, resulting in aphasia, apraxia of speech, and right side hemiparesis. He attended the CILT study three months post-onset for a total of 27 hours. By the time MX entered the study, his aphasia was qualified as mild to moderate and non-fluent; he struggled with word finding problems as well as initiating of the first syllable. After CILT intervention, he continued with daily speech and language therapy at the rehabilitation hospital until his discharge shortly after. Continued speech and language therapy was applied for, but not available. However, MX and his significant others continued to practise together and used every opportunity to improve his speech skills. He resumed the use of his computer for reading and writing purposes. Follow-ups were conducted twice, 4 and 13 months post CILT, respectively.

TT was a 54-year-old man with aphasia, right-side hemiparesis, mild cognitive deficits (memory and process planning), and diplopia following a left hemisphere cerebral vascular accident. His speech fluency approached the fluent category but was characterized by anomia, perseverations, paraphasia, and a high percentage of non-content words (for example, interjections). TT participated in the CILT study eight weeks post-onset for a total of 30 hours. He received continuous speech and language therapy following his participation in the CILT study, including individual and group approaches.

RD, a 55-year-old woman, survived a large intracerebral haemorrhage located in the capsula interna, sustaining in aphasia, cognitive impairments (prolonged reaction time, problem solving, abstract thinking, and reduced initiative), and visuospatial deficits. RD was diagnosed with childhood dyslexia and recently glaucoma. Her speech was in periods characterized by indistinct verbal production (without scoring for explicit apraxia of speech), which she was able to adjust by reduced tempo and attended articulation. Her passive behaviour in conversations seemed to reflect both reduced initiative as well as word finding problems. When providing an answer, RD often repeated the utterance of the conversational partner. She participated in the CILT study four months post-onset for a total of 28 hours. She is therefore the person with the most progressed rehabilitation schedule post-onset as

well as with experience of more complex cognitive deficits as compared to other participants.

BM, a 59-year-old male, developed mild to moderate aphasia and memory deficits following a cerebral vascular accident in the left hemisphere. His speech was described as anomic; he talked in a slow, but fluent manner with breaks and perseverations. Initially, he struggled with self-correction. BM entered the CILT study six weeks post-onset for 30 treatment hours. He continued with speech and language therapy (individual and group offers) beyond the time of the follow-up.

DS, a 66-year-old woman acquired severe aphasia, apraxia of speech, and mild sensibility deficits in her right arm after a parieto-occipital infarction in the left hemisphere. She had experienced a minor stroke several years ago without any form of sequela, and was therefore included in the study. Her aphasic speech was non-fluent with typical anomia, where her severe apraxia of speech utterly limited her attempts of word production. At the CILT initiation, her communication consisted of a few single words including yes and no. She derived advantage by prompting the initial phonemes, body language, and written letters. DS participated in the CILT study two months post-onset for a total of 26 hours. She continued with regular speech and language therapy post intervention beyond the follow-up assessment.

PL, a 67-year-old retired man, survived an ischemic stroke in the left middle cerebral artery and received acute thrombolytic treatment. Consequently, he developed moderate to severe aphasia and apraxia of speech as well as mild cognitive impairments, as reported in his neuropsychological assessment, in the form of general reduced processing speed and reduced capacity for new learning and abstract thinking. PL's speech fluency displayed large variations, consisting of both episodes with fluent utterances including neologism, semantic and phonological paraphasia, and perseveration as well as longer breaks with typical word finding problems. His attempts at self-correction often seemed to worsen the situation, during which he would show signs of frustration of his personally experienced linguistic incompetency. He entered the CILT study two months post-onset for 30 treatment hours. After the CILT intervention, PL continued daily speech and language therapy at a

rehabilitation hospital for six weeks until discharge. Application for further continuous local speech and language therapy resulted in an offer first after the follow-up assessment period.

GA, a 68-year-old male, sustained a left intracerebral haemorrhage with midline shift, resulting in severe receptive and expressive aphasia, apraxia of speech, and dysphagia. His language production was limited to yes/no, monosyllabic words, and neologisms at the start of the study, six weeks post-onset. Despite his severe aphasia, he actively participated in communication and was interested in reading newspapers, etc. Shortly after the CILT intervention, he was accepted as an inpatient at a rehabilitation hospital where he again received daily speech and language therapy for several months. Unfortunately, his physical condition worsened, thereby affecting his mood and motivation; hence, he was released from the follow-up assessment for medical and ethical reasons.

LL, a 78-year-old woman, developed aphasia, motor apraxia, and mild cognitive deficits (spatial orientation, initial right side neglect) following a cerebral vascular accident. She underwent thrombolytic treatment within the first hours of stroke appearance, without any specified effect. Possible memory deficits were initially observed at the hospital but not formally assessed; they could not be ruled out as having existed before the onset of the stroke. Her aphasic speech was described as fluent and anomic without explicit neologisms or paraphasia, but she had severe writing and reading problems. LL started participating in the CILT study five weeks post-onset for a total of 27 hours. Despite further application for speech and language therapy after discharge from the hospital, she received only a few hours of training until the follow-up assessment. In addition, her physical condition forced her to several instances of rehospitalization.

HP, an 89-year-old woman, developed aphasia, apraxia of speech, and right side hemiparesis following a cerebral vascular accident. She entered the CILT study six weeks post-onset for 20 treatment hours. At initiation, her aphasia was described as mild to moderate and non-fluent, but speech intelligibility was limited by her significant apraxia of speech. HP continued undergoing speech and language therapy twice a week for the following two years. She participated in two follow-ups, 4 and 14 months post CILT. At that time, her speech was still characterized by disturbances and dysarthria. Therefore, she had started to

use technological support in the form of a specialized typewriter to type words that she found difficult to pronounce intelligibly.

3.3 CILT-program and stimuli material

The Norwegian CILT stimuli material was modelled by Maher et al. (2006), which I was introduced to when I was a visiting student in Houston, USA. The content of the intervention is based on the card game activity "Go Fish" with the purpose of collecting pairs of matching pictures (cf. Paper I). Inspired by the categorical classification and frequency dimensions of the American material, the Norwegian picture stimuli were chosen for similar content but with relevance for Norwegian language use and specifically for everyday communication in the early phase of aphasia rehabilitation.

3.3.1 The frequency of stimuli

Frequency was determined by two Norwegian corpus (both Bokmål[7]) provided by the Text Laboratory at the University of Oslo (Tekstlaboratoriet, 1999) (cf. also Johannessen, Priestley, Hagen, Åfarli, & Vangsnes, 2009). The written corpus (based on news articles, fiction, etc.) was preferred to the spoken corpus (NOTA) for selection of stimuli nouns because of the richer content (9.6 million words and 1.7 million words, respectively) at that time. Despite this, the importance of the spoken corpus for intervention of expressive language is strongly recognized, and extension and development of this corpus are highly awaited for future research. Paper II on oral text production refers to this consideration.

A split point high-low frequency distinction was applied following the same criteria as the Norwegian version of the PALPA (Kay, Lesser, & Coltheart, 2009). The following criteria were personally provided by speech and language pathologist Ingvild Røste who worked on the translation of the PALPA at the Bredtvedt Resource Centre. High frequency was set to cover the first percent of nouns, ranking from number 1 to 3000, because the majority of

[7] Norway has two official written languages; Bokmål and Nynorsk. The majority (ca. 80%) uses Bokmål as the primary written language (Språkrådet, retrieved 17.10.2010).

nouns presented a low frequency rate in general (average frequency: 19.4). Even within the high frequency group, frequencies differed significantly (for example, ranging from 62,887 to 958 occurrences within the most frequent 500 words of the list).[8] A buffer zone (middle frequency, not chosen for stimuli) consisted of the next percent of nouns on the list, ranging from 156 to 72 occurrences, ranking from number 3001 to 6000, respectively. Finally, low frequency was defined to cover all other nouns left on the list, ranking from number 6001 and up.

3.3.2 The picture stimuli

The picture material was based on nouns chosen from the frequency list by the following criteria:

- Nouns that appeared in the test battery were excluded for research validity reasons (cf. Paragraph 3.4 assessment battery) (Nickels, 2002).
- Nouns had to be relevant for daily communication including the rehabilitation setting.
- Nouns had to present high imagebility (Whitworth et al., 2005). This excluded most of the abstract words (year, day, etc.).
- Nouns should be easy to picture in different versions in order to visualize the four levels of difficulty.

Proper nouns and pictures of famous persons were avoided because of reported differences in activation patterns in the brain (Best, 2000). On the other hand, prototype words were preferred if available, with the expectation of easier word activation (ibid).

[8] Note that a different definition of high frequency was applied in Paper II for text production with the first one hundred nouns being high frequency only.

Finally, the CILT material consisted of ten categories with ten nouns in each. High frequency categories included *persons, personal belongings, transportation*, *buildings,*[9] *home and house*, and *food,* whereas low frequency categories covered *persons, personal belongings, home and house*, and *food*. See Appendix D for all stimuli words with frequencies and property examples.

The majority of pictures were selected from the Word for Windows picture database in the absence of a similar, rich and freely accessible Norwegian database. Photography was preferred to colour drawing, if available. The disadvantage of this database is that some pictures have an Anglo-American cultural background instead of Norwegian. Some participants with aphasia commented on this aspect during the CILT intervention, for example, on the picture of a police officer who wears a typical British uniform. Additional pictures particularly pictures of health professionals were included from the Norwegian edition of the Supported Conversation for Aphasia material (Kagan et al., 2003). Purchasable picture sets available for speech and language pathologists (for example, colour cards) were deliberately avoided owing to the recognisability and learning effect for persons with aphasia from other therapies.

In addition to the distinction between high and low frequency stimuli pictures, each noun appeared in four different levels of difficulty (cf. Paragraph 3.3.3 and Appendix C). This required a different set of pictures for each level. For systematic and easy use by the co-operating speech and language pathologists, all pictures were colour coded (cf. Appendix C) as well as laminated for hygienic appropriateness.

3.3.3 The CILT intervention structure

In the preparation phase for CILT intervention, all co-operating speech and language pathologists participated in one-day courses, where they were specifically trained to conduct the CILT intervention and understand the assessment battery, scoring system, and CILT content and structure. Practical exercises (video scoring of subtest and card game activities)

[9] *Buildings* was the only category where no picture cards exist at level 4, because it did not feel like a natural act of communication, for example, to ask for two hospitals.

were mandatory to establish a reliable practise across persons and rehabilitation units. In addition, the speech and language pathologists received written instruction describing the CILT-program. These instructions included detailed examples of the introduction to the dual card task and references for gradual progression to higher levels (See Appendix E for a sample of the Norwegian protocol describing the card activity).

The participating speech and language pathologists were highly encouraged to accept contact by phone or email at any time for questions and reflections, which all made use of. Relevant comments for all speech and language pathologists involved in the data collection (for example, the extension of the data collection period) were distributed in writing by email.

CILT was preferably carried out in a group setting with two to three persons with aphasia and a speech and language pathologist, or in individual settings, where the speech and language pathologist acted as the communication partner. In three intervention settings, an additional person with aphasia who did not fulfil the inclusion criteria for the study was invited to join the CILT treatment in order to establish a group setting. A premise for being such a "group helper" was the relevance of treatment for their aphasia characteristics. No data were collected from these persons; therefore, they are not reported further in this thesis.

The CILT-program consisted of a dual card task based on the activity "Go Fish". The task covered four levels of difficulty, ranging from simple object naming (for example, "Towel?") to producing complex interrogative sentences (for example, " Pete, do you have three blue towels?"). Table 3-2 presents an overview of the characteristics of each of these four levels of difficulty. The appendix in Paper I covers a more detailed description with examples of requested questions on each level as well as affirmative and negative responses.

Table 3-2 Description of the four levels of difficulty for the CILT intervention.

Level	Expected request	Example
1.	Word naming, preferable intonation of an interrogative phrase	"Towel?"
2.	Addressing another person, word naming in a interrogative phrase	"Peter, do you have a towel?"
3.	Addressing another person, word naming in a interrogative phrase including an object description	"Peter, do you have a blue towel?"
4.	Addressing another person, word naming in a interrogative phrase including an object description and an amount	"Peter, do you have three blue towels?"

The main task for the participants was to produce a verbal expression describing the picture to the other participants in the CILT group, in order to request a matching card to collect a pair. Criteria for response accepted the use of different names for each pictured noun as long as correct information was conveyed. This allowed for acknowledgment of local dialects and possible sociocultural differences. For example, for the target word "bag pack," acceptable responses included *ranzel* (old Norwegian for school bag*)*, backpack, or school bag.

Levels 3 and 4, there were no limits as to what kind of object characteristics the person with aphasia produced, opening for extended word activation and variation in the card activity. Usually, a colour, form, or other typical external features were modelled by the speech and language pathologist if necessary. For Level 4 with different amounts, a few pictures showed more than five of the same object on one card, and mass adjectives were accepted in these cases, for example, "Do you have many bicycles?"

The use of Norwegian language opens up several possibilities when expressing a descriptive sentence, where adjectives and adverbs were often exchanged for a relative construction; for example, "Can you give me a red apple?" as well as "Can you give me an apple which is red?" Since this enhanced the complexity of the sentences, the use was supported for those participants who mastered it successfully. However, in a few cases (for example, MX and LL), sentence structure initially had to be maintained at a more simplified level because of difficulties in producing the longer utterance successfully. This was gradually shaped to the level of personal mastering later during the intervention.

During the CILT intervention, persons with aphasia did not receive any other speech and language therapy or participate in any group settings focussing on communicative skills.

3.4 Assessment battery

The assessment battery was modelled by Maher et al. (2006), as it provided a reasonable and convenient basis for developing the Norwegian test battery. Comparing the assessment measures across published chronic CILT studies (cf. Table 2-2), the majority includes a general aphasia test measure, naming tasks, and study-specific items. Because the focus of the CILT treatment concerns verbal speech production, tasks capturing expressive speech at several levels were included in the present study, for instance, naming on word level (for example, NGA-naming, PALPA), sentence construction (Verb and Sentence Test (VOST)), and more complex text production (for example, the Cookie Theft Picture). Additional measures of receptive tasks, reading, and writing were included for investigation of experimental control for spontaneous recovery. Table 3-3 provides an overview of the original Maher et al. (2006) test battery and the available Norwegian assessment equivalents and extensions. A short description of the individual tests is provided in Paragraphs 3.4.1–3.4.8.

Table 3-3 The construction of the Norwegian assessment battery

Original battery by Maher et al. (2006)	Norwegian equivalents
Western Aphasia Battery (WAB) (all language tests up to page 9, PACE-group: some reading/writing	Norwegian Basic Aphasia Assessment (NGA) (syntax subtest excluded)
Apraxia battery for adults, task 5	Assessment of apraxia of speech
Boston naming test Action naming test	PALPA- task 54: naming nouns –frequency Verb and sentence test (VOST) – task 7, sentence construction
Cinderella story (text production)	Conversational interview from the NGA
Cookie theft	Cookie theft
CILT-baseline	CILT-baseline
	TROG-2 (Test for reception of grammar)

The test battery includes tasks either specifically constructed for the aphasic population or at least standardized for aphasic speakers. The only exception is the Test for Reception of Grammar, (TROG; Version 2) (Bishop, 2009), which was added to the Norwegian test battery for a more complex comprehension task on sentence level, thereby supplying the NGA (Reinvang & Engvik, 1980b). Bishop (2003) refers to the applicability of the test to persons with aphasia; however, there are so far no Norwegian norms available for adults (neither aphasic or non-aphasic speakers).

The process of constructing a relevant test battery involved useful feedback and co-operation from experienced speech and language pathologists in the field of aphasia, thereby supporting the validity of the assessment battery for measuring the outcome of the CILT intervention.

The assessment battery and stimuli material were piloted with two persons with aphasia, who did not participate further in the study. No tests were excluded, but a more detailed scoring system was applied for two tests (PALPA-54 and CILT Baseline). The original score of either correct or incorrect did not consider speech deficits as apraxia of speech or dysarthria. In other words, correct word activation may be masked by incorrect pronunciation. Therefore, the new scoring system included a two-point score if the naming and pronunciation was correct; a one-point score if the naming was correct and intelligible, but had phonological errors; and zero points for wrong or unintelligible answers.

All assessment material was controlled for *not* including treatment items with the exception of the CILT–baseline test, where the comparison of trained and untrained items was a specific factor (cf. Nickels, 2002).

According to the ICF model, standardized language tests primarily provide measures on the impairment level, whereas the participation and activity axis is assessed within functional outcome measures (Cherney et al., 2008). As stated in the latest Cochrane review (Kelly et al., 2010), the ultimate outcome of speech and language therapy concerns enhanced functional communication. However, these authors also recognized the limited availability of valid and standardized assessments for functional communication internationally. Norway is no exception, and the measures for functional communication available and included in this intervention are The Communicative Effectiveness Index (CETI, Lomas et al., 2006) and

analysis of connected speech samples (cf. Extended description later in this chapter and Paper II).

The CILT intervention progression is illustrated in Figure 3-2, showing the different phases of assessment and treatment.

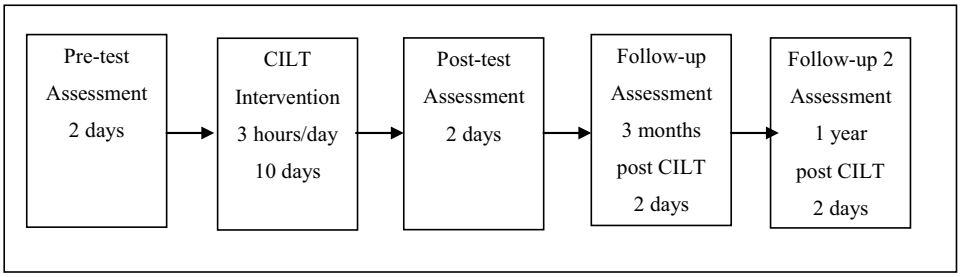

Figure 3-2 The CILT intervention schedule.

All speech and language pathologists received written procedures with detailed instructions to ensure the reliability of test administration, and a copy set of all required test scoring papers (and material if necessary). For reliability and validity reasons, an assessment protocol was provided for the treating speech and language pathologists (See Appendix F for an English summary of the assessment protocol).

Assessment was scheduled over two consecutive days in order to capture some of the daily variance in language production and use as well as to limit test exhaustion. Breaks on testing days were permitted based on individual needs. In the next section, a short description of the different assessment tools is presented.

3.4.1 The Norwegian Basic Aphasia Assessment (NGA)

The characteristics and severity of aphasia were assessed with the Norwegian Basic Aphasia Assessment[10] (NGA) (Reinvang, 1985; Reinvang & Engvik, 1980b), the most common and standardized aphasia test in Norway at present. The NGA is based on the diagnostic traditions of the Boston school and is therefore similar to the Boston Diagnostic Aphasia examination (Goodglass & Kaplan, 1972) and the Western Aphasia Battery (Kertesz, 1982).

[10] An English description of the NGA is provided in Reinvang & Engvik, 1980b.

As a fundamental test, the NGA provides preliminary information on all language modalities, that is, auditory comprehension, repetition, speech production, reading aloud, reading comprehension, writing, and syntax. The NGA includes items both on the word and sentence level; however, it's limitations include having small numbers of test items within each subtest category. Hence, the appropriateness of the NGA for measuring changes has to be considered and will be discussed later (Lind & Haaland-Johansen, 2010).

All subtests of the NGA were applied at all times with the general exception of the subtest "syntax," which was excluded from the test battery. The syntax task is based on ordering sentence fragments (cards with written words) into correct sentences, thereby presupposing a certain level of reading comprehension, which was not relevant for this study. Syntax was considered to be better assessed by the TROG-2 (TROG-2, comprehension Bishop, 2009) and the VOST (VOST, sentence production Bastiaanse, Lind, Moen, & Simonsen, 2006), both described in the following paragraphs.

The distinction between fluent and non-fluent aphasia is a commonly used parameter for the specifications of aphasia. For this study, the classification by Reinvang and Engvik (1980b) was followed,[11] which defines word production of less than 40 words per minute as non-fluent, and of more than 80 words per minute as fluent. However, this results in an unspecified in-between group (for example, in the case of HP), consistent with the authors' (ibid) argument of a rather large group of indefinable cases of aphasia. This is also typically considered for other aphasia parameters and illustrates some of the difficulties of defining and applying clear-cut aphasia syndromes. Despite this, the NGA provides a relevant first overview of the language skills and deficits of persons with aphasia. Reinvang and Engvik (1980b) report good overall reliability for the NGA (Cronbach's α =.995), but address the consideration of the skewness of the reference group for interpreting group percentiles.

[11] In contradiction to Reinvang and Engvik (1980b)'s guidelines, perseverations and repetitions were included in the transcription and word count to preserve the most realistic utterances and texts produced by each person with aphasia. Hence, speech fluency might reflect a slight misalignment to the fluent definition which in this case will be an overestimation.

Reinvang and Engvik (1980b) also provided an assessment form for apraxia of speech, which was included in the test battery.

3.4.2 The CILT-baseline

In order to explore specific treatment changes, an assessment form was developed, modelled by Maher et al. (2006), the so-called CILT-baseline. The term baseline here does *not* refer to the convenient understanding of the methodological application of dealing with a stable, repeated baseline measure as applied for single-subject studies (Schiavetti & Metz, 2006). Rather, the CILT-baseline describes a task-specific assessment tool.

The CILT-baseline is a picture-naming test, consisting of ten picture cards with high frequency objects and ten picture cards with low frequency objects. Five of each frequency sets are trained items, while the other five are untrained items. The participant was asked to produce a sentence to the picture following the same structure as provided in the CILT treatment (See Appendix G and H). For the high frequency objects, the utterance should include addressing by name, an interrogative phrase, the object, and a characteristic or property of the object (cf. CILT level 3, for example, "Jane, do you have a red apple?"). The question for the low frequency objects should in addition include the pictured amount of the object (cf. CILT level 4, for example, "Pete, do you have two white envelops?").

Scores of 2, 1, or 0[12] were given for each item requested, adding up to a total of 80 points for the high frequency objects, and 100 points for the low frequency objects. The CILT baseline was administered twice at all times of measurement, recommended once each day of assessment.

3.4.3 The Psycholinguistic Assessments of Language Processing in Aphasia (PALPA)

The PALPA (Kay et al., 1992) is based on the cognitive-neuropsychological model for language processing (Whitworth et al., 2005). The persistent relevance of the PALPA as an

[12] 2 = correct, 1 = pronunciation errors, but unambiguous, or over-generalization (e.g., fruit instead of apple), 0 = incorrect

international clinical and research instrument was verified by Bate, Kay, Code, Haslam, and Hallowell (2010). For the CILT assessment, the picture-naming task PALPA -54; (word naming related to frequency), was chosen as a relevant measure of the impact of word frequency on word retrieval and activation for persons with aphasia. The task consists of 20 high frequency and 20 low frequency nouns. Since the Norwegian version of the PALPA (Kay et al., 2009) was still in preparation when the CILT study was started, permission was given to use a preliminary version of the subtest for the present study. This preliminary version comprised all the target words of the final, published Norwegian version, but used a different set of picture stimuli. The pictures applied for the CILT study followed the structure of the PALPA; they were black and white drawings with four pictures presented on each page. The Norwegian PALPA has so far no norms for persons with aphasia but it has a reference group of non-aphasic speakers for each subtest.

3.4.4 The Verb and Sentence Test (VOST)

The VOST (Bastiaanse et al., 2006) consists of several subtests assessing verb and sentence comprehension and production. Subtest 7 "sentence construction" was included in the CILT test battery as a measure of expressive verbal production beyond word level. The task required persons with aphasia to produce one sentence for each of the 20 drawings presented. An utterance was scored as correct if it was a complete and grammatical correct sentence describing appropriate content for the picture stimuli. Phonological mistakes were accepted if there was no doubt of the intelligibility of the words produced. The reliability of this subtest is reported to be acceptable (Cronbach's $\alpha = 0.84$). Despite resulting in a good evaluation of sentence production, the authors (ibid) propose not to apply standardized norms for this subtest because of its complexity. Instead, error analysis is suggested as a more informative assessment.

3.4.5 The Test of Reception of Grammar Version 2 (TROG-2)

The TROG-2 (TROG-2, Bishop, 2003; Bishop, 2009) was included in the CILT test battery as an additional measurement of auditory comprehension and a supplement for the more executive, receptive tasks of the NGA. The TROG-2 assesses the syntax structure by asking persons with aphasia to choose one of four pictures corresponding to an auditorily presented target sentence. The test has a hierarchical structure of 20 by 4 sets (blocks) of complex

syntactic representations in the original English version. However, responses using the Norwegian version indicate a more flexible complexity, where some higher elements were more easily accessible than previous blocks (cf. the Norwegian Manual, Bishop, 2009). Therefore, the complete test was administered where the response structure indicated this as useful or relevant for persons with aphasia, instead of applying the original cut-off point for testing (recommended after five blocks containing incorrect answers).

3.4.6 The connected speech samples

Connected speech in the form of larger oral text production was conducted based on the Cookie Theft Picture description (Goodglass & Kaplan, 1972) and the interview questions from the NGA (Reinvang & Engvik, 1980b). The conversational interview consists of three closed questions ("What is your occupation?" "Where do you live?" "What is your favourite TV show?") and three open questions ("Can you tell me a little about your family?" "Can you tell what you did today, before you met me?" "What do you usually do during the summer holidays?"). The conversation was not restricted to these questions; rather they were the starting point for a communicative exchange where both the person with aphasia and the speech and language pathologist were encouraged to extend their responses and turns.

The text samples of the Cookie Theft Picture and the conversational interview were transcribed orthographically. Speech fluency as measured in words per minute was calculated for all cases and assessment times. A detailed description of the transcription procedure and methodological consideration of the use of connected speech samples is presented in Paper II. Since the conversational interview reflects a more natural communication setting than the semi-structured Cookie Theft Picture, Paper II presents the results of the text analysis for the conversation interview for HP, MX, and LL.

3.4.7 The Communicative Effectiveness Index (CETI)

Lomas et al. (1989, 2006) developed an index to measure change in "pragmatic communication" in the recovery phase of aphasia. A significant communication partner rates the present communicative effectiveness of the person with aphasia in 16 situations relative to pre-stroke performance on a 10 cm line scale, where each millimetre equals one percent. The CETI average is calculated by dividing the total number of scores with the number of

rated tasks. Lomas et al. (1989) describe significant changes (for a time interval of six weeks) on the group level at a critical value of 12 points of the CETI average. Results from the CETI are presented in Paper III.

3.4.8 The CILT participant experience survey

In order to gain information about the experience of participating in the CILT intervention (cf. Kelly et al., 2010), a self-reported evaluation survey was developed for persons with aphasia, the CILT participant experience survey. The CILT participant experience survey included four open questions for a general first expression of the experience of participating in a CILT treatment. These open questions were followed by fifteen closed questions covering details of the CILT-program based on a five-point answering scale with the format, *to a very high*, *high, neutral, low, and very low degree*.

The survey was developed to suit different linguistics skills of persons with aphasia by including pictures, symbols, and written key words in addition to the oral presentation of each question by the treating speech and language pathologist. The use of examples was encouraged where necessary. The detailed content of the CILT participant experience survey and an example of the presentation format are attached in Appendix J.

The persons with aphasia responded to the CILT participant experience immediately after finishing the post-test session. Results are addressed in Paper I, and extended reports can be found in Paper III.

4. Methodological considerations

In the previous chapter, the design and progress of the present study were presented. The quality of this intervention study and the drawn inferences on the CILT treatment outcome for early aphasia rehabilitation rely on sufficient consideration of validity and reliability. The methodological transparency provided in this frame of the thesis allows for replication of the study.

Shadish, Cook, and Campbell (2002, p. 34) define validity as "the approximate truth of an inference." They emphasize that validity judgments are not absolute, since there is no final certainty that all inferences drawn from an experimental or quasi-experimental study are true, or rightfully falsified. Threats to validity are not mutually exclusive, which indicates that decreasing the threat to one type of validity may increase another (Lund, 2005; Shadish et al., 2002). For example, applying the CILT intervention in several clinical settings with different speech and language pathologists enhances ecological and external validity, but limits internal validity. Furthermore, having multiple institutions contributing to the data collection reduces threats of validity and reliability related to specific personal characteristics of the intervention provider or tester.

4.1 Validity of statistical inference

The validity of statistical conclusions concerns the inference of the existence of a relation between the CILT intervention and its measured outcome, and the strength of such a relation. Threats to statistical validity are violations of statistical rules and low statistical power (Shadish et al., 2002). Both are relevant points of discussion for the CILT intervention.

Standardized tests (for example, the NGA) provide data on the interval level, which are presented as either raw scores or percentage correct answers in the different papers. Because of the lack of norms for several of the Norwegian tests, significant improvement on the individual level was defined as more than one standard deviation (SD) from the SD of the group pre-test mean on the respective measures.

The sample size of 10 persons with aphasia is rather small considering the application of group statistics. Tests of normality with Kolmogorov-Smirnov revealed non-significant results at the .01 level for all but one (subtest comprehension, NGA (p = .006)) pre-test dataset as well as age and education. Hence, a relatively normal distribution was assumed, thereby allowing the use of parametric statistics. However, with such a small sample size, specific high or low individual results can affect the group statistics in either direction.

Furthermore, the probability to detect statistical significant differences may be limited by the power of the small sample size and could lead to the failure to reject a null hypotheses (type II error) (Schiavetti & Metz, 2006). Therefore, a larger sample size would be preferable for this type of study; however, this was impossible to accomplish within the given time schedule of the study. Therefore, changes of statistical significance and inferred conclusions on the group level have to be interpreted cautiously. Replication or extension of the study would be preferable in the future.

Recognizing the challenges of significance testing in small samples, effect size calculations provide important additional information on the intervention outcome. Effect sizes are estimates of how much the independent variable explains of the dependent variable, which is independent of statistical significance (Schiavetti & Metz, 2006) Therefore, effect sizes are frequently requested in aphasia treatment outcome studies (Beeson & Robey, 2006). For papers including only three cases (as in Paper I and II), reviewers recommended the following formula to calculate the effect size:

$$d = \frac{Mpretest - Mposttest}{SDpretest}.$$

In general, group effect sizes of 1.0 equal one standard deviation in normal distributed samples, and effect sizes of 0.5 and 0.8 reflect medium and large changes, respectively (Domholdt, 2005; Schiavetti & Metz, 2006). In order to differentiate treatment effects from untreated, spontaneous recovery, Robey (1998) recommends a group effect size of minimum 0.63. For the investigation of a specific treatment outcome in the early rehabilitation phase, an effect size of d = 1.15 is suggested (ibid).

In 1979, Sarno and Levita (1979) addressed the methodological issue of the correlation between group statistical inferences and individual outcome prediction. Group statistics may

mask relevant outcome changes on the individual level. Further, they (ibid) argue that statistical significance of an outcome result has limited relevance for the actual personal experience of change. For a person with severe aphasia, for example, GA, increasing verbal skills with only a few words can significantly add to his functional communication and could enhance his participation in everyday life. Respecting the small sample size, results will be presented mainly at the individual level; however, the group analyses provide more generalisable data.

4.2 Validity of internal inference

Internal validity refers to inferences on causality, that is, if an observed covariation between two variables reflects a causal relationship (Shadish et al., 2002). In order to investigate causal relationships, a randomized control study design is recommended (Domholdt, 2005; Shadish et al., 2002). Therefore, the CILT intervention was originally intended as a comparison group study modelled by Maher et al. (2006) with the same intensity and material for both groups as well as the same inclusion criteria. The experimental group was expected to accomplish the CILT treatment with focus on spoken verbal utterances, whereas the comparison group would be trained to use total communication allowing the use of all language modalities such as writing, gesturing, etc., as described in the approach called Promoting Aphasic's Communicative Effectiveness (PACE; (Davis & Wilcox, 1985). Because of the presented difficulties in recruitment, this had to be adjusted during the study period. Since the CILT intervention did not include a randomized comparison group, the final design qualifies as quasi-experimental or one group pre-test-post-test design (cf. Shadish et al., 2002). Therefore, inferences about causal relationships are restricted, and results should be interpreted more correctly as trends.

Threats to internal validity include all factors that may evoke or influence the assumed treatment effect. In order to ensure comparable CILT treatment sessions across speech and language pathologists and rehabilitation units, fidelity was established by collecting 10-minute (minimum) video samples from each intervention day. However, the CILT intervention was part of a multi-disciplinary rehabilitation process, and general effects of other treatments (for example, physical or occupational therapy) cannot be fully excluded.

The research method literature addresses a number of threats to internal validity (Domholdt, 2005; Shadish et al., 2002), and the most relevant threats for the CILT intervention are further explored in the following section. Because of the possible interference of spontaneous recovery to the intervention outcome, maturation is an important factor for discussion. In addition, the influence of multiple testing is addressed.

4.2.1 Maturation

The human body and brain possess the important potential to repair and heal themselves, which is known as spontaneous recovery. However, methodologically, spontaneous recovery constitutes a major threat to internal validity for conclusions on treatment intervention outcomes in acute and early rehabilitation phases, including aphasia (Basso, 2003; Wertz, 2000). One way to control for spontaneous recovery involves the use of chronic patients, as mentioned in the introduction. Furthermore, the methodological challenges connected to spontaneous recovery may explain the fact that there are fewer aphasia rehabilitation studies conducted in the acute or early stages compared to the chronic stage (cf. Cherney et al., 2008).

In general, for studies in early aphasia rehabilitation, the advantage of a comparison group study with randomized participants is the control of the effect of spontaneous recovery. Because of the randomization, spontaneous recovery as a random measurement error should affect both groups equally, and any changes in treatment outcome may indicate a treatment-specific effect (Tompkins, Scott, & Scharp, 2008). However, in order to investigate to which degree spontaneous recovery interferes with a certain treatment (for example, CILT), methodologically, having no treatment would be the best control for spontaneous recovery. Any outcome changes for a control group without treatment should either refer to spontaneous recovery or possible other third factors.

However, having a control group that does not receive treatment has strong ethical limitations for several reasons (Tompkins et al., 2008). First and foremost, the consequences of withdrawal or exclusion of available treatment in the early rehabilitation phase are not fully explored (cf. Irwin et al., 2008; Malec, 2009). Furthermore, limitation or withdrawal of treatment would negatively interact with the theories of neural plasticity and intensive treatment that CILT is based on, as presented in the previous chapters.

A solution could be to include persons with aphasia who for natural reasons did not receive any speech and language therapy, for example, while awaiting new treatment approvals or in the absence of speech and language pathologists. Recruiting persons within these categories for the CILT study proved to be difficult. For example, one person withdrew from participating because she did not want to interact with too many people while awaiting her convenient speech and language therapy in the community.

Based on these premises, a within-subject control was aimed for in this present CILT intervention in order to explore the influence of spontaneous recovery for the outcome measures. The analysis of non-equivalent dependent variables was applied in the form of receptive and written tasks, which were not the training focus of the CILT intervention (cf. Shadish et al., 2002). Based on the assumption of an overall general effect of spontaneous recovery for all language modalities (Pedersen et al., 2004), no or limited changes on the non-equivalent dependent variables compared to sufficient improvement on verbal expressive tasks would imply a treatment-specific outcome of CILT.

Even so, there are several other factors to be considered for further discussion. Research from early aphasia rehabilitation resulted in contradicting conclusions about the overall effect of spontaneous recovery, as reported in Paper I. Some studies support the theory of an overall effect of spontaneous recovery (Pedersen et al., 2004), while others discovered particular changes in specific language modalities, for example, comprehension (cf. Lomas & Kertesz, 1978; Sarno & Levita, 1979). It has to be recognized that the type of assessment of aphasia differs throughout these studies, where modern large population studies more often apply general stroke scales and only to a limited degree in-depth testing by a speech and language pathologist. Hence, the previously reported outcome results may be masked by wide assessment tools.

Further, many language models acknowledge the interaction of modalities at some point in language processing, which is also reflected in the idea of generalisation of treatment effects to other linguistic tasks or language areas (Tompkins et al., 2008). Consequently, it is difficult to distinguish between possible effects of spontaneous recovery for all dependent variables and preferred changes due to a generalisation effect. Since there is no agreement about the general influence of spontaneous recovery on language (concerning amount and

duration), the possible influence of spontaneous recovery has to be acknowledged in methodological decisions. Furthermore, in order to improve aphasia rehabilitation outcomes, research studies should not fight or avoid, but rather utilize the properties of spontaneous recovery in the rehabilitation process (e.g., Holland & Fridriksson, 2001; Murray & Holland, 1995). This point of view is reflected in the frame of the present thesis.

4.2.2 Testing

Using the same pre-test and post-test assessment relies on the assumption that any outcome changes should be due to the intervention or other external factors. However, in the case of language testing, each test also implies a form for exercising a language function; hence, possible learning effects should be considered (Spreen & Risser, 2003). In a ten-day intervention schedule such as the CILT study, this may therefore imply a specific threat to the interference with the treatment outcome.

Respecting the methodological challenges of randomized group studies, multiple baseline studies have proven to be a methodological relevant design for single-case studies in aphasia (Beeson & Robey, 2006; Cherney & Robey, 2008; Thompson, 2006). However, the request for multiple baseline testing enhances the challenges of retesting. In addition, a possible change due to spontaneous recovery may infer with establishing a stable baseline. Improvement (natural or treated) may not develop in a linear direction, indicating difficulties in predicting stable changes as an alternative to a stable baseline.

The double role of being the treating speech and language pathologist as well as examining the outcome of the treatment holds methodological challenges and ethical considerations based on treatment expectations (Malec, 2009). For economical reasons, it was not possible to apply blind evaluation to the CILT intervention for the analysis of the test results. Instead, the following procedure was carried out. The treating speech and language pathologist of each participant was the first evaluator of all test results, whereas I double-checked all scorings based on videotapes from the test session. Further, the order of the video scoring (specifically pre-testing and post-testing) was varied, so that expectations of treatment outcome based on the pre-test scoring were restricted to a certain degree. In cases where I was the treating speech and language pathologist, an additional speech and language pathologist would check samples of the scorings.

4.3 Validity of construct inference

There are two ways of defining operational definitions. The concept is either defined by means of the indicants; for example, aphasia is what is measured by an aphasia test. Alternatively, it is specified how a concept is measured; for example, the theoretical definition of aphasia as a language disorder indicates measures on linguistic tests, whereas a consequence-based approach may evaluate the communicative environment. Since all measurement involves errors, threats to construct validity cover random measurement errors and systematic measurement errors.

4.3.1 Systematic measurement errors

Since a construct seldom represents the term perfectly, either construct underrepresentation or construct-irrelevant variance occurs to a certain degree (Kleven, 2002). For this study, the treatment outcome of CILT focuses on speech production (dependent variable). Hence, the definition of speech production is required and, in this study, it refers to all verbal expressive utterances (cf. Introduction). Measuring speech production covers different methods depending on what kind of and in which setting speech production is assessed. This includes tasks such as naming on word level and repetition (NGA), production on sentence level (VOST), complex text production in the form of a picture description (Cookie Theft), or spontaneous data provided by a conversational interview. The outcome may concern treatment-specific effects (for example, comparing trained and untrained items on the CILT baseline) or explore generalization to more natural communication settings, that is, the impact on functional communication. Paper II presents a discussion of quantity versus quality in spontaneous speech production changes. The combination of several types of assessment, so-called triangulation, strengthens construct validity by limiting measuring error related to a single outcome measure.

Systematic measurement errors also pertain to the use of the assessment tool. The included tests were developed for assessing language modalities and linguistic characteristics, thereby capturing the presence of aphasia. However, with the exception of the CILT-baseline, none of the standardised language tests was originally constructed to measure change (Spreen & Risser, 2003). Nevertheless, in the absence of better options, they are often applied for this

purpose in research settings, as this present one. Depending on expectations of the speed of improvement, assessment tools should be treatment sensitive and provide norms for shorter (for example, 2–3 weeks for a CILT intervention) and longer intervention periods in order to compare individual outcomes.

In order to establish reliable results, a test measuring change should involve a relatively large number of items or tasks for each subtest. This is one of the limitations of several applied tests (Tompkins et al., 2008). For example, the subtest "NGA writing" consists of only 10 tasks and the subtest "sentence construction from the VOST" includes 20 items, whereas naming tasks in the PALPA and NGA include 40 tasks each. The combination of tests will provide a supplementary as well as more distinct picture than each test does individually.

Few of the applied tests so far provide norms for non-aphasic or aphasic speakers, which generally restrict statistical calculations of significant change and individual effect sizes based on standard deviation of an appropriate large reference sample. Therefore, the individual cases in the CILT study are compared to their own group data, where general norms are of less importance. Even so, test norms would be helpful when considering possible ceiling effects of the different tests as well as for the investigation of certain patterns of rehabilitation for the CILT group compared to a larger population.

A typical problem within language research involves the complexity of speech processing, with an interconnection of different linguistic aspects that are difficult to focus on singularly. Measures of all language modalities in aphasia as mentioned in this study provide information on possible interactions, for example, of changes in untreated language modalities as written naming and reading comprehension.

4.3.2 Random measurement errors

Reliability is used to describe the degree of random measurement errors (Kleven, 2002), that is, indications about errors occurring during measurement rather than relating to what is measured.

To improve completeness of datasets at each test point, a form with check off possibilities was provided to all speech and language pathologists. Despite these efforts, the absence of data could not be avoided due to issues of availability of the person to be tested, errors in

procedure, and the challenge of data collection from external persons. The last point particularly refers to the CETI, which is to be completed by significant others of the persons with aphasia. Having external or untrained persons to contribute to the data assessment therefore appears to be a distraction for reliability.

With regard to the reliability of the test assessment and scoring, inter-rater agreement for the first three cases (as reported in Paper I) ranged from 50% to 100%, with an average of 92.9%. Lower agreement scores were the result of the treating clinician scoring more liberally, and in cases of disagreement, the more conservative scoring was used. The lowest agreement scores were related to the transcription and scoring of sentences text production, where samples of various speech intelligibility (for example, according to apraxia of speech) distort the analysis. Throughout the study, an increase in inter-rater agreement was observed, consistent with more experienced use of the assessment battery.

For the reason that I am not a Norwegian native speaker, ambiguities in scoring of test results concerning dialectic variance (for example, from the Mid-Norwegian regions) were discussed with experienced Norwegian speech and language pathologists with regional background, and resolutions were followed.

4.4 Validity of external inference

Lund (2005, p. 388) describes generalizations as "non-statistical inferences of study results from studies to targets of treatment, outcomes, individuals, settings, or times." Another possibility involves "across generalizations," for variations of the causal relation of persons, settings, outcomes, and treatment that were not in the experimental study (Shadish et al., 2002).

For example, Pulvermüller et al. (2001) discussed whether the use of conventional aphasia therapy in a mass practice setting would have the same effects as CILT therapy, implying a generalization to another treatment. More recent studies have achieved results that confirm this initial CILT therapy results compared to conventional therapy, even under same conditions as intensity and material (Kurland et al., 2010; Maher et al., 2006; Meinzer et al., 2005; Meinzer et al., 2004). Hence, replication of studies provides an important gain of

knowledge to rehabilitation theory and implications for evidence-based practice (Malec, 2009).

Persons with aphasia present a heterogenic population (Murray & Clark, 2006). Hence, individual differences may explain why one person or group show better outcomes of the treatment as compared to others. Therefore, random assignment to experimental and control group is recommended for an experimental study. Because this option could not be fulfilled in the present study because of difficult recruitment and time restriction, results have to be cautiously interpreted. On the other hand, the application of the inclusion and exclusion criteria (cf. Paragraph 3.2.1) provides information about which populations or treatment settings can a treatment outcome be generalized to (Lund, 2002, 2005).

In addition, a representative sample is a necessity for generalisation to a particular population. The distribution of gender, educational background, and aphasia severity in the present sample is consistent with international studies on stroke populations in acute and early aphasia rehabilitation. However, the group age of this sample (M = 63, SD 13.6) lies between the approximately 55 years of age reported in chronic CILT studies (Barthel et al., 2008; Breier et al., 2009; Pulvermüller et al., 2001) and the average of approximately 75 years in other Scandinavian stroke studies (Hysing, Sarjomaa, Skog, & Lydersen, 2007; Laska, Hellblom, Murray, Kahan, & Arbin, 2001; Pedersen et al., 2004). Even so, no statistically significant differences for age and treatment outcome were apparent in this study.

Homogeneity of the participants based on the inclusion and exclusion criteria can therefore be a threat to external validity and question the relevance for the clinical aphasia population that shows a wider set of symptoms. The relatively wide inclusion criteria for this present study allowed participation for persons with different levels of aphasia in severity and form. Thus, the outcome of the applicability of CILT to early aphasia rehabilitation does not have to be limited to certain aphasia types. However, personal characteristic pre- and post-stroke—for example, motivation, experience with training, or depression—are supposed to similarly influence the therapy efficacy.

Participating in a research study is voluntary. It is reasonable to assume that the majority of persons who consent to participate in a research have some kind of positive outcome

expectations (Malec, 2009). Since the CILT study is a new, intensive treatment with focus on spoken language, this may affect outcome expectations to a different degree (either positive or negative) than if the treatment was a regularly provided treatment available for all.

In the past, time post-onset has been assumed to be a negative factor for therapy outcome. For chronic persons with aphasia (minimum 1 year post-onset), Moss & Nicholas (2006) reported in their review of single-subject studies that time post-onset did not significantly interact with the treatment outcome. However, Robey (1994) reports a better treatment outcome (twice the size of those compared to no treatment) for aphasia rehabilitation when it was started up to three months post-onset. This may indicate a difference in the best timing for early and chronic aphasia rehabilitation. However, according to individual differences in rehabilitation progress, there is no single answer to this subject. Multidisciplinary researchers address the necessity to deal with possible impacts of too early intervention, which depends on the degree of restitution where participating in intensive treatments is medical and ethically reasonable (Carter et al., 2010; Ponsford, 2004b).

4.5 Ethical considerations

Ethical consideration underlies all aspects of rehabilitation, independent of research or clinical practise. Providing information and treatment grounded on evidence-based practise is the primary function of rehabilitation (Cicerone et al., 2000; Malec, 2009). The presented methodological consideration and the development of the study rely on ethical evaluation and reflections.

Hence, this paragraph presents additional reflections in relation to the presented CILT study and CILT research in general. The focus on early rehabilitation and brain plasticity implies the ethical obligation not only to focus on positive outcomes but also to consider possible side effects and long-term effects. In order to provide an evidence-based practise, a more complex research picture is requested, involving access to studies with non-supportive and mixed results (Malec, 2009). However, publication of this type of studies seems to be far more restricted. For clinical practise, this implies outcome expectations on restricted premises and possible over- or under- application to relevant populations.

In the case of CILT, several reviews point to the necessity for further studies on the post-onset timing, duration, and structure of the program for persons with aphasia in order to establish more knowledge about the connection of behavioural changes (for example, producing more speech) to brain processing (Carter et al., 2010; Cherney et al., 2008; Ponsford, 2004a; Raymer et al., 2008).

5. Summary of the papers

5.1 Paper I: CILT application in early aphasia rehabilitation

The focus of Paper I concerns the applicability of CILT in the early aphasia rehabilitation phase; that is, one to four months post-stroke. The theoretical background describes the neuroscientific rationale of experience-dependent brain plasticity and learned non-use for the development of CILT as well as characteristics of the CILT treatment. Previous CILT research is reviewed, referring to chronic studies in the absence of early rehabilitation studies. Because of this lack of early studies, an extended discussion covers the challenges of research in the sub-acute/early rehabilitation phase and the threat of spontaneous recovery. Therefore, the purpose of the paper is to explore the applicability of CILT in a clinical rehabilitation hospital setting.

The paper reports the first three cases (HP, FOT, and GA) of an early aphasia rehabilitation CILT study. Because early rehabilitation results have not previously been published internationally, the findings in the paper are an important contribution to the field.

The results section describes pre- and post-test outcomes and changes in formal language assessments and participant experiences. The three cases showed an overall improvement, with a remarkably larger positive change on expressive tasks (e.g., naming and sentence construction) compared to receptive tasks (e.g., TROG-2) and non-treated written tasks. This is consistent with the treatment focus.

Assuming that the influence of spontaneous recovery has an overall effect for all language modalities (consistent with recent research), the outcome differences in expressive tasks compared to receptive and non-treated tasks indicate a CILT treatment-specific effect. This is supported by medium to large group effect sizes for the expressive tasks. Furthermore, the effect sizes exceed the critical level of the effect of spontaneous recovery alone. However, the influence of variables contributing to the outcome, other than the CILT intervention, has to be considered, especially in the absence of a control group. Therefore, the discussion focuses on the influence of individual factors (i.e., type of stroke, motivation, and influence of apraxia of speech). In conclusion, the results of the study support the application of an

intensive aphasia approach such as CILT during the early rehabilitation phase. However, clinical modifications are expected to accommodate individual needs.

5.2 Paper II: CILT generalisation to spontaneous speech

Paper II applies a linguistic perspective to the data material and explores the relevance of oral text production as an additional outcome measure of the CILT intervention. The oral text production assessment reflects a more natural communication aspect of language than most standardised aphasia tests. In general aphasia rehabilitation, further research is warranted to explore the generalisation effect of specific impairment-based treatment forms (e.g., CILT) on spontaneous speech production and everyday communication.

The theoretical rationale of the paper describes several methods for text analysis and their specific characteristics as applied in recent studies. Further, CILT studies applying text production measures (including four studies from the chronic aphasia population but no early aphasia studies) are reviewed. Therefore, the purpose of the paper is to investigate the generalisation of the CILT outcome to oral text production with a focus on vocabulary and content.

Text analyses are based on the pre- and post-intervention transcriptions of the conversational interviews of three participants: HP, MX, and LL. The paper includes a detailed methods section describing the applied guidelines for transcription and text analysis features. The analyses include quantitative measurements of speech production (number of words, number of utterances, and mean length of utterances), lexical production of nouns and verbs (proportion, variation, frequency, and specificity), and content (proportion of informative utterances, meta-communicative utterances, and qualitative evaluations).

Results show an overall improvement in noun production for all three cases following the CILT intervention, consistent with the CILT intervention focus on noun activation. Differences in improvement of noun diversity and specificity are observed for the three cases and enhance the individuality of the appearance of aphasia. The improvement in noun production is supported by medium to large effect sizes. An analysis of verb production, which was not the main treatment focus, indicates a slight decrease in the number of verbs

produced. However, the specificity of verbs that were produced improved post-intervention, which is reflected in large effect sizes and may indicate a generalisation effect of CILT to other word forms.

Qualitative content evaluation of the texts and quantitative measures of informative units demonstrated an improvement in informativeness on the individual level. Large group effect sizes exceed the effect of spontaneous recovery alone and support a generalisation effect of increased word production in natural conversation.

Individual characteristics such as aphasia severity, fluent and non-fluent speech production, individual talking styles, the role of the communication partner, and the subject for communication are discussed as influential factors for individual outcome.

To conclude, the usefulness of oral texts as a supplement to standardised tests for the analysis of treatment outcome is supported. The applied text analysis measures seem feasible for use in a clinical speech and language therapy context. Most importantly, the findings in this study support generalisation of the CILT intervention outcome to functional communication.

5.3 Paper III: CILT experience and long-term outcome

Paper III presents the pre- and post-intervention results for all participants in the study (N=10), with analysis on the individual as well as on the group level. The aim of this paper is to replicate previous case study results exploring the outcome of CILT in early aphasia rehabilitation. Furthermore, the paper investigates the long-term outcome of the CILT intervention at minimum three months post-intervention (N=9) and at a one-year follow-up for three cases (MX, HP, and FOT). In addition, the quality of the CILT intervention is explored using data from the CILT participant experience survey.

The theoretical rationale for this paper concerns the need for more research studies investigating the timing of effective aphasia rehabilitation in general and addresses the impact of experience-dependent brain plasticity on CILT treatment.

All participants completed the intervention study, whereas one case was lost to follow-up assessment. On the individual level, eight of the ten cases showed significant improvement on at least one language measure post-CILT intervention. Group analysis demonstrated significant improvement on the overall language measure. This was supported by a large effect size (d = 2.1), which exceeded the effect of spontaneous recovery alone and indicated a treatment-related effect. Expressive tasks (PALPA, CILT-baseline, VOST, NGA-naming) showed better improvement than receptive tasks or reading/writing, consistent with the treatment focus. However, the influence of spontaneous recovery must be acknowledged in changes of non-treated tasks such as reading comprehension, which is addressed in the discussion section.

Evaluation of the CETI (N=4) showed significant changes for communication in daily living situations, and this supports the relevance of the CILT intervention for everyday communication. Participant evaluations revealed positive experiences with CILT, thereby supporting the clinical relevance of CILT.

At the follow-up assessment (M = 7 months post-CILT), continued significant improvement on the group level was observed, and suggested at least no negative long-term outcome of the early intervention. The majority of participants continued with low-intensive, conventional speech and language pathology after the CILT intervention, which may have influenced the degree of individual improvement at the follow-up. The relevance of experienced-dependent use to maintain and improve a skill such as expressive language is discussed using two case examples.

To conclude, the small group study supports previous case results of the application of CILT in early aphasia rehabilitation to a wider range of personal characteristics. However, the influence of spontaneous recovery and additional factors must be considered. Modification of the CILT structure to individual needs as well as clinical premise is encouraged.

6. General discussion

The purpose of this chapter is to summarise and discuss the main findings from the three papers related to the theoretical background and methodological considerations presented in this frame of the thesis. In order to evaluate the applicability of CILT in early aphasia rehabilitation, the structure of this chapter embraces the different research subjects underlying the overall purpose of the study (cf. Paragraph 1.1).

The main purpose was the adoption and application of the CILT treatment to the Norwegian setting (cf. Research area *a*). Since the whole frame of this thesis, but especially Chapters 3 and 4, discusses the progress of this study, the focus in this chapter concentrates on the other research areas of interest.

6.1 CILT application on the individual level

The findings in Papers I and III directly support the application of CILT to persons with aphasia in the early rehabilitation phase (cf. Research area *b*). Since there are to my knowledge so far no other CILT studies in acute or early aphasia to date, these results warrant further replication and extension, preferably in a comparison group study or a series of single-case studies with multiple baseline scores to explore language improvement over time. At the same time, because of its rarity, the present study provides new information regarding early aphasia rehabilitation in general and the CILT treatment specifically.

6.1.1 Improvement on language measures

Related to the ICF model, improvement on the impairment level is captured in language-specific tests. All participants in the present study improved individually on multiple language measures following the CILT intervention. Despite the small sample size, this improvement is reflected by the group outcome. On the group level, significant improvement on a general aphasia assessment (e.g., AAT) was also reported for studies in chronic aphasia (Meinzer et al., 2005; Pulvermüller et al., 2001) with one exception (Goral & Kempler, 2009). This supports the application of a general aphasia assessment instrument for measuring outcome even for brief interventions.

Further, findings reported in Papers I and III show a significantly better group outcome post-intervention and medium to large effect sizes for *expressive* tasks (CILT baseline, PALPA 54, VOST, NGA-naming and NGA-repetition) compared to smaller changes in receptive (NGA-comprehension, TROG-2) and written (NGA-writing) tasks. These outcome changes in favour of the expressive tasks are also reflected on the individual level and indicate a treatment-specific improvement. This supports the clinical relevance of CILT (cf. Research area *b*).

In contrast, several chronic CILT studies report significant improvement on different *receptive* tasks (e.g., on the Token Test) in addition to naming tests (Barthel et al., 2008; Goral & Kempler, 2009; Meinzer et al., 2005; Pulvermüller et al., 2005; Pulvermüller et al., 2001). Not all of the chronic studies explicitly describe the primary goal for their CILT treatment outcome, but the applied constraint setting to verbal speech production indicates a focus on expressive speech, at least as part of the therapy outcome. This raises the question of whether CILT may have a more general outcome impact on expressive speech *and* comprehension, a generalisation effect on comprehension, a combination of the first two, or maybe explained by additional factors (e.g., timing of the treatment).

First, the CILT treatment does not only involve verbal speech production, but each verbal request also demands a response from the other person in the group, which requires a certain level of comprehension of the received question. The structure of the card game matches the content of other comprehensive tasks (e.g., auditory sentence-picture matching). The use of a visual hinder seems to increase the need to pay attention to the solely auditory stimuli. Further, requesting matching cards facilitates the control of correct comprehension, thereby giving direct feedback to the aphasic person about their linguistic performance.

Therefore, changes in measures of comprehension can be explained by the CILT structure and may even be expected to a certain degree. This raises the question of the difference between the early and chronic CILT studies concerning the variation in expressive and receptive outcome measures, and may have indications on research area *d*. Group size and thereby statistical power seems to be of limited relevance as an exploratory factor, because the CILT group sizes within these referred chronic studies (Barthel et al., 2008; Meinzer et al., 2005; Pulvermüller et al., 2005; Pulvermüller et al., 2001) usually equals or

approximates the group size of the present study (N=10). Another explanation considers the applied tests and number of items, where tests with low item numbers may result in larger percentage changes. For example, the subtest NGA-writing only contains ten items, whereas NGA-repetition consists of forty items. Hence, an improvement of one raw score results in important percentage increases. However, the NGA-comprehension subtest consists of 71 items, the TROG-2 of 80 items, and the Token Test of the AAT of 50 items. Content wise, both the TROG-2 and the Token Test cover complex linguistic segments arranged by item difficulty.

An alternative explanation addresses differences in improvement of receptive and expressive tasks, either because of different levels of impairment on the individual level, different rehabilitation potentials concerning time, or a combination. The data in the present study does not provide sufficient answers on this subject. Brain imaging studies may yield relevant information based on different activation levels for speech production and comprehension. On the other hand, a difference in speech production and comprehension processes argues against an overall general recovery processes as assumed for the case of spontaneous recovery (Pedersen et al., 2004).

In theory, the influence of spontaneous recovery should be observed across all areas of deficit. Results from the Copenhagen Aphasia Study (Pedersen et al., 2004) support this hypothesis by finding no explicit difference in the recovery process for comprehension and speech production (spontaneous speech, naming) within the first year post-onset. However, these results must be interpreted cautiously, since there is no description of the amount and content of speech and language therapy given to the participants in the Copenhagen Aphasia Study (Pedersen et al., 2004).

Furthermore, when differences in early rehabilitation of comprehension and speech production were reported in older studies (e.g. Kenin & Swisher, 1972; Vignolo, 1965), these seem to be in favour of improvement of comprehension, contrary to the results from the presented CILT cases in this study. Lomas and Kertesz (1978) reported varying results regarding spared comprehension skills, with overall language improvement for persons with high comprehension scores and improvement on comprehension and imitation for persons with low comprehension measures. Reinvang and Engvik's (1980a) study of recovery three

to six months post-onset with limited aphasia treatment reported general improvement for fifty percent of the participants, while the other half showed more varying and specific changes on the language modality measures of the NGA. Importantly, none of those studies evaluated changes within a 10-day treatment perspective. Hence, further studies are warranted to investigate the comprehension-speech production difference and thereby gain more knowledge about the different processes in early aphasia rehabilitation (cf. Research area *d*).

While discussing a possible effect of generalisation of CILT to other areas, a comment has to be added to the discussion of the results comparing expressive verbal speech tasks with receptive tasks and writing. In Paper I (Kirmess & Maher, 2010, p. 731), the following is proposed: *"Assuming that verbal and written word retrieval activates some of the same language processes in the brain, writing can be viewed as a non-equivalent dependent variable, which should not change with CILT, but which has similar threats to internal validity as spoken language (Shadish et al., 2002)."* However, this assumption has to be more distinguished dependent on what causes the deficits in the writing process. If the process of general word activation (i.e., to know what to write) is the difficulty, enhanced activation processes as focused on with CILT may prove helpful for word activation independent of the written or oral output. However, if the deficits are orthographically or physically based (e.g., problems with hand movement), CILT is not expected to have a treatment effect on those processes.

6.1.2 Improvement on functional outcome measures

The overall goal of aphasia rehabilitation concerns improvement of functional communication (Kelly et al., 2010; Thompson & Worrall, 2008). As described in the introduction of the frame of the thesis, measuring of this complex term is difficult to operationalise. Hence, indirect measures (e.g., qualitative data in text production analysis, participant experiences, outcome measures for communication provided by significant others, and measures of quality of life) provide relevant sources of data collection. According to this, functional outcome measures provide information on the participation and activity level of the ICF model. Findings regarding functional outcome may provide

knowledge about the relevance of the CILT intervention for speech production, consistent with research areas *b* and *d*.

Specific measures of more complex speech production are investigated in Paper II of this thesis, exploring the generalisation effect of the CILT treatment to a conversational interview for three cases. The analysis revealed positive improvement on the assumed measures based on the treatment focus of CILT, which was also supported by medium to large effect sizes. In contrast, results from chronic studies (Faroqi-Shah & Virion, 2009; Goral & Kempler, 2009; Maher et al., 2006) reported mixed outcomes on measures of semi-spontaneous speech (cf. Paper II). However, differences in text type and analytic method may complicate a direct comparison of the studies. Therefore, further research should investigate the interaction of time post-onset and implications for generalisation to spontaneous speech following a CILT treatment.

Further, the present study reveals positive feedback of the participant experience as assessed in the CILT participant experience survey, reported in Paper III. Expectations for the CILT-treatment were met to a high (n=6) or very high (n = 4) degree. In addition, eight out of ten participants reported a high or very high degree of experienced positive changes in their communicative skills following the CILT intervention. Some of the participants also expressed their gratefulness for being part of this new and intensive intervention, which may influence the evaluation responses to be more positively loaded than one would expect for therapy that is applied in a conventional clinical setting. Despite this, the experience of personal improvement still indicates a valuable rehabilitation outcome.

Maher et al. (2006) reported anecdotal descriptions of participant feedback. To my knowledge, to date, no other known study has employed a participant experience survey. Therefore, the data from the CILT participant experience survey provides substantial information for clinical relevance. In addition, they hold information for further adjustment of the CILT structure based on individual preferences and needs (i.e., the form of stimuli material, the intensity and duration, levels of difficulty, as well as extension to other language areas such as reading and writing).

In line with several chronic CILT studies, the present study applied the CETI, a measure of communicative effectiveness provided by significant others of the person with aphasia

(Barthel et al., 2008; Meinzer et al., 2005). All studies reported improvement on the individual and/or group levels but with varying levels of significance. This suggests a change in communicative behaviour by the person with aphasia as observed by a significant other, which implies communicative changes beyond a given treatment setting. Thus, generalisation to functional communication is supported, and the clinical relevance of CILT is acknowledged. However, significant others may also have extraordinary expectations (similar to the person with aphasia) of the outcome of a research study, which may alter their responses in either direction. For future research, additional data based on observation of communicative behaviour in different settings would provide important information on the actual linguistic behaviour.

A self-reported measure similar to the CETI is the Communicative Activity Log (CAL) (Pulvermüller et al., 2001). CILT studies that included the CAL, reported improvements post-intervention (Barthel et al., 2008; Meinzer et al., 2005).

6.1.3 Long-term outcome

An intervention effect within aphasia rehabilitation is of limited functional and clinical relevance if there is no outcome stability to a certain degree (Tompkins et al., 2008). Long-term outcomes for the present study are reported in Paper III, indicating outcome stability and even continued improvement on at least one language measure for all participants. On the group level, the improvement on the overall outcome measure showed continued significant improvement at the follow-up. Therefore, there do not seem to be negative consequences of early intervention with CILT, at least for this sample. However, the majority of participants continued with conventional speech and language therapy after the CILT intervention, and therefore, outcome interferences cannot be excluded or controlled for in this study.

By coincidence, two of the participants did not receive any more speech and language therapy following the CILT intervention, and therefore acted as their own control. These two cases (LL and MX), discussed in Paper III, revealed opposite patterns. LL showed a slight decline at follow-up, whereas MX showed continued improvement. In addition to age, type of stroke and aphasia severity, one of the factors that may influence the long-term outcome of these cases may concern the impact of living in an environment that offers multiple

communicative settings. MX was encouraged by his significant others to discuss all aspects of social life, whereas LL lived alone with limited opportunities to talk to other persons. This supports the theoretical underlying of the principle 'use it or lose it', where experience-dependent language use is assumed fundamental to improve and even maintain a function. Thus, the findings in this study indicate a scholarly contribution.

On the other hand, chronic studies show mixed results for long-term outcome stability, depending on the time schedule of the follow-up measure and certain CILT-treatment structures. Maher et al. (2006) reported maintenance and improvement one month post-CILT intervention. Similarly, Barthel et al. (2008) presented continued improvement results on a six-month follow-up. In contrast, Meinzer et al. (2005) reported follow-up stability only for the CILT group that had extended homework and involved significant others to a higher degree than other CILT studies. Even so, the latter outcome holds implications for the extension of the CILT treatment into the home environment for further generalisation of the treatment effect to everyday communication. Neuroscientific research indicates the positive influence of the enriched and known environment on brain plasticity, which would support such a home-based rehabilitation effort (Raymer et al., 2008).

6.1.4 The capability of participating in an intensive treatment

Informal feedback by participants with aphasia as well as the treating speech and language pathologist left the impression that having a treatment schedule of a few weeks seems to be appealing for the participants (cf. Participant comment referred in Paper III "I like to come and do a job."). That is, participants saw the CILT intervention as a form of work obligation with clearly defined evaluation goals for a given period. Further, observations from clinical CILT groups imposed the assumption that some persons benefit from the group experience as well as from the strict CILT groups in order to extend their communicative activities to areas outside a therapeutic setting.

Previous studies of acute aphasia rehabilitation have questioned if persons with aphasia were capable of attending more than two hours of speech and language therapy a week before the end of ten weeks post-onset (Lincoln et al., 1984), or showed mixed results (Bakheit et al., 2007). The findings in the present CILT study demonstrated that intensive treatment is applicable as early as five weeks post-onset (cf. Research area *b*). Responses from the

persons with aphasia themselves to the CILT participant experience survey in this study revealed individual preferences for daily treatment duration, but some participants even asked for more hours of CILT treatment. However, considerations of stamina and overall health status have to be made for each individual in line with general professional ethics. Further, since stroke is a life-changing incident, speech and language therapy in the first time following a stroke may focus on information about aphasia and supportive counselling for the person with aphasia and his or her significant others (Holland & Fridriksson, 2001).

Some adjustments in timing and location may be necessary in order to arrange the best stimulating environment for the person with aphasia. Bersano, Burgio, Gattinoni, and Candelise (2009) contend that strokes with aphasia are often more severe than those without aphasia. Therefore, more complex stroke rehabilitation is expected for this population, and co-operation with the interdisciplinary team and the family is fundamental for a holistic approach to the person's needs.

6.1.5 The relevance of personal characteristics for the treatment outcome

The degree to which the characteristic and severity of aphasia influence the possible amount of change is discussed across disciplines. Persons with mild aphasia and high pre-test scores may be limited in their measure of improvement by ceiling levels of tests. On the other hand, persons with very severe aphasia (e.g., GA) might show a higher degree of improvement, taking into account the low pre-test scores and the greater rehabilitation potential implied by this (Moss & Nicholas, 2006).

In general, reported outcome expectations and measures based on aphasia severity differ. Sarrno and Levita (1979) report better outcome changes for fluent speakers with aphasia compared to persons with severe aphasia for the first six months post-onset, whereas the opposite pattern was observed for the following six months. On the contrary, the study by Laska, Hellblom, Murray, Kahan, and Arbin (2001) shows the best improvement potential for severe aphasia within the first three months but demonstrates a general improvement potential for all types of aphasia measured until 18 months post-stroke. Strokes resulting in aphasia are described as more complex and, hence, often represent a higher mortality (Bersano et al., 2009; Tsouli, Kyritsis, Tsagalis, Virvidaki, & Vemmos, 2009).

Tsouli et al. (2009) suggest aphasia severity as a prognostic tool for short and long-term outcome for language measures as well as general stroke disability outcome. On the contrary, Lazar and Antoniello (2008) conclude that aphasia outcome prognosis based on severity in the early stages alone is not a reliable measure because of large individual differences. Following this argument, a general rehabilitation potential is suggested for stroke survivors, but prediction of long-term outcome is restricted (Carter et al., 2010). The degree to which rehabilitation offers based on initial aphasia severity can be accepted requires strong ethical consideration. Furthermore, motivation seems to be one of the most relevant factors for a positive treatment outcome, independent of aphasia severity (Shill, 1979). This is of certain importance in an intensive and demanding treatment such as CILT.

Apraxia of speech is an additional speech deficit observed in a great number of aphasic speakers (Wambaugh, 2009). The CILT intervention does not emphasise a special treatment of apraxia of speech. However, the individual stimulation and scaffolding by the speech and language pathologist as well as frequent repetition of tasks at a limited but interchangeable set of difficulty levels seem to have a positive impact on apraxia of speech. In Paper III, aspects of the improvement of apraxia of speech are discussed (e.g., as observed in the positive outcome on the task of reading aloud). Based on the cases in this study (e.g., MX compared to DS), it seems advantageous to have a certain degree of speech production abilities preserved in order to benefit the most from the treatment. This includes knowledge about oral motor positioning in sound production. However, DS showed significant improvement at the follow-up. Hypothetically, although not confirmable in this study, the early intervention may prevent the learned-use of compensatory strategies and thereby allow participants to retain access to re-activation of the processes involved in speech production (Taub et al., 2006).

Helm-Estabrooks (2000) contend that for rehabilitation and treatment outcome, the interaction of language with cognitive skills such as attention, concentration, memory, and visual spatial function has to be considered. Apparently, outcome prognoses for aphasia seem to improve the more cognitive skills are spared and intact. RD exemplifies a case where memory deficits and reduced skills of new learning may influence outcome of the CILT treatment within a two-week perspective. However, over the long-term recovery process, her results improved even on the follow-up measures of the CILT-baseline.

6.2 The CILT application on the systemic level

One purpose of the present study was to apply the CILT treatment to the Norwegian speech and language therapy clinical practise of aphasia rehabilitation (cf. Research areas *a* and *c*). The defined structure of the CILT intervention allows application and adjustment in a clinical setting. However, the Norwegian aphasia rehabilitation system meets challenges with the organisation of this type of intensive therapy. Even though the national stroke rehabilitation guidelines support and encourage an aphasia therapy amount of at least five times a week to gain a certain effect, this is so far not legally established, and no suggestions are presented on how to accomplish this in the geographically spread Norwegian population (cf. Helsedirektoratet, 2010). Further, feedback from several CILT introductions to speech and language pathologists employed by the community within adult education (*Voksenopplæring*) reveal at least some limitations by their school-year-based timetable structures and, hence, restricted flexibility to carry out aphasia treatment with higher intensity, even for shorter periods of time.

Acknowledging these issues of timetables, transport, and personal availability for a group setting, an inpatient rehabilitation format seems to meet the demands of the intensive schedule more easily than outpatient services. Based on feedback from other clinical speech and language pathologists as well as personal experience, support to fulfil a started intensive treatment schedule before discharge of the person with aphasia would be preferable in rehabilitation units. Otherwise, interventions are easily postponed because of the insecurity of the length of stay (hospitalisation) and effort-outcome balance for both the person with aphasia as well as the speech and language pathologist. Contrary to this argumentation, prolonged inpatient stays interfere with medical care goals of reduced hospitalisation and rehabilitation in the home environment.

The involvement of clinical speech and language pathologists during the study had the advantage of continuously provided feedback of the CILT-treatment structure for the clinical practise as well as further implementation of the CILT methodology in the clinical field. Of the co-operating speech and language pathologists, the majority reported to have applied parts of the CILT principles or the treatment material to rehabilitation programs with some of their clients, including extending the CILT structure to other areas (e.g., writing). In

addition, based on previous CILT research for persons with chronic aphasia and the availability of the Norwegian material, one rehabilitation hospital has incorporated the CILT method into a complex intensive aphasia rehabilitation program.

6.3 Implications for clinical application and aphasia rehabilitation

On the philosophical level of rehabilitation science, the most important question addresses if and how a rehabilitation therapist can be sure to provide the best treatment for the person in need (Malec, 2009). The application of evidence-based practise concerns a growing area of interest within rehabilitation science and aphasia, but so far, results are limited (Cherney et al., 2008; Cicerone et al., 2000). Malec (2009) addresses some of the disadvantages of evidence-based practise. That is, not all rehabilitation programs are best studied through randomised control trials. Generalisation of randomised control trials may be limited and clinical application thereby restricted. Further, individual preferences and differences may be unattended, and non-specific effects can be missed. In the case of aphasia, neither randomised control studies nor single-subject studies alone provide sufficient knowledge to fit the needs of the population (Moss & Nicholas, 2006).

Concerning the heterogeneity of the aphasia population and evidence-based procedures, Nickels (2002) concluded that the prediction of treatment outcome for a specific person is still very restricted, despite an increase in positive outcome efficacy studies (e.g., in word production). These results are supported by a recent meta-analysis (Wisenburn & Mahoney, 2009) that emphasised the influence of additional skills (e.g., cognitive, linguistic, etc.), general health situation, state of mind, learning style, and the like on the evaluation of treatment potential.

Wisenburn and Mahoney (2009) proposed two methodologies to investigate the best treatment on the individual level in aphasia: either a series of single case studies where everybody participates in the same treatment program or one individual undergoing several treatment programs. The present CILT study fits into the first category with a given treatment structure that is applied to persons with different degrees of aphasia and presenting various individual characteristics. The CILT study by Kurland et al. (2010) addresses a

design within the second category. The methodological challenge with multiple treatments for one person concerns the influential factor and learning effect from one treatment to the other (the so-called order effect) (cf. Tompkins et al., 2008). In the Kurland et al. study (2010), a program of CILT was followed by a program of PACE. Thus, the person with aphasia had first acquired a therapy form requesting solely verbal expressive speech, which thereafter was followed by an approach favouring total communication, where speech is one element of choice. Therefore, it may be difficult to distinguish possible long-term effects from newly gained skills (i.e., an order effect).

In addition, most therapies involve more than one therapeutic process. In other words, it is difficult to extract exactly which factors are actually contributing to the effect in general and for each individual. Concerning the CILT treatment, several studies have addressed the complex components of the study in order to investigate their outcome relevance. Maher et al. (2006) controlled for the effect of intensity by comparing two treatment programs that just differed in the language modality in which communicative responses were accepted (verbal versus total communication). Results still revealed a better outcome for CILT than for PACE. Barthel et al. (2008) compared a model-oriented approach (MOAT) to CILT. MOAT involves the same intensive treatment structure and applies the principle of shaping but differs from CILT by setting (i.e., individual instead of group) and involves individual-based treatment for specific speech-production deficits. Results revealed improvement for both groups immediately post-intervention and at follow-up on language measures and rating of everyday communication. The Barthel et al. study (2008) focused on the contribution of the MOAT program rather than CILT, thereby making implications on the necessity of the constraint setting to verbal communication and a group setting. Their results support the application of individual-based intensive treatment.

However, the advantage of the CILT structure beyond the principles of intensity, massed practice, and shaping concerns the interactional focus of the communicative act and the relevance of natural situations as described by Pulvermüller and Berthier (2008). Pulvermüller and Berthier (2008) refer to Wittgenstein's philosophy of the relation of language to interaction, the relevance of speech acts, and language games, which also has references to the considered superiority of verbal communication for conveying detailed information. Hence, the degree of relevance of the communicative exchange for the

individual will influence the effort that is made to produce an utterance. The card game activity often applied in the CILT setting is described as a typical request communication. Despite the relevance of the task, a group setting is still assumed to present a more natural interaction setting than an individual therapy setting with the speech and language pathologist (Elmann & Bernstein-Ellis, 1999). The group setting may contribute further external factors to the complex rehabilitation setting, which may influence the optimal outcome of functional communication (e.g., group identity and self-esteem). However, these factors have to be further investigated.

Furthermore, Pulvermüller and Berthier (2008) demonstrate the lasting or renewed relevance of the connection of language and action in neuroscience and network activation in the brain. This illustrates parallels to the previously described principle of experience-dependent brain plasticity (Kleim & Jones, 2008)—a person has to use a skill within a specific setting to improve neuronal activation and enhance behavioural outcome. Carter et al. (2010) support the importance of being an active communication partner for best therapy outcome. This is acknowledged in the CILT-program structure.

To summarise, the CILT structure provides important implications for clinical application in aphasia rehabilitation based on the principles of intensity, massed practice, shaping, and relevant communicative treatment settings. On the other hand, the relevance of the constraint setting per se to certain language modalities as well as timing and duration in real clinical settings has to be further investigated in line with translational research (Cherney et al., 2008; Kelly et al., 2010; Raymer et al., 2008).

The present doctoral thesis contributes with new knowledge concerning the application in early aphasia rehabilitation and within a clinical setting (Papers I and III). Hence, the study offers specific implications for application of a CILT-program in speech and language therapy. The application of text analysis (Paper II) suggests additional informative measures of treatment outcome, which may be useful in clinical practise, especially for cases where tests may not be sufficient. For example, MX reached a ceiling level on the NGA quite early in his rehabilitation progress but showed continued improvement on oral text production. Further studies are warranted to replicate and extend these preliminary research results, where the balance between the methodological threat of spontaneous recovery in early

rehabilitation and the clinical relevance of research conducted in a chronic phase should be addressed.

6.4 Concluding remarks

At the beginning of this study, the main concern was related to the persons with aphasia and their capability to attend an intensive speech and language treatment schedule such as the CILT intervention in early rehabilitation. Acknowledging the small sample, outcome results indicate that CILT is applicable in early aphasia rehabilitation presuming that the person is motivated for this type of extensive treatment, has appropriate cognitive skills to benefit from the treatment, and has a supportive rehabilitation plan respecting the multi-professional team involved in stroke rehabilitation.

During the research process, the focus of applicability has been extended from the individual-based factors to the challenges of integrating such an intensive treatment program into existing public aphasia rehabilitation offers. This was illustrated by difficulties of recruiting for and conducting this study as well as by feedback on presentation of the CILT principles to Norwegian speech and language pathologists. Thus far, further clinical application of CILT seems to be restricted by a complicated rehabilitation system for aphasia dependent on both health and educational rights. Despite those challenges, a few rehabilitation institutions offer CILT-based speech and language therapy as part of their varied rehabilitation programs. Thus, CILT has already made an impact in Norwegian aphasia rehabilitation. However, in order to approach the guidelines in stroke rehabilitation concerning intensive speech and language therapy offers for aphasia (Helsedirektoratet, 2010),future evaluation on the systematic level seems necessary.

CILT presents a rather new treatment in a constantly developing rehabilitation research field. Throughout this frame of the thesis and the papers, areas of further research interest have been discussed with suggestions for methods suitable for the aphasia population. To conclude, further studies that investigate optimal aphasia rehabilitation and timing for best short-term and long-term outcome are warranted.

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Appendix A Personal and medical history

Original Norwegian version with English translation in Italics.

Fyll ut så nøyaktig som mulig. Ettersendt eventuelt informasjon som måtte fremkomme som relevant under prosjektperioden. Ikke benytt navn eller personnummer!
Please, complete as detailed as possible. If necessary, forward any additional information throughout the intervention period. Do not use names or personal ID numbers.

Personlige opplysninger *Personal background*
1. Sted for deltagelse (anonymisert) *Institution (depersonalized):*_____
2. ID-nr: *ID number*: _____
3. Født (Årstall)*Year of birth*:_____
4. Kjønn *Gender:*_____
5. Utdannelse - antall år *Years of education:*_____
   Hvis usikkerhet om antall år, kan det noteres høyeste utdannelse, for eksempel folkeskole, universitet osv. *If years of education is unknown, report highest educational level*:____
6. I jobb før det aktuelle *Pre-stroke employement*: Ja *Yes* □ Nei *No* □

Språk *language (pre-stroke):*
7. Morsmål *Mother tongue:* _____
8. Andre språkkunnskaper *Foreign languages:*_____
9. Tidligere forstyrrelse av tale, lesing eller skrift? Ja □ Nei □ Ukjent □
   Previous disorders of speech, reading, or writing? Yes □ No □ Unknown □
   Eventuelt hvilke *If so, which*:_____
10. Hendthet *Handedness:* _____
11. Hørsel *Hearing* _____
12. Syn *Vision*: _____

Medisinsk status *Medical history*:
13. Syk, dato *Date of strok:* _____
14. Førstegangs hjerneslag? *First time stroke?* Ja *Yes* □ Nei *No* □
15. Diagnose *Diagnosis:*_____
16. Lokalisering av cerebral skade *Location of the brain injury:* _____
17. Lateralisering av cerebral skade *Laterality*:
    Høyre *Right* □Venstre *Left* □ Bilateral *Bilateral* □ Ukjent *Unknown* □
18. Tilgang til røntgenbilder ved behov *Available brain images*: Ja *Yes* □ Nei *No* □
19. Tidligere skader/sykdom av sentralnervesystem: Ja □ Nei □ Ukjent □
    Additional pre-stroke neurological diagnosis: Yes □ No □ Unknown □
Hvis ja, hva *If so, which:*_____

20. Andre relevante medisinske opplysninger *Additional relevant medical history:*
_____

Status etter det aktuelle *Medical history post stroke*

21. Kognitive vanske *Cognitive deficits* : Ja Y*es* □ Nei *No* □ Ukjent *Unknown* □
    Hvis ja, hvilke *If so, which:*_____
    _____
22. Apraksi *Apraxia*: Ja *Yes* □ Nei *No* □
    Hva *Which*: Motorisk *Motor* □ Oral *Oral motor* □ Tale *Apraxia of speech* □
23. Svelgevansker *Dysphagia*: Ja *Yes* □ Nei *No* □ Ukjent *Unknown* □
    Kommentar *Comments:*_____
24. Dysartri *Dysarthria*: Ja *Yes* □ Nei *No* □ Ukjent *Unknown* □
    Kommentar *Comments*:_____
25. Synsvansker *Visual impairment*: Ja *Yes* □ Nei *No* □ Ukjent *Unknown* □
    Kommentar Comments:_____

Pareser *Paresis*

26. Arm *Upper extremities:* Høyre *Right* □ Venstre *Left* □
    Kommentar *Comments*:_____
27. Ben *Lower extremities*: Høyre *Right* □ Venstre *Left* □
    Kommentar *Comments*:_____
28. Ansikt *Facial*: Høyre *Right* □ Venstre *Left* □
    Kommentar *Comments*:_____
29. Tunge/svelg *Tounge/pharynx:* Ja *Yes* □ Nei *No* □
    Kommentar *Comments:*_____
30. Mobilitet *Mobility*:_____

Logopedisk eller annen form for språklig relatert tilbud i perioden fra innleggelse til deltagelse i CIST – prosjekt

Speech-language therapy or communication related offers pre-CILT intervention:

31. Hva (for eksempel metode, gruppe, individuell, hvem) *What (e.g., approach, group, indiviual):*_____
_____
32. Omfang (antall timer og hyppighet) *Amount (number of treatment hours, intensity*):
_____
33. Kort beskrivelse av språklig funksjon fra innleggelse *Short report of post-onset language function* :_____
_____
34. Eventuelt kontaktperson for videre opplysninger *Contact person for additional information*:_____

Appendix B Informed consent letter, example

UNIVERSITETET I OSLO
DET UTDANNINGSVITENSKAPELIGE FAKULTET
Institutt for Spesialpedagogikk
Postboks 1140 Blindern
0318 Oslo

Høst 2008

Forespørsel om å delta i forskningsprosjektet
CIST: bedring av tale ved afasi

Til personen med afasi.

Mitt navn er **Melanie Kirmess.**

Jeg er **logoped.**

Jeg jobber som stipendiat ved **Universitetet i Oslo.**

Jeg **forsker** på **afasi.**

Prosjektets navn: **CIST - bedring av tale ved afasi.**

Hva er CIST?

= forkortelse for constraint induced språkterapi

= bygger på ny teori om hjernens plastisitet og aktivering/stimulering

= intensivt program for taletrening

Formål med prosjektet:

Jeg ønsker å vite om

CIST – Virker det? JA NEI

UNIVERSITETET I OSLO

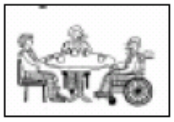
DET UTDANNINGSVITENSKAPELIGE FAKULTET

Hvem passer det for? > Afasirammede med talevansker


> 4-9 uker etter hjerneslag

> Individuell evaluering med logoped

Hvordan foregår **CIST?**



- 2-3 afasirammede i en **gruppe med logoped**
- **Intensiv trening: 3 timer daglig i 10 dager**
- **Kartlegging før** og **etterpå,** samt **etter 3 måneder**
- **Lokalt**

Jeg lærer opp logopeder. Din kontaktlogoped er:_____

Kriterier for deltakelse – oppfylles de?

Ja => CIST program

Nei => kontrollgruppe

Kontrollgruppe = vanlig behandling, samme kartleggingsprosedyre.

Når skjer CIST? > våren 2009

Data analyseres og oppbevares frem til 2015, for å bevare mulighet for oppfølging over tid. All data makuleres senest deretter.

Video

Det tas opp **video** under **kartlegging** og **deler av CIST-programmet.**

= behov for eget **samtykke**.

UNIVERSITETET I OSLO

DET UTDANNINGSVITENSKAPELIGE FAKULTET

Deltagelse

- ✔ **Frivillig**
- ✔ **Krever samtykke**
- ✔ **Konfidensielt**

- ✔ **Rett til å trekke seg:**

> du **kan stoppe** når som helst

> det er **ok** å trekke seg

> tidligere **informasjon** vil **slettes**

Data **avidentifiseres** og **oppbevares** etter forkskrift for konfidensielt materiell tilknyttet Institutt for Spesialpedagogikk.

- ✔ Prosjektet er **tilrådd** av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS og
- ✔ **godkjent** av Regional komité for medisinsk forskningsetikk Sør B.

? Hvis du har **spørsmål** til prosjektet, ta gjerne **kontakt** med **meg personlig.**

Du kan også **spørre** din **kontaktlogoped.**

Takk for din interesse!

Med vennlig hilsen

Melanie Kirmess

Telefon: 22 85 80 48 (jobb), 95 12 91 42 (mobil),

E-post: melanie.kirmess@uv.uio.no

UNIVERSITETET I OSLO

DET UTDANNINGSVITENSKAPELIGE FAKULTET

Erklæring om samtykke

Opplysningene på de foregående sidene har blitt **forklart.** JA

Jeg **samtykker** i å delta i prosjektet **CIST** – Bedring av tale ved afasi.

JA NEI

Jeg **samtykker** om at det kan **filmes** med **video**.

JA NEI

Jeg **samtykker** om at **videoopptak** kan **brukes utover** prosjektperioden

- **i fremlegg av forskningen** JA NEI
- **i undervisning** JA NEI

Jeg har fått en **kopi** av dette skjemaet.

JA NEI

Underskrift av deltaker _____ Dato_____

Underskrift av pårørende/vitne_____Dato_____

Skjemaet returneres ferdig utfylt i vedlagt konvolutt til prosjektansvarlig Melanie Kirmess.

Appendix C CILT intervention structure

Appendix table 1 CILT intervention structure

Level	Material	Description	Expected request	Expected response
1	Picture set with pairs of cards	Single word naming. Preferable using intonation for indication of an interrogative phrase.	*Naming* of the pictured object" e.g."Bread?"	"Yes/no + naming" e.g."Yes, bread" " No bread"
2	Picture set with pairs of cards	Addressing the other player by name, interrogative phrase including naming of object	"Name, do you have a *naming*? e.g. "Jane, do you have bread?	"Yes/no, name, I do/don`t have a *naming*. e.g. "Yes, Pete, I have bread.""
3	Each object is in addition displayed in two versions.	Addressing the other player by name, interrogative phrase including naming of object and differentiating from the other possibility by adding an adjective/adverb.	"Name, do you have a description *naming*? e.g. "Jane, do you have toasted bread?	"Yes/no, I do/don`t have description *naming*. e.g." Yes, Pete, I have toasted bread"
4	Each object is in addition to level 3 displayed in two different amounts	Addressing the other player by name, interrogative phrase including naming of object, an adjective/adverb and an amount.	"Name, do you have an amount of description *naming*? e.g. "Jane, do you have 2 (slices) of toasted bread?"	"Yes/no, I do/don`t have an amount of description *naming*. e.g."Yes, Pete, I have 2 (slices) of toasted bread."

Appendix table 2 Colour coding for levels of difficulty

Frequency	Level 1	Level 2	Level 3	Level 4
High-frequent	Yellow	Yellow	Red	Blue
Low-frequent	Pink	Pink	Green	White

Appendix D Overview over picture stimuli material

Appendix table 3 High frequency - Persons

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Kvinne 'woman'	11108	10	4	6530	Young, old, smiling	1 & 2
Mann 'man'	8943	14	60	855	Young, old, thinking	1 & 5
Politi/politimann 'policeofficer'	5805	32	31	1327	English, tall, young	2 & 3
Jente 'girl'	4659	48	61	843	Playing, blond	1 & 2
Gutt 'boy'	2304	150	49	986	Playing, sitting	1 & 5
Lege 'doctor'	1835	215	16	2127	Male, female	1 & 5
Lærer 'teacher'	1479	298	123	497	Male, female	1 & 2
Advokat 'lawyer'	1182	392	1	16302	Standing, walking	1 & 3
Sykepleier 'nurse'	447	1152	1	21593	Male, female	1 & 2
Baby, 'baby'	158	2979	15	2163	Sleeping, smiling	1 & 2

Appendix table 4 High frequency – Food

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Vann 'water'	2830	109	117	516	Blue, green, fresh	1 & 3
Egg 'egg'	1099	432	17	2009	Boiled, raw, broken, whole	1 & 6
Melk 'milk'	902	547	22	1684	A glass of, a bottle of, light	1 & 2
Fisk 'fish'	784	638	30	1358	Small, large, fresh, boxed	1 & 2
Brød 'bread'	518	997	38	1174	Fresh, toasted	2 & 5
Kaffe 'coffee'	475	1093	150	442	Black, white, with milk	1 & 3
Kake 'cake'	444	1156	17	2010	Small, large, yellow, round, high	1 & 3
Potet 'potato'	313	1650	1	18053	Green, brown	3 & 9
Ost 'cheese'	219	2257	13	2444	Small, large, round, triangular	1 & 3
Te 'tea'	n.a.	n.a.	21	1743	Boiled, bag, blue, with lemon	1 & 6

Appendix table 5 High frequency - Personal belongings

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Pass' passport'	853	581	22	1692	Red, blue	1 & 2
Ring 'ring'	490	1052	29	1385	Small, large, gold, diamond	1 &2
Sko 'shoe'	483	1073	36	1207	Brown, red, ladies,	2 & 1
Vest 'waistcoat'	345	1498	64	798	Green, red, military	2 & 1
Kamera 'camera'	314	1642	22	1690	Small, large, digital, black	2 & 1
Mobil telefon 'cell phone'	251	2000	5	5240	Open, closed	2 & 3
Hatt 'hat'	240	2075	428	198	Black, red, cowboy	1 & 3
Skjorte 'shirt'	175	2734	5	4647	White, blue	1 & 2
Skjørt 'skirt'	170	2809	10	2908	Pink, grey, short	1 & 2
Kjole 'dress'	166	2866	18	1927	Light, green, white	1 & 2

Appendix table 6 High frequency - Home and house

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Avis 'newspaper'	3234	89	5	4944	Large, small, today's	2 & 5
TV 'tv'	2077	169	144	453	Old, new, widescreen,	1 & 2
Lys 'candle'	1898	197	47	1011	Pink, red, flaming	3 & 3
Radio 'radio'	699	718	15	2239	Old, new, brown	2 & 2
Toalett 'toilet'	318	1628	34	1260	Old, modern, white,	2 & 2
Ttrapp 'stairs'	318	1631	6	4588	Wooden, stone, brow	1 & 2
Kniv 'knife'	298	1732	12	2515	Small, large, share	1 & 3
Skap 'wardrobe'	283	1808	17	2023	Brown, green, closed, open	1 & 3
Saks 'scissor'	213	2311	5	4680	Blue, silver, grey	2 & 3
Panne 'pan'	212	2319	0	-	Black, large, with handle	1 & 2

Appendix table 7 High frequency - Transportation

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Fly 'plane'	1676	250	52	947	Blue, white	1 & 6
Skip 'ship'	1613	263	3	7570	Old, modern, cruise ship, cargo	1 & 2
Båt 'boat'	1204	383	63	827	Small, red, yellow, stranded	1 & 2
Buss 'buss'	813	618	108	540	Red, white, modern, old, English	1 & 2
Tog 'train'	542	952	37	1193	Red, black, old, modern	2 & 1
Sykkel 'bicycle'	399	1291	33	1285	Red, black	1 & many
Helikopter 'helicopter'	353	1465	2	8581	Yellow, white, model, real	1 & 2
Ferge 'ferry'	341	1513	2	10854	Large, small, grey, blue	1 & 3
Trikk 'tram'	188	2573	24	1576	Yellow, red, short, long	3& 2
T-bane 'subway'	1227	374	24	1568	Blue, grey, light blue	1 & 2

Appendix table 8 High frequency - Buildings

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	No amounts
	Freq.	Rank	Freq.	Rank		
Kirke 'church'	5262	39	40	1133	Little, large, white, grey, stone	
Hus 'house'	3826	67	208	327	Large, light, nice, expensive, yellow	
Sykehus 'hospital'	3154	95	22	1682	Modern, drawing, red light	
Bank 'bank'	2493	133	24	1583	Modern, vault, cash dispenser	
Teater 'theatre'	1394	320	27	1475	Modern, large, red, small	
Butikk 'shop'	1089	437	28	1431	Little, old, new, black/white	
Stadion 'stadium'	1044	453	13	2410	Old, new, stone, soccer, public	
Museum 'museum'	705	709	10	2962	Modern, glass, old, stone	
Hytte 'cabin'	521	990	80	677	Small, large, wooden, drawing	
Restaurant 'restaurant'	417	1247	7	3797	Little, simple, expensive, decorated	

Appendix table 9 Low frequency - Persons

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Baker 'baker'	71	6040	11	2799	Male, female, home, industrial	1 & 3
Servitør 'waiter'	70	6154	1	18916	Male, female	2 & 2
Ffrisør 'hair dresser'	69	6193	17	2003	Male, female, old time, modern	1 & 2
Sjømann 'sailor/seaman'	62	6786	1	13710	Young, old, white, blue, bearded	1 & 3
Hjemmehjelp 'home care/ maid'	57	7240	0	-	Young, pink, orange, tidy, crowded	2 &2
Apoteker 'pharmacist'	53	7648	0	-	Male, female	1 & 2
Postmann 'postman'	41	9493	2	8791	Young, old, brown, blue	1 & 2
Ergoterapeut 'occupational therapist'	11	27028	0	-	Male, female, testing, kitchen	1 & 2
Logoped 'speech and language pathologist'	6	44376	1	20089	Female, talking, assessing, testing	1 & 2
Fysioterapeut 'physical therapist'			1	24036	Blue, green, walking, massaging	1 & 2

Appendix table 10 Low frequency - Food

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Pasta / nudler 'pasta'	71	6071	1	17406	Dried, fresh, cooked	1 & 2
Skinke 'ham'	67	6371	0	-	Pink, grey, smoked, pear formed	1 & 2
Pære 'pear'	68	6288	0	-	Yellow, green	1 & 2
Syltetøy 'jam'	63	6709	4	6005	Red, yellow	2 & 3
Hamburger 'hamburger'	55	7460	3	7415	Large, small, brown, green	2 & 2
Paprika ' sweet pepper'	55	7497	1	14343	Yellow, red	1 & 2
Vaffel 'waffle'	52	7879	4	6541	Norwegian, Belgian, heart, square	3 & 3
Sitron 'lemon'	49	8220	9	3146	Whole, half	2 & 2
Krabbe 'crab'	48	8314	12	2553	Red, blue	2 & 2
Kirsebær 'cherries'	41	9835	0	-	Red, black	2 & 3 (pair)

Appendix table 11 Low frequency - Personal belongings

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Bluse 'blouse'	63	6635	2	10541	White, red, with a bow	2 & 4
Kredittkort 'credit card'	60	6965	0	-	Gold, silver, blue	2 & 2 (4)
Bag 'bag'	56	7320	3	6883	Brown, green, open, closed	2 & 3
Frakk 'coat'	50	8039	1	14431	Red, green, with stripes	1 & 2
Videokamera 'video camera'	49	8249	2	11885	Large, small, silver	1 & 2
Ryggsekk 'backpack'	48	8364	2	11020	Large, small, green, red	3 & 2
Undertøy 'underwear'	44	9017	2	8717	Pink, blue	1 & 2
Vott 'mitten'	43	9199	0	-	Pink, blue, large, padded	3 & 2
Medalje 'medal'			4	5547	Gold, silver,	2 & 3
Kompass 'compass'	40	9657	1	19281	Old, modern, grey	2 & 1

Appendix table 12 Low frequency - Home and house

Stimulus word (Level 1& 2)	Written corpus		Spoken corpus		Properties (Level 3)	Amount (Level 4)
	Freq.	Rank	Freq.	Rank		
Stige 'ladder'	71	6094	1	17576	Brown, silver, metal, wooden,	3 & 2
Ledning/ kabel 'cord,cable'	70	6132	5	4778	Black, round, red, snapped	1 & 2
Garasje 'garage,car port'	68	6265	15	2201	Big, small, white, brown	1 & 2
Kalender 'calendar'	66	6432	2	9168	Big, small, monthly,	1 & 2
Håndkle 'Towel'	65	6510	1	24138	Green, yellow, light, hanging	2 & 1
S*piker* 'nail'	62	6792	8	3471	Black, silver, large, thin	2 & 4
Sil 'colander ,sieve'	61	6895	0	-	Green, brown, plastic, wooden	1 & 2
Tallerken 'plate'	56	7401	4	5722	Silver, white, large, serving plate	1 & 4
Grill 'grill'	53	7684	2	10416	Old, modern, round, gas, big	2 & 2
Bokhylle 'bookcase, bookshelf '	54	7555	0	-	Big, small	2 & 3

Appendix E The Norwegian CILT protocol (sample)

Presentasjon av CIST - innholdet: kortspill "Samle par"

Generelt mål er å samle par. Hver deltaker trekker noen kort fra en bunke. Man spør så en av de andre deltakere (også logopeden) om vedkommende har et bestemt kort som matcher med et kort man selv har på hånden. Hvis svaret blir ja, får man kortet og legger paret til siden. Er svaret nei, trekker man et nytt kort. Nytt kort trekkes også når man ikke har flere kort på hånden.

Presentasjon av kortspillets struktur og gjennomføringsmåte

Alle kort foreligger parvis i 10 ulike kategorier og 4 nivåer. Kategoriene deles videre inn i høyfrekvente ord (6 kategorier) og lavfrekvente ord (4 kategorier). Beskrivelsen starter med høyfrekvente ord, men foregår på samme måte for lavfrekvente ord.

Ved oppstart av CIST intervensjonen kan man innlede de første gangene med følgende ord:

"Vi skal nå spille et kortspill. Det finnes to kort av hvert bilde, og målet er å samle par. For å få et kort man mangler, må man spørre en av de andre deltakere om de har det. Dette skal gjøres på en bestemt måte. Du skal si navnet til den du spør, og lage et spørsmål om du kan få det kortet du ønsker. For eksempel kan du gi, har du, kan jeg, etc. - en bil. Jeg begynner, slik at dere kan høre hvordan jeg sier det."

Introduksjon av bildene ved innføring av en ny kategori

Gjennom pilotprosjektet har det vist seg nyttig å vise bildene i en ny kategori til deltakere for å bli kjent med dem. Siden ikke alle begreper er like lett å visualisere kan det være greit å være enig i hva bildet forestiller, eventuelt hva man ønsker å fokusere på. Der det er mulig har afasirammede deltakere selv benevnt bildene, og på den måten ivaretatt ønske om å fremme muntlig tale. Ofte kan det være nok at deltakere gjenkjenner bilde, uten at logopeden nødvendigvis trenger å si ordet. Vises derimot ingen tegn til gjenkjenning hos den afasirammede, benevner logopeden bildet for å etablere en felles forståelse rundt målbegrepet.

Bildesett kan introduseres på følgende måte:

"Vi skal nå bruke en kategori som heter:_ _ _ _. La oss se på bildene for å bli kjent med hva de skal forestille. Hva tror du det kan være? "

Ved behov kan den generelle introduksjonen til hvordan kortspill skal foregå gjentas etter dette.

Appendix F Summary of the assessment protocol

Assessment is carried out over two consecutive days immediately prior and post intervention. All assessment is videotaped.

The following assessment schedule is recommended for all points of assessment (pre- and post-test, follow-up):

Day 1	**Day 2**
NGA –conversational interview	CILT-baseline (second time)
CILT-baseline (first time)	The Cookie theft picture description
Assessment of apraxia of speech	VOST
PALPA	NGA
TROG-2	
Hand out CETI to significant other	At post-test: CILT participant experience survey

Videotapes and copies of the depersonalized test papers have to be posted in separate shipments.

The following check list is provided to enhance complete data submission for the different assessment points:

Pre – test & Follow-up	Post - test
Page A - NGA –conversational interview	Page A - NGA –conversational interview
Page B –CILT-baseline - day 1 Page B – CILT-baseline - day 2	Page B –CILT-baseline - day 1 Page B – CILT-baseline - day 2
Page C- Assessment of apraxia of speech	Page C- Assessment of apraxia of speech
Page D- PALPA	Page D - PALPA
Page E: TROG-2	Page E: TROG-2
Page F: The cookie theft picture	Page F: The cookie theft picture
Page G: VOST	Page G: VOST
NGA	NGA
	Page H: CILT participant experience survey
CETI	CETI
Page I: Personal and medical history (pre-test only)	Protocol summarizing CILT intervention
Video - assessment	Video - assessment
	Video - Daily CILT intervention samples

Appendix G The CILT-baseline form

Norwegian version with examples of scoring

The translated instruction given to the person with aphasia was the following: “I will show you a picture. Can you produce a question about the picture? Your question should include an addressing (my name), a question phrase, the object (in other words what the picture shows), and a property of the object. For example, “Melanie, can you give me red flowers?”

Baseline CILT
Ark B

Navn/ ID:_____ Dato:_____ Pre-test: ☐ Post-test: ☐ Follow-up: ☐ Halvveis dag 5 eller 6: ☐

Testleder:_____ Dag 1 ☐ Dag 2 ☐

Instruksjon: **”Jeg skal vise deg et bilde. Du skal lage en spørresetning om det bilde. Spørsmålet ditt skal innholde en tiltale, en spørreformulering, et objekt dvs. det som vises på bildet og en egenskap av objektet. For eksempel: ”Melanie, kan du gi meg røde blomster?”**

Høyfrekvente ord, 4 ledd.
10 lysegule kort, tilfeldig rekkefølge (fem trente: kamera, sykkel, radio, ost, jente; fem utrente: bilde, traktor, speil, eple, bonde)

Navn	*Melanie* [2]	Melanie[2]	*Melanie* [2]	Melanie[2]						
Spørrefrase	*har du en* [2]	do you have a[2]	*kan du gi meg en* [2]	can you give me a[2]						
Egenskap	*rød* [2]	red[2]								
Objekt	*sykkel*[2]	bicycle[2]	*taktor* [1]	tactor[1]						
Poeng	8	8	5	5						

Skåring: 2 poeng for hvert korrekte ledd, 1 poeng for hvert ledd som er utvetydig, men kan ha artikulasjonsfeil, 0 poeng for ukorrekte svar

Totalpoeng:

Fortsett på baksiden!

For the low frequency words the amount of objects had to be included in the question, too. For example, “Melanie, can you give me 4 red flowers?”

Appendix H CILT-Baseline stimulus pictures

Appendix table 13 CILT-baseline: High frequency

Stimulus word*	Written corpus		Spoken corpus		Properties
	Freq.	Rank	Freq.	Rank	
1.*Jente* 'girl'	4659	48	61	843	Running, playing, blond, dark
2.Radio 'radio'	699	718	15	2239	Old, new, brown, blue
3.Sykkel 'bicycle'	399	1291	33	1285	Red, black
4.Kamera 'camera'	314	1642	22	1690	Small, large, digital, silver,
5.Ost 'cheese'	219	2257	13	2444	Small, large, round, triangular
6.Bonde 'farmer'	1038	456	2	10125	Walking, male, sowing, harvesting
7.Eple 'apple'	180	2667	8	3377	Green, red/yellow
8.Speil 'mirror'	158	2992	3	8451	Small, hand hold, square, large
9.Traktor 'tractor'	208	2362	3	8211	Red, drawn, yellow, bronze
10.Bildet 'picture'	3815	69	45	1037	Black /white, coloured

Appendix table 14 CILT-baseline: Low frequency

Stimulus word*	Written corpus		Spoken corpus		Properties	Amount
	Frequ	Rank	Frequ	Rank		
1.Frisør 'hair dresser'	69	6193	17	2003	Male, female, old time, modern	1 & 2
2. *Pære* 'pear'	68	6288	0	-	Yellow, green	1 & 2
3.*Kalender* 'calendar'	66	6432	2	9168	Big, small, monthly, daily	1 & 2
4.*Bouse* 'blouse'	63	6635	2	10541	White, red, with a bow	2 & 4
5. *Sil* 'colander /sieve'	61	6895	0	-	Green, brown, plastic, wooden	1 & 2
6. *Kjede* 'necklace'	n.a.	n.a.	7	3992	Gold , heart, pearls, white	1 & 1
7.*Trekkspill* 'Accordion'	56	7404	0	-	Old, large, small, blue, red	1 & 2
8.*Langrennsløper* 'cross country skier'	48	8320	0	-	Racer, man, cartoon	1 & 1
9. *Mais* 'corn, maize'	42	9284	0	-	Corns, corn stand, whole, pieces	3 & many
10. *Konvolutt* 'envelop'	67	6353	1	22332	Closed, opened, white, sheet inside	1 & 2

*1-5 = trained, 6-10 untrained

Appendix J The CILT participant experience survey

Original Norwegian version with English translation in Italics.

Open questions:

1. Kan du kort beskrive hva du synes om behandlingsprogrammet? Det programmet vi har gjort de siste 10 dagene. *'Can you tell me what you think about the trainings program? The program we have used the last 10 days.'*

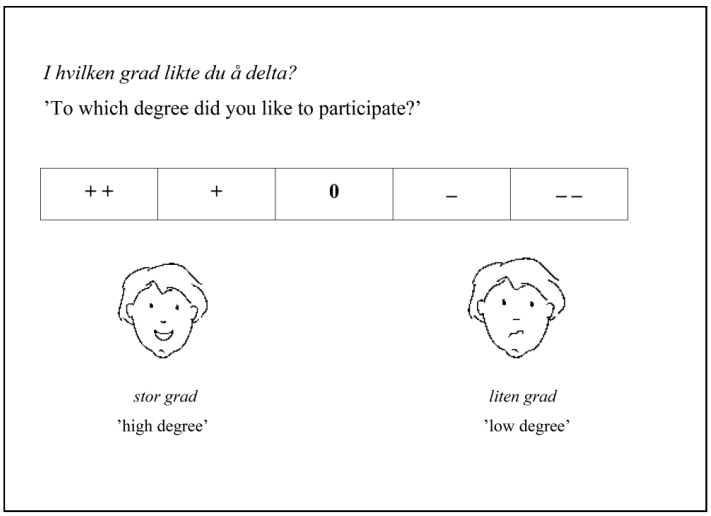
2. Er det noe du likte spesielt godt? *'Is there something you liked especially well?'*

3. Er det noe du ikke likte /opplevde som negativ? *'Is there something you did not like or experienced as negative?'*

4. Er det andre språkområder du ville ønsket mer trening av? *'Are there any other language areas you would like to have more training in?'*

Closed question with picture support:

Example:



I hvilken grad likte du å delta? *'To which degree did you like to participate?'*

I hvilken grad likte du bildemateriell generelt? *' To which degree did you like the picture material?'*

I hvilken grad var de ulike kategoriene aktuelle begrepsområder for deg? *'To which degree were the different categories' appropriate for you?*

I hvilken grad likte du at det var ulike vanskegrader? *' To which degree did you like the different levels of difficulty?'*

I hvilken grad passet de ulike vanskegradene for deg? *' To which degree did the different levels of difficulty match your needs?*

I hvilken grad opplevde du treningsformen som anstrengende? *'To which degree did you experience the training as exhausting?'*

I hvilken grad opplevde du treningsformen som ensformig? *'To which degree did you experience the training as monotonous?*

I hvilken grad opplevde du treningsformen som nyttig? *' To which degree did you experience the raining as useful?'*

I hvilken grad passet intensiteten av programmet for deg? *'To which degree did the intensity of the training match your needs?*

Ville du forandret timeantall per dag? *'Would you liked to change the number of trainings hours per day?'*

I hvilken grad passet intensiv språktrening med resten av din dagsplan? *'To which degree did the intensive language training fit with the rest of your daily program?'*

I hvilken grad opplever du forandring fra før vi startet? *' To which degree did you experience any changes compared to before we started with this?'*

Er denne forandring positiv – negativ på denne aksen? ' *Is this change on the positive or negative side of the axis?'*

I hvilken grad oppfylte programmet dine forventninger? *' To which degree did the program fulfill your expectations?*

Ville du deltatt igjen? *'Would you participate again?'*

Er det noe du vil tilføye? Noe som jeg ikke har spurt om? *' Is there anything else you would like to comment? Anything I have not asked you about?'*

Errata

Paper II and paper III have been under review during the process of the evaluation of the thesis and invited revisions are submitted. This information has been added as footnotes on page ix and on the front page of the respective paper:

[a] The manuscript has been reviewed and by invitation of the editor of *Aphasiology,* a revision is submitted. ID PAPH-2010-0085.R2

[b] The manuscript has been reviewed and by invitation of the editor of the *International Journal of Speech-Language Pathology,* a revision is submitted.ID TASL-2010-104.

Page 38, heading 3.2.5 Indiviual presentation of the cases Changed to**:** Individual presentation of the cases. Consequently to the formatting, this change is also apparent in the table of content, page ii.

Page 56, start of 3rd paragraph: ...in small samples and effect size...Changed to**:** ...in small samples, effect size...

Page 96: A white page was inserted for the correct print set up. Thereby, all page numbering for the appendices increased by one compared to the evaluated manuscript.

Page 110, above picture: For example' Melanie, can you give me red flowers?" Changed to: For example, "Melanie, can you give me red flowers?"

Page 110, below picture: ...too.For example, Changed to: ...too. For example, "Melanie can you give me 4 red flowers?"

Paper II, page 5, end of 3rd paragraph: The reference (Bybee, 2007, 2010) was removed.

Paper III, page2, end of 1st paragraph: ...constrain induced language therapy (CILT). Changed to: ...constraint induced language therapy (CILT).

I

Paper I

Constraint induced language therapy in early aphasia rehabilitation

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Constraint induced language therapy in early aphasia rehabilitation

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Background: Constraint induced language therapy (CILT) focuses on improving acquired expressive language deficits after stroke by applying intensive, use-dependent treatment with constraint to spoken verbal expression. Most CILT research has utilised individuals with chronic aphasia, and previous results indicated improvement on the language assessments after intervention that was largely retained at follow-up.
Aims: The purpose of this study was to explore the applicability and outcome of a programme of CILT in individuals in the early phase of recovery from aphasia (1–2 months post onset) in an inpatient rehabilitation hospital setting.
Methods & Procedures: A 10-day/3 hours a day pre–posttest CILT intervention case series was carried out 1–2 months post onset with three Norwegian rehabilitation inpatients with aphasia following left CVA. Procedures involved card activities using high- and low-frequency picture stimuli with communicative relevance at four levels of complexity, either in a small group or one-to-one with a trained SLP.
Outcomes & Results: Results suggested an overall improvement on the language assessments post CILT intervention, as well as at the follow-up. A greater degree of improvement in performance on expressive speech tasks compared to receptive and written tasks suggested a treatment-specific effect of CILT for early aphasia rehabilitation. Participant evaluation of the CILT intervention reflected positive feedback for the treatment experience and satisfaction with individual gains. Challenges in the application of CILT to this phase of recovery were the need to accommodate the demands of the inpatient rehabilitation setting and the decreased stamina of the participants.
Conclusions: The results of this study support the applicability of CILT in early aphasia rehabilitation, with some modifications of the original protocol.

Keywords: Aphasia; Constraint induced language therapy (CILT); Early rehabilitation.

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Aphasia is defined as an acquired neurological multimodality language disorder following focal brain injury (McNeil & Pratt, 2001). Demographic studies across countries indicate that approximately 30–50% of stroke survivors will experience aphasia. With the number of elderly and older people in Western countries projected to grow over the next few decades (Truelsen et al., 2006), the incidence of stroke will increase and the need for effective aphasia treatment will increase simultaneously. Previous reviews on the effect of aphasia treatment have been somewhat contradictory (Greener, Enderby, & Whurr, 1999; Robey, 1994, 1998); however, more recent reports seem to support the importance of intensive treatment (Bhogal, Teasell, & Speechley, 2003; Raymer et al., 2008). Increasing knowledge about brain plasticity and behavioural-dependent neuronal change and recovery invites exploration of new or improved treatment methods (Nudo, 2006b; Robertson & Murre, 1999; Thompson, 2000).

Constraint induced language therapy—CILT, also referred in the literature as constraint induced aphasia therapy (CIAT)—emphasises improving impaired spoken language production following acquired brain injury based on the principles of brain plasticity. In accordance with experience-dependent learning theory, it is assumed that the general use of compensatory strategies exploits healthy brain functions but at the same time reduces stimulation opportunities for the impaired regions. Reduced stimulation opportunities often result from effortful activation, which in turn induces a negative cycle of decreased use resulting in the phenomenon referred to as "learned non-use" of a function (Taub, Uswatte, Mark, & Morris, 2006). CILT represents an expansion of constraint induced movement therapy (Taub & Uswatte, 2006) to language; theoretically targeting the negative effects of learned non-use of spoken verbal communication. In speech, learned non-use is believed to be related to an overuse of compensatory strategies exemplified by gestures, drawing, and writing to the detriment of spoken language recovery (Pulvermüller & Berthier, 2008; Pulvermüller et al., 2001). The theoretical model for CILT relates further to Kleim and Jones's (2008) principles of experience-dependent brain plasticity, in which function-specific activation is presupposed in order to maintain or improve a function or skill, i.e., the "use it or lose it" principle. CILT explicitly utilises a number of these principles in the construction of the treatment setting and treatment characteristics (Pulvermüller et al., 2001): intensive, use-dependent treatment (intensity), 3 hours a day for 10 days; constraint to spoken verbal expression by the use of visual barriers between communication partners, thereby preventing the use of compensatory strategies such as gestures (specificity); massed practice (repetition); shaping of the required response to match individual skill; and stimuli material based on communicative relevance for the person with aphasia (both salience).

Previous CILT research suggested positive results for increased language test scores for persons with *chronic* aphasia. Pulvermüller et al.'s (2001) seminal study compared CILT to distributed, general speech and language therapy, with a significantly better outcome for the CILT group. Meinzer, Djundja, Barthel, Elbert, and Rockstroh (2005) replicated and extended those initial results, comparing CILT and CILT+, where CILT+ included written material as well as involving significant others to extend speech production training beyond the laboratory and into a home setting. To control for the possible effect of intensity alone, Maher et al. (2006) conducted a study comparing CILT to PACE therapy (Davis & Wilcox, 1985), where the group treatments solely differed by either constraint to spoken output (CILT) or the use of total communication facilities (writing, gestures, speech, drawing). Results showed positive outcomes for both groups, but with significant gains for spoken output in the CILT group.

Barthel, Meinzer, Djundja, and Rockstroh (2008) assessed possible factors accounting for the positive outcome of CILT in chronic aphasia by comparing and reviewing CILT, CILT+, and a modality-based treatment (MOAT), specifically tailored for treatment adaptation to individual aphasic deficits for communicative improvement. Everyday training of individual needs yielded positive outcomes across groups, while intensity, shaping, specificity, and the involvement of significant others should be further explored. Recently, Pulvermüller and Berthier (2008) proposed that the communicative relevance and natural communication setting within the treatment structure might be the main reasons for increased verbal production and implicit language changes, based on Wittgenstein's philosophy of the direct relationship of language to action (e.g., language games). The authors introduced "intensive language-action therapy" (ILAT), reflecting those relevant treatment structures and indicating that the role and influence of the actual constraint in constraint induced language therapy (CILT) should be explored further.

Raymer et al. (2008) emphasised the need for research on the impact of time post onset and intensity treatment outcomes within CILT research. Further, Linebaugh, Baron, and Corcoran (1998) discussed the paradox between the methodological claims of efficacy studies in aphasia based on chronic patients, and their applicability and appropriateness in the clinical reality of acute and early rehabilitation services for people with aphasia as is typically seen by the speech and language pathologist (SLP). Hillis and Heidler (2002) described several neural mechanisms as possible causes for variations in the timeline of spontaneous or rapid recovery. Their model supports treatment that targets the structural and functional reorganisation of the brain in the subacute or early aphasia rehabilitation phase, consistent with the theoretical underpinnings of CILT. While general research articles point to a better outcome the earlier intensive treatment is started—addressed by, e.g., Poeck, Huber, and Willmes (1989) and Robey (1998)—such results should be tempered with the possible negative consequences of interventions begun too early. Results from selected animal studies indicated an extension of the stroke area with too-early intervention. However, these findings were mostly connected to intensive treatment occurring within the hyper-acute phase (first 24 hours) and were not replicated in later studies (Kleim & Jones, 2008; Nudo, 2006a).

Despite the increased understanding of brain neuroplasticity, the importance of early rehabilitation for stroke survivors, and encouraging outcomes from chronic studies, there are so far no known studies investigating CILT in early recovery from aphasia (Cherney, Patterson, Raymer, Frymark, & Schooling, 2008). The purpose of this study was therefore to explore the applicability and outcome of a programme of CILT in individuals in the early phase of recovery from aphasia. If it could be shown with some modifications to be effective, clinicians could more easily justify their use of CILT at that time. The term *early aphasia rehabilitation* in this paper refers to the rehabilitation phase after the acute care hospital setting, beginning at about 1–2 months post onset. This time frame also respects the possibility for the stroke survivor to establish a more medically stable condition and aphasia pattern, as well as to adjust somewhat to the life-changing situation.

METHOD AND PROCEDURE

Participants

A pre–posttest intervention study was conducted with three right-handed, highly educated (> 12 years) native Norwegian speakers (named HP, FOT, and GA) with

aphasia and right-side hemiparesis following first-time CVA. HP was an 89-year-old woman with mild to moderate aphasia following a left MCA CVA, which had evolved to non-fluent speech with limited intelligibility and significant apraxia of speech (AOS) by the time she participated in the study 40 days post stroke. FOT was a 43-year-old male with non-fluent aphasia following a left medial/anterior CA CVA. He received acute thrombolytic treatment as well as a hemi-craniectomy prior to beginning the study. FOT's expressive language was marked by severe anomia without AOS by the time he participated in the study 58 days post stroke. GA, a 68-year-old male, sustained a left intracerebral haemorrhage with midline shift, resulting in severe receptive and expressive aphasia, apraxia of speech (AOS), and dysphagia. GA's language production was limited to yes/no, monosyllabic words, and neologisms at the start of the study, 42 days post onset.

Intervention

For each participant, CILT was scheduled for 3 hours a day for 10 days, replicating previous studies (Barthel et al., 2008; Maher et al., 2006). However, the acute hospital setting and stamina of the clients required modifications to the original protocol. In some instances the treatment dose needed to be modified, i.e., administered in multiple shorter sessions of 45 minutes rather than in a 3-hour block. Also, in this phase the scheduling of treatment needed to be flexible to accommodate other rehabilitation treatments and medical issues, making the scheduling of group intervention problematic at times. In other instances it was necessary to deliver the intervention at bedside because of physical fatigue. Therefore the number of therapy hours given daily ranged from 1.15 to 3 hours, resulting in a total number of therapy hours of 20 (HP), 24.5 (GA), and 30 (FOT).

The treatment (TX), modelled after Pulvermüller et al. (2001) and Maher et al. (2006), involved constrained spoken output with shaping of the targeted responses in the context of card activities with visual barriers between the participants. The paired cards presented coloured pictures in 10 categories based on assumed communicative relevance for daily living within two frequency rates, and at four complexity levels (see appendix for a detailed description). Hand movements for individual support were neither prohibited nor encouraged. Videotaped samples from all training sessions were checked by the first author to ensure TX fidelity. TX was conducted in a group setting with a second person with aphasia and an SLP (FOT), or individually, with the SLP acting as the communication partner (HP and GA).

The CILT treatment carried out in this study does not involve constraints outside the training sessions, as there are in some constraint motor studies, and therefore we could not control for the use of compensatory strategies for the remaining hours of the day. However, as all three participants were in-patients the environmental surroundings are relatively similar, with typical hospital conversations as the main communication activity. Hospital professionals and significant others were informed about the study but were not informed about specific training items, nor were they encouraged to involve the participants in more communicative action than any other patient. However, individual motivation to practise independently outside the treatment sessions cannot be ruled out, and personal characteristics should be considered as influential factors for outcome in such cases.

Assessment

The presence and nature of the aphasia were assessed with the Norwegian Basic Aphasia Assessment (NGA) (Reinvang & Engvik, 1980b; Reinvang 1985), which is based on the Lichtheim-Wernicke model and similar to the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) and the Western Aphasia Battery (Kertesz, 1982). In addition, the Norwegian versions of the Test for Reception of Grammar (TROG-2) (Bishop, 2009), the subtest 7 (sentence construction) of the Verb and Sentence Test (VOST) (Bastiaanse, Lind, Moen, & Gram Simonsen, 2006), the experimental version of subtest 54, (naming frequency) from the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA) (Kay, Lesser, & Coltheart, 2009), the Cookie Theft (CT) picture description (Goodglass & Kaplan, 1972), and CILT-baseline measures were administered pre and post treatment. The CILT baseline consisted of independent productions of five trained and five untrained high-frequency level 3 requests and low-frequency level 4 requests (total number of items = 20, see appendix). AOS was clinically assessed based on Reinvang and Engvik's form (1980b). In addition to these specific language measures of performance, a questionnaire was developed to evaluate the participants' experience of CILT, including open questions and comments of agreement on a 5-point—2, 1, 0 (neither nor) –1, –2—picture-supported rating scale. Follow-up measures were conducted at 3 months (HP) and 6 months (FOT) post intervention. Because of medical complications, GA was not tested at 3 months post onset. CILT TX and assessments were carried out by experienced SLPs, all trained in CILT administration by the first author. All measures were scored from videotape by the treating SLP, and subsets were scored by a second SLP for reliability. Inter-rater agreement for all available subtests ranged from 50% to 100%, with an average of 92.9%. The lower agreement scores were the result of the treating clinician scoring more liberally, and in cases of disagreement the more conservative scoring was used. Written informed consent was obtained from all participants before the pre-test and renewed orally at the other assessment points. The study was approved by the Regional Committees for Medical Research Ethics (REK) and the Norwegian Social Science Data Services (NSD).

RESULTS

All participants completed the CILT TX successfully with an overall pre–posttest average improvement on the five language tests (NGA, TROG-2, VOST, PALPA, CILT baseline) ranging from 5.1% (GA) to 18.7% (HP) and 23.3% (FOT) (see Table 1 for detailed scores).

Descriptive quantitative analysis indicated improvement on the six speech production subtests (CILT baseline, NGA repetition, NGA naming, NGA reading aloud, PALPA, VOST) in all three cases (GA, M = 12%; HP, M = 22%; FOT, M = 23%), with individual variation ranging from 1.5% (GA, PALPA 54) to 40% (HP, VOST) (Figure 1).

In comparison, receptive measures (NGA comprehension, NGA reading comprehension TROG-2) and written output (NGA writing) indicated a change of –0.6% (HP), 3.25% (GA), and 4.4% (FOT) after controlling for the fact that FOT did not receive all of the writing subtests pre-TX. HP and FOT showed the most improvement on the sentence-level tasks, whereas for GA, word-level tasks improved the most.

TABLE 1
Pre-test, post-test, and follow-up scores for all cases in percent correct answers and words per minute (wpm)

	HP			*FOT*			*GA**	
	Pre	*Post*	*Follow-up*	*Pre*	*Post*	*Follow-up*	*Pre*	*Post*
CILT baseline (180 **)	39	52	62	47.5	85	85	8	15
NGA repetition (40**)	10	15	25	75	85	95	10	27.5
NGA naming (41**)	53	78	94	66	83	93	11	43
NGA reading aloud (26**)	42	69	85	70	85	96	10	20
PALPA 54 naming frequency (80**)	37.5	61	81	59	89	95	11	12.5
VOST sentence construction (20**)	20	60	70	45	75	90	0	5
TROG-2 (80**)	84	93	98	72.5	80	80	9	10
NGA comprehension (71**)	99	97	98.5	89	94	100	31	30
NGA reading comprehension (23**)	100	100	100	73	73	100	17	30
NGA writing (10**)	80	70	90	20	70	40	0	0
Cookie theft (wpm)	57.3	64	67.4	11.1	15.9	27	39	36
Conversational interview NGA (wpm)	54.4	69.8	66.1	9.8	19	23.4	45	47.4

*Follow-up results for GA could not be obtained for medical reasons.
** Number of items (N) available for each test.

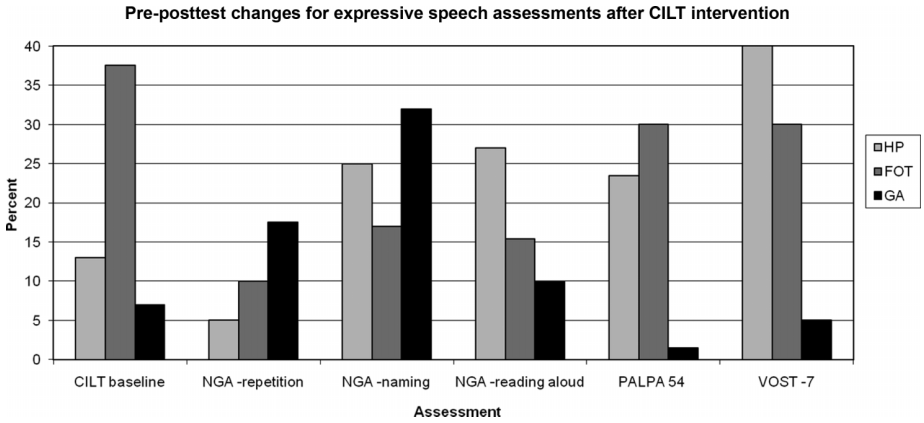

Figure 1. Pre- to post-test changes for expressive speech assessments for all three cases.

Typically, when reporting a case series, individual effect sizes would be preferred. However, due to the lack of normative data for many of the Norwegian versions of the tests, effect sizes were calculated within the group, see Table 2.

The effect sizes for expressive oral tasks, while modest, exceed the level of .63 reported by Robey (1998) for untreated recovery and provide support for the treatment effect for speech production tasks.

Analyses of more complex speech production revealed a larger increase of words per minute for the NGA conversational interview (HP = 28%, FOT = 48%, GA = 6%) compared to the Cookie Theft (HP = 12%, FOT = 30%, GA = –1%). These changes suggested an increase in expressive speech output beyond single word naming, indicating a possible impact of CILT on functional communication for at least HP and FOT. Despite limited parametric change in the number of utterances for GA, intelligibility and effort seemed to improve.

TABLE 2
Within-group effect sizes for $N = 3$

Assessment	*M Pre-test (min; max)*	*M Post-test (min; max)*	*M Std error Pre-test*	*SD Pre-test*	*d**
NGA (overall)	110.33 (37; 156)	132.17 (61.5;180)	37.03	64.14	0.34
NGA (naming)**	17.83 (4.5; 27)	27.833 (17.5; 34)	6.82	11.81	0.85
NGA (aud. comp.)	51.67 (22; 70)	52.33 (21; 69)	14.97	25.9	0.03
NGA (writing)	3.33 (0; 8)	4.67 (0: 7)	2.40	4.16	0.32
PALPA subtest54**	29 (9; 47)	43.33 (10; 71)	11.02	19.0	0.75
VOST subtest 7**	4 (0; 9)	9.33 (1; 15)	2.64	4.58	1.16
TROG-2	34.33 (7; 67)	38 (8; 74)	17.52	30.35	0.12
CILT baseline**	56.83 (14.5, 85.5)	91.5 (27.5; 152.5)	21.61	37.42	0.93

*Within-group effect size ($N = 3$) calculated with the following formula:

$$d = \frac{M_{pre} - M_{post}}{SD_{pre}}$$

** Verbal speech production tasks.

Qualitative evaluation of participation in CILT using the self-report questionnaire revealed mostly positive experiences in all three cases. However, intensity of the intervention was one of the challenges in applying the CILT protocol in this setting. While HP and FOT preferred fewer hours per day, GA preferred more intensive TX. FOT's self-reported evaluation measures did not reflect specific language changes; however, he reported that the experience was positive, and his family members reported better communication on his behalf. FOT was also the most ambivalent about participating at the beginning of the intervention, related to his primary interest in physical therapy, which might be reflected in a more negative performance during the pre-TX evaluation. However, at the follow-up he expressed his appreciation for the study, seeming to have obtained greater understanding of his aphasia and living situation. Follow-up results for both FOT and HP indicate further overall improvement, as expected in early aphasia recovery, as all clients continued with more traditional speech therapy addressing all language modalities after CILT.

DISCUSSION

Being aware that a pre–post treatment study without a control group has severe limitations and therefore cannot be generalised, we feel the results of this study certainly warrant a larger controlled group study. Taking those methodological concerns into account, the present case series points to some interesting findings. First, all participants completed the study with positive results and continued improvement at follow-up, revealing at least no explicitly negative influences of CILT in early aphasia rehabilitation. Second, the improvement in expressive speech compared to the relatively limited change in receptive language tasks (respecting a likely ceiling effect for some of the comprehension subtests for HP) might indicate a treatment specific outcome. Further, there was also a greater improvement in expressive spoken language compared to expressive written language for HP and GA. Assuming that verbal and written word retrieval activates some of the same language processes in the brain, writing can be viewed as a non-equivalent dependent variable, which should not change with CILT, but which has similar threats to internal validity as spoken language (Shadish, Cook, &

Campbell, 2002). This argues against spontaneous recovery as the overall explanatory factor for the observed positive results. Furthermore, since the emphasis of CILT is primarily on spoken output, the difference in oral versus written production following therapy suggests a predictable treatment-specific response that may be attributed at least in part to the intervention.

One of the challenges in assessing the impact of intervention in acute rehabilitation is the contribution of spontaneous recovery (Poeck et al., 1989). In theory, the influence of spontaneous recovery (or other threats to validity such as a placebo effect) should be observed across all areas of deficit. Results from the Copenhagen aphasia study (Pedersen, Vinter, & Olsen, 2004) support this hypothesis, by finding no explicit difference in the recovery process for comprehension and speech production (spontaneous speech, naming) within the first year post onset. Other studies reported differences in favour of improved comprehension (e.g., Kenin & Swisher, 1972; Vignolo, 1965) or varying results depending on spared comprehension skills (Lomas & Kertesz, 1978), both contrary to the results in this study. While specific changes after a 6-month interval were observed on the NGA by Reinvang and Engvik (1980a), few studies have addressed changes within as short a treatment period as the current study (10 days). The presented TX effects should therefore be considered cautiously.

Another factor that may influence recovery is the type of stroke. In general a better outcome is predicted for haemorrhagic than ischaemic strokes (Murray & Clark, 2006). However, in this case series the participants with ischaemic strokes (FOT and HP) and not the one with a haemorrhagic stroke (GA) had the better outcome, supporting the conclusion of a CILT treatment effect rather than spontaneous recovery. Further, severity of aphasia and size of the lesion are frequently reported as predictors of outcome (Holland, 1989; Kertesz & McCabe, 1977), predicting FOT's positive response based on medical history and absence of AOS. However, while CILT does not particularly emphasise the treatment of AOS, the results on the expressive speech production tasks indicate improvement in the articulatory and speech output levels (HP and GA). The CILT setting with its repetitive pattern and shaping of responses should be further explored for its possible impact on AOS.

Other factors, such as age, pre-stroke physical activity, and motivation are addressed as possible impact factors on treatment outcome, but to varying degrees, (Holland, 1989; Pedersen, et al., 2004). Holland (1989) reported age differences where older persons showed more severe forms of aphasia and fewer effects of spontaneous recovery, predicting a better outcome for the youngest case, FOT. On the other hand, despite her age, HP was an extremely active elderly woman, reinforcing that personal characteristics play a role in treatment intervention. Breitenstein et al. (2009) discussed the influence of cognitive factors on language performance and recovery, arguing for better linguistic prognosis if fewer cognitive deficits are present. From this point of view, additional cognitive tasks would be recommended in future studies.

Pulvermüller and Berthier (2008) addressed the importance of natural speech actions for the best generalisation effect of CILT to daily living, in line with the transfer package as emphasised by Taub et al. (2006) for constraint induced movement therapy, to promote gains beyond the laboratory setting. Using a group setting has previously shown better generalisation effects on communication skills than individual treatment with an SLP (Elmann & Bernstein-Ellis, 1999). However, Barthel et al. (2008) reported no significant differences regarding group or individual treatment. FOT's intervention occurred in a group setting, in contrast to the other two cases. However, the one-to-one settings with the SLPs allowed for more talking time per participant.

Future studies could address differences in individual versus group delivery more systematically. In addition, more detailed functional communication and quality-of-life outcomes should be explored.

Previous CILT research with chronic patients excluded severe aphasia, and GA's positive results encourage exploration of intensive spoken language therapy for severe aphasia. The Pedersen et al. (2004) study indicated a positive prognosis for persons diagnosed with global aphasia within the first weeks post onset by showing an evolution within the first year to a Broca-type aphasia, supporting their therapeutic qualification for aphasia rehabilitation. In the case of GA, changes measured across standardised assessments might partly be limited by the correct/not correct dichotomy of scoring. A more detailed scoring system might reveal more subtle areas of improvement, as observed in functional speech and communication. This notion is supported by the Marini, Caltagirone, Pasqualetti, and Carlomagno (2007) study where small changes on clinical tests were associated with better outcomes on connected speech samples after treatment. Linebaugh et al. (1998, p. 533) also focused on the "magnitude of inaccuracy in changes" as an additional factor in determining efficacy outcomes and in the discussion of the duration of language therapy. Further, the effect of an expressive speech treatment might be different if the goal challenges quality or quantity of speech production, such as increasing fluency using more circumlocutions or decreasing the number of attempts by errorless activation (Bauer & Auer, 2009).

Another consideration is that CILT focuses on expressive speech production, leading to the assumption that it might be more applicable for non-fluent aphasia types as was the case for these three participants. However, extension to fluent aphasia (e.g., Wernicke aphasia) would afford a better assessment of the impact of CILT on (a) comprehension and auditory discrimination, and (b) inappropriate fluency (neologism, paraphasia etc.) based on the structured treatment setting CILT represents. Finally, the influence of memory on recovery of language function after stroke has recently been reinforced, and invites further exploration in the context of CILT.

CONCLUSION

In conclusion, the results of this study support the applicability of CILT for expressive language production in early aphasia rehabilitation. The strength of this study lies in its real-world clinical setting, applied in typical rehabilitation facilities in Norway, covering the challenges of everyday life in hospitals for patients with acute stroke rehabilitation. Within the overview of research stages as presented by Cherney et al. (2008), this study shows indications for the effectiveness stage; however, exploration in a larger population and control group studies are warranted. Concerning further clinical use, modifications of the original protocol by treating SLPs should be expected based on individual needs.

Linebaugh et al. (1998) suggested criterion-based rehabilitation research in aphasia rather than time-based to assess factors such as generalisation and maintenance. This should be implemented in further studies investigating the optimal time post onset for beneficial intensive treatment outcome, as well as the amount and duration of intensive treatment. Present CILT studies focused mainly on speech production and comprehension in aphasia, and future research should, to a higher degree, extend the treatment-induced intensive training to other language areas such as reading and writing, and investigate the interaction of these language areas.

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APPENDIX

CILT treatment structure based on the card activity "Go fish"

Level	*Material*	*Description*	*Expected request*	*Expected response*
1	Picture set with pairs of cards	Single word naming. Preferable using intonation for indication of an interrogative phrase.	*Naming* of the pictured object e.g., "Bread?"	"Yes/no + naming" e.g., "Yes, bread" "No bread"
2	Picture set with pairs of cards	Addressing the other player by name, interrogative phrase including naming of object.	"Name, do you have a *naming*? e.g., "Jane, do you have bread?	"Yes/no, name, I do/don't have a *naming*." e.g., "Yes, Pete, I have bread."
3	Each object is in addition displayed in two versions	Addressing the other player by name, interrogative phrase including naming of object and differentiating from the other possibility by adding an adjective/adverb.	"Name, do you have a description *naming*?" e.g., "Jane, do you have toasted bread?	"Yes/no, I do/don't have description *naming*." e.g.," Yes, Pete, I have toasted bread"
4	Each object is in addition to level 3 displayed in two different amounts	Addressing the other player by name, interrogative phrase including naming of object, an adjective/adverb and an amount.	"Name, do you have an amount of description *naming*?" e.g., "Jane, do you have 2 (slices) of toasted bread?"	"Yes/no, I do/don't have an amount of description *naming*." e.g., "Yes, Pete, I have 2 (slices) of toasted bread."

Change of level or category at about 80% correct.

Categories: 10 objects each

High frequency	*Example*	*Low frequency*	*Example*
Persons	Girl	Persons	Physical therapist
Home and housing	Radio	Home and housing	Ladder
Personal belongings	Dress	Personal belongings	Credit card
Food	Bread	Food	Waffles
Vehicles	Bus		
Buildings	Restaurant		

II

Paper II

Oral text production as measurement for treatment outcome in aphasia

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Oral text production as measurement for treatment outcome in aphasia

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Abstract

Background: Oral text production reflects a more natural communication aspect of language than most standardised aphasia tests. Several methods for text analysis have been developed; however, clinical application in speech-language therapy has so far been limited. Further, exploration of the generalisation effect of specific impairment-based treatment forms to spontaneous speech and everyday communication is still warranted.

Aims: The present study explores the relevance of oral text production for measurement of aphasia treatment outcome with constraint induced language therapy (CILT). The study investigates if improvement on standardised tests generalises to connected speech production with a focus on vocabulary and content.

Methods & procedures: Analyses are based on the pre- and post-intervention transcriptions of conversational interviews with three speakers with aphasia participating in a clinical CILT treatment study in early aphasia rehabilitation. The analyses include quantitative measurements of the speech production (number of words, number of utterances, and mean length of utterance), of the lexical production of nouns and verbs (proportion, variation, frequency and specificity), and of the content (proportion of informative utterances and meta-communicative utterances). In addition, the analyses include a qualitative evaluation of the content.

Outcome & results: Results indicate an overall increase in noun production for all three cases post-CILT; however, the improvement of noun diversity and specificity also revealed individual differences. The use of verbs indicates a slight decrease in the amount of verbs produced; however, more specific verbs were produced post-intervention. Content evaluation

and the quantitative measures of content demonstrate increased informativeness on the individual level.

Conclusion: The applied measures provide a helpful structure for interpreting outcome changes in the use of nouns and verbs. Content analysis supports a generalisation effect of increased word production to everyday communication.

Keywords: Aphasia, Text production, Constraint induced language therapy (CILT), Treatment outcome

Introduction

Improvement of daily-life communication is a general goal of language rehabilitation for speakers with aphasia (Armstrong & Ferguson, 2010; Kelly, Brady, & Enderby, 2010). The ability to participate fully in oral communication in various daily-life contexts is arguably dependent on the quantity and quality of the individual's spontaneous speech production. Hence, in planning treatment and measuring treatment outcome, improvement of spontaneous speech production is a key component. The relevance of measurements relating to oral text production is independent of the particular type of speech and language therapy that is offered. In this study we investigate a possible generalisation in expressive language skills, in particular noun production, to connected spontaneous speech.

Methods for assessment of spontaneous speech production in aphasia

In clinical practice as well as in research, various types of data and methods are used for gaining knowledge on the abilities of an aphasic speaker to produce contextually adequate connected speech spontaneously. Prins and Bastiaanse (2004) distinguish between several types of connected speech samples based on the stimuli source. Semi-spontaneous texts include situational picture description, retelling of culturally well-known stories, such as fairytales, retelling of predetermined stories (as in the Story Retell Procedure (Doyles et al., 1998)), and texts elicited from role-play. Semi-spontaneous texts are generally monological in the sense that one speaker is primarily responsible for producing the text. Often such texts are also pre-planned. Spontaneous texts, on the other hand, include conversations in institutional or non-institutional contexts and semi-structured interviews with open questions. These types of texts are more genuinely dialogical, in the sense of involving at least two different participants, and they are less pre-planned. In this study, the analysis is based on spontaneous speech samples elicited in semi-structured interviews.

The methods used for assessing the connected speech production of speakers with aphasia range from rating scales to contextually sensitive analyses of conversational practices and quantitative linguistic approaches. Standardised aphasia batteries (Goodglass & Kaplan, 1972; Huber, Poeck, Weniger, & Willmes, 1983; Reinvang & Engvik, 1980) often contain rating scales that are used to assess the spontaneous speech production. Although widely applied in clinical practice (Katz et al., 2000), such rating scales are unsatisfactory in that they often do not provide sufficient information about an individual's spontaneous speech for changes to be measured reliably (Grande et al., 2008; Prins & Bastiaanse, 2004).

Another method for assessment of spontaneous speech production is provided by conversation analysis (CA). CA essentially constitutes a qualitative, data-driven, bottom-up approach to the investigation of interactional practices, and traditionally little or no weight has been put on the quantification of results (Beeke, Maxim, & Wilkinson, 2007; Wilkinson, 1999, 2008). Several case studies have used CA as an intervention tool (Beeke, Maxim, et al., 2007; Prins & Bastiaanse, 2004), and recently steps have been taken to develop a therapy approach for speakers with agrammatism based on CA including a valid quantitative measure of change in conversation (Beeke, Maxim, Best, & Cooper, In press).

For use in clinical contexts CA has been described as time consuming and thus not feasible. As pointed out by Beeke, Wilkinson, and Maxim (2007:141), it does not necessarily require more time than other forms of analysis of spontaneous speech samples, though. However, as with any other method, the use of CA requires an analytic competence by the speech and language therapist, and such a competence depends partly on the extent to which the method is embraced within the professional training of speech and language therapists in different countries (Lind, 2005). Despite being a method with high ecological validity (Armstrong & Mortensen, 2006; Beeke, Wilkinson, & Maxim, 2003), CA may thus not yet be universally applicable for use in clinical contexts.

A range of quantitative linguistic measures for the analysis of connected speech production in speakers with aphasia has been proposed. An advantage of quantitative linguistic methods is that they allow for easier comparison of performance of spontaneous speech intra- and inter-individually as well as between various population groups (McNeil, Doyle, Tepanta, Hark, & Goda, 2001). Two of the more widely used methods are the Quantitative Production Analysis (QPA) (Saffran, Berndt, & Schwartz, 1989) and the Reading aphasia analysis (Edwards, 1995, 2005). A main difference between these methods is the amount of editing that is performed on the texts before analysis. The Reading aphasia analysis is comprehensive in analyzing all utterances, whereas the QPA excludes various items (neologisms and meta-communicative utterances) before analysis.

Quantitative linguistic methods face some of the same challenges as conversation analysis does in the clinical context. Transcription and analysis of speech samples are time consuming, and interpretation of the results can be complicated, demanding a sophisticated

background in clinical-linguistic analysis (Prins & Bastiaanse, 2004). Despite the usefulness of assessing the spontaneous speech production of speakers with aphasia – disregarding the method used for assessment – it is our experience that such assessments are rarely conducted in clinical practice (Grande et al., 2008).

To facilitate the use of a quantitative linguistic form of assessment of spontaneous speech in aphasia therapy, computer-assisted methods of analysis have been proposed. An early report of computer-assisted analysis is by Holland et al. (1985), who used a modified version of SALT (Systematic Analysis of Language Transcripts) to describe the spontaneous recovery during the first two weeks in a globally aphasic patient. More recently, the AphasiaBank cooperation offers computer-assisted analysis and databases of semi-spontaneous (for example, the Cinderella narrative) and spontaneous texts (MacWhinney, Fromm, Holland, Forbes, & Wright, 2010). Also, in Germany, a computer-assisted method for the analysis of spontaneous speech by aphasic speakers has been introduced (Hussmann et al., 2006) . This method has been used to measure changes in spontaneous speech following aphasia treatment in 28 speakers, and the method was compared to judgments on conventional rating scales (Grande et al., 2008). The results show that the computer-assisted method captures significant changes in spontaneous speech in far more speakers than the rating scale method does.

The use of computer-assisted methods for analysis seems promising, but its clinical feasibility is dependent upon the development of appropriate computer programs for languages beyond English and German. Furthermore, even when the necessary programs are available, discussions concerning clinically relevant parameters for measurement will continue. This study uses a modified version of a set of measures for the analysis of lexical aspects of oral text production in speakers with aphasia that has been proposed based on Norwegian data (Lind, Kristoffersen, Moen, & Simonsen, 2009). The proposed measures have been shown to distinguish between speakers with anomic aphasia and speakers without aphasia, but so far they have not been applied in a treatment context.

Generalisation from treatment to connected speech

The analysis of connected speech production is used both to assess the linguistic and communicative abilities and impairments of speakers with aphasia and to measure the degree of improvement following therapy. In the latter case it is often a question of possible generalisation from treatment at micro-linguistic levels such as word finding or sentence

construction to connected speech. It varies according to how close the relationship is between the level of impairment that is targeted in therapy and the measures that are made in the connected speech sample following therapy.

In the study by Grande et al. (2008) the participants received 'symptom-specific therapy, which aims primarily at relearning degraded linguistic knowledge, reactivating impaired linguistic modalities, and learning compensatory linguistic strategies' (p. 412), whereas the variables used in the analysis of the spontaneous speech are so-called 'basic parameters [that] are essential units of language and can be identified in every conceivable verbal output' (p. 409). Examples of such parameters are the percentage of words relative to interjections and neologisms, the percentage of open-class words, the percentage of syntactically complete clause-like units, the percentage of clause-like units in compound sentences, and mean length of utterance in words (MLU). Given this constellation of impairment, treatment, and assessment, it is, as the authors point out, difficult to have straightforward hypotheses about particular patterns of change.

Conroy, Sage, and Lambon Ralph (2009) is a study in which there is a close relationship between the elements targeted in therapy and those measured in connected speech. This study deals with naming skills in seven speakers with aphasia and the question of generalisation from single-word naming to connected speech. Among the words targeted in therapy are nouns and verbs that the participants had failed to name correctly in either a simple picture-naming task or a connected speech task. The participants received decreasing and increasing cue therapy for nouns and verbs in ten therapy sessions. Post-therapy assessments included naming accuracy of the treated words in single naming and connected speech. The results show improved naming accuracy for the treated items in all tasks, but to differing degrees. The improvement is greatest in single naming, lower in situational picture description, and lowest in retelling of a fairytale. The study by Conroy et al. (2009) convincingly demonstrates the possibility of a generalised improvement of treated items in a linguistically and cognitively more demanding context. However, their connected speech samples are semi-spontaneous and the question of generalisation to spontaneous connected speech remains open.

Aphasia rehabilitation with constraint induced language therapy

Constraint induced language therapy (CILT) emphasises improvement of oral speech production in an intensive treatment setting based on the features of mass practice, feedback, shaping, and communicative relevance (Pulvermüller & Berthier, 2008; Pulvermüller et al., 2001). Communication is constrained to verbal production by a visual barrier between the communication partners. Previously reported results indicate positive outcomes on several standardised measures for the chronic aphasic population (Breier et al., 2009; Pulvermüller & Berthier, 2008; Pulvermüller et al., 2001). Recently, CILT has also been applied in early aphasia rehabilitation (Kirmess & Maher, 2010).

Because of the strict treatment structure and suppression of alternative communication, the CILT approach may evoke critical concerns about the impact and generalisation of the treatment outcome to functional communication. The treatment impact on everyday communication has been evaluated with the Communicative Activity Log (CAL) (Pulvermüller et al., 2001) and The Communicative Effectiveness Index (CETI) (Lomas et al., 1989) also see Barthel, Meinzer, Djundja, and Rockstroh (2008), Berthier et al.(2009) and Meinzer, Djunda Barthel, Elbert, and Rockstroh (2005), but so far few studies have directly investigated generalisation to linguistically and cognitively more demanding speech contexts.

Maher et al. (2006) applied QPA (Berndt, Wayland, Rochon, Saffran, & Schwartz, 2000; Saffran et al., 1989) to retellings of the Cinderella story following a CILT intervention. The results indicate an overall increase in the number of words and improvement in sentence production, but with important individual differences, including a reduction in word production for certain cases. Faroqi-Shah and Virion (2009) used a CILT approach to study the role of grammatical constraints on the production of verbs in four agrammatic speakers. Outcome measures included retelling of the Cinderella story and an informal conversational sample (semi-structured interview). The assessment of the morpho-syntactical structure was based on the first 15 utterances of each of the two text samples and included the proportion of sentences and well-formed sentences, the accuracy of tense and diversity in tense marking. Despite improvement on standardised morpho-syntactic tests, they authors did not find any significant outcome changes on any of the discourse measures and report a rather diverse pattern of individual changes. Goral and Kempler (2009) investigated the outcome of verb production in a narrative context for a modified CILT approach for one non-fluent speaker. Their results show a relatively stable general word production, a significant improvement in

the number of verbs produced, an increase in the use of auxiliary verbs (not previously produced) and improvement in verb inflection. In comparison the number of nouns (which was larger than that of verbs in all three narratives) remained unchanged. Naeser et al. (2010) combined a study of repetitive transcranial magnetic stimulation (rTMS) with a CILT intervention and reported outcome measures on the semi-structured Cookie Theft picture for one non-fluent speaker. The results show no change in MLU, but qualitative changes are observed, measured by an increase in narrative words in general and nouns specifically. These few and mixed results from existing studies warrant further exploration of generalisation from CILT interventions to connected speech production. Furthermore, previous studies have investigated speakers with chronic aphasia, and a further research on outcomes in different rehabilitation phases is needed.

Aims

The purpose of this study is to explore a possible gain in expressive language skills in spontaneous speech production following CILT in early aphasia rehabilitation (Kirmess & Maher, 2010). The specific focus of treatment is oral production of noun phrases within a limited contextual frame (*cf.* below for a description of the intervention). Hence, in measuring treatment outcome in spontaneous speech, we focus on various lexical measurements of nouns and verbs (lexical diversity, lexical richness, token frequency, and semantic specificity). Given the treatment focus we assume positive outcome changes in the lexical measures related to nouns and less particular changes in verb production. On the basis of the intervention, we also assume a general increase in word production (number of words and MLU) and speech fluency. Improvement in lexical production in spontaneous speech presumably furthermore relates to the improvement of informativeness and expression of meaningful content. Hence, we propose and explore measures of content in the text samples using quantitative and qualitative assessments.

Methods & Procedures

Participants

The study is based on three cases – MX, LL, and HP[1] – who participated in the CILT study as part of their early aphasia rehabilitation following first-time left hemisphere stroke. The

[1] Results from the formal testing for HP were previously reported in Kirmess and Maher (2010). The data presented here are based on additional analyses.

participants were all native speakers of Norwegian. They were chosen for text analysis because of their sufficient amount of verbal production pre-therapy. Their aphasia types, relative severity of aphasia, and fluency were assessed with the Norwegian Basic Aphasia Assessment (NGA) (Reinvang & Engvik, 1980).[2] A summary of participant characteristics is provided in table 1.

Table 1 Participant characteristics.

	MX	LL	HP
Gender	male	Female	female
Age (years)	51	78	89
Education (years)	12	7	>12
Stroke type	Intracerebral haemorrhage	Cerebral vascular accident[3]	Cerebral vascular accident
Hemiparesis	Right	None	Right
Time PO (weeks)	14	4	6
Aphasia severity pre-therapy	Mild to moderate, non-fluent	Mild to moderate, fluent	Mild to moderate, non-fluent
Apraxia of speech	Yes	No	Yes
CILT (hours)	27	27	20

In addition, we also note that pre-therapy MX strived with word-finding problems as well as initiation of the first syllable. LL's speech production is described as fluent and anomic without many neologisms and paraphasias. She also had severe reading and writing difficulties. In the case of HP, her speech intelligibility was greatly limited by her severe apraxia of speech.

Intervention

A pre- and post-test intervention case study was carried out 1–4 months after the onset of aphasia. The intervention aimed at improvement of oral speech production with a particular emphasis on the production of nouns. The present CILT intervention consists of intensive, repetitive treatment based on a card activity for 3 hours a day for 10 days as described in

[2] An English description of the NGA is provided in Reinvang (1985).

[3] LL underwent thrombolytic treatment within the first hours of stroke appearance without any specified effect.

previous studies (for details, see Kirmess & Maher, 2010). In the card activity, participants request and collect pairs of coloured pictures displaying objects within different thematic categories relevant for daily living (food, personal items, etc.). The pictured objects comprise four levels of difficulty with high- and low-frequency nouns, stimulating verbal production ranging from simple naming of the object ('Peppers?') to producing an elaborate noun phrase embedded in an interrogative construction, for example, 'Peter, do you have two red peppers?' For response, elaborate noun phrases are modelled and preferred to simple interjections, for example, 'Yes, Mary, I have two red peppers.' The interaction of the card activity presents a communicative setting which allows and encourages extended verbal production related to the stimuli and group action. Trained speech and language pathologists (SLPs) shape the treatment conditions for individual needs and act as role models whenever necessary to enhance mastering.

Assessment

Assessment was scheduled over two consecutive days pre- and post-therapy to capture possible daily variance in performance as well as limit any assessment exhaustion. All assessments were video-recorded and carried out by experienced SLPs. The oral text samples were collected on the first day before any other assessment.

Outcome measures include the following standardised tests: the Norwegian Basic Aphasia Assessment (NGA) (Reinvang & Engvik, 1980), the sentence construction test from the Verb and Sentence Test (VOST) (Bastiaanse, Lind, Moen, & Simonsen, 2006), an object-naming test (subtest 54) from the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA) (Kay, Lesser, & Coltheart, 2009), the Test for Reception of Grammar version 2 (TROG-2) (Bishop, 2009), and a set of CILT-specific measures developed for this intervention (CILT average; Kirmess & Maher, 2010). Connected speech samples were obtained in the form of spontaneous speech (the semi-structured interview from the NGA) and semi-spontaneous speech (description of the Cookie Theft) (Goodglass & Kaplan, 1972)). Only the spontaneous speech samples are analysed in the present paper.

The conversational speech samples consist of responses to six questions, three closed questions ('What is your occupation?', 'Where do you live?', and 'What is your favourite TV programme?') and three open questions ('Can you tell me a little about your family?', 'Can you tell me what you did today, before you met me?', and 'What do you usually do during

the summer holidays?'). The conversations were not limited to the given questions, and in several cases the dialogues were extended through additional questions by the SLP to elicit more specific answers as well as further information.

Transcription and standardisation of sample sizes

The oral texts were video-recorded and transcribed by the treating SLP in each case. The transcription is a simple, orthographic one in which all words, including neologisms and attempts at words (false starts) as well as dysfluencies (repetitions, etc.), are included (Lind et al., 2009; Müller, 2006). Aphasia often co-occurs with other speech disorders such as apraxia of speech or dysarthria which may influence the intelligibility of the speaker's utterances (Murray & Clark, 2006). We applied the list of criteria presented in Appendix A to distinguish between words and non-words and between one or more word forms. Before analysis all transcripts were checked against the video recording and if necessary adjusted by the first author, who also segmented the texts into syntactic units (sentences and sentence-equivalent units) (Lind et al., 2009). Inter-rater reliability of transcription and segmentation with the second author was a consensus.

For the quantitative analyses we used standardised text lengths of 200 words to allow for comparison across times and cases (Malvern, Richards, Chipere, & Duran, 2004; Prins & Bastiaanse, 2004). The starting point for the word count for each text was set at the beginning of the response to the first question for the three participants. The truncated samples included the first three questions for all three speakers pre- and post-therapy. To what extent the last three questions were covered depended on the total length of the text sample in each case. For the qualitative content analyses of the conversational interviews, the entire texts were considered for all three cases.

Analytical categories: Nouns and verbs

For the lexical analysis of nouns and verbs, we applied the measures proposed by Lind et al. (2009), with slight modifications. These measures focus on lexical variation (diversity and richness), frequency, and semantic specificity, and they include

a) the proportion of nouns and verbs,

b) the number of types[4] and tokens[5] of nouns and verbs,
c) the number of nouns and verbs which are used only once in the text (hapax legomena) (Malvern et al., 2004),
d) the proportion of high-frequency nouns and verbs,
e) the number of compound nouns in the text, and
f) the proportion of semantically light verbs.

High frequency is defined as the 100 most frequent nouns and 50 most frequent verbs, respectively, in a 9.6-million-word corpus of written Norwegian (news articles) (Lind et al., 2009). As spoken and written language represent different text styles (Biber, 1988), one would ideally base one's frequency calculations on spoken language corpora when analysing oral text production. Recently, frequency lists have also been made available for Norwegian spoken language corpora (conversational data, approximately 1.7 million words), allowing us to compare the results of our measurements of noun frequency based on various types of corpora.[6]

For the measure of semantic specificity of nouns, we count the number of compound noun types in the texts. Compound nouns are generally less frequent and have a more specified lexical meaning than simple nouns. Compounding is also claimed to reflect an increase in vocabulary richness (Fromkin & Rodman, 1998), and compounds are reported to be difficult for speakers with aphasia cross-linguistically (Semenza & Mondini, 2006).

Semantic specificity of verbs is measured as the proportion of semantically light (non-specific) verbs (Butt, 2010), which for Norwegian have been defined as the following by Lind, Kristoffersen, Moen, and Simonsen (2010): *ha* 'have', *være* 'be', *bli* 'become/remain', *holde på med* 'is doing', *drive med* 'is doing', *få* 'get', *gå* 'go', *komme* 'come', *la* 'let' and *ta* 'take'. Gordon (2008) discusses the influence of semantically heavy (rich) versus semantically light (empty) verbs as one of the factors that differentiate between fluent and

[4] Type refers to the number of different nouns or verbs produced in the sample (Malvern et al., 2004).
[5] Token refers to the total number (occurrences) of nouns or verbs produced in the sample (Malvern et al., 2004).
[6] Frequency lists for spoken and written Norwegian are available from the Text Laboratory at the University of Oslo (www.hf.uio.no/tekstlab/frekvensordlister/) (cf. also Johannessen, Priestley, Hagen, Åfarli, & Vangsnes, 2009).

non-fluent aphasia. She argues that the use of light verbs is more efficiently related to syntactic performance for fluent than for non-fluent speakers. Hence, by applying this measure of verb specificity, we may gain relevant information with regard to the three cases in this study (one fluent and two non-fluent).

Analytical categories: Content

For comparable assessment of content across cases and test points, the truncated text samples (200 words) were used. All intelligible utterances except interjections and meta-communicative utterances were classified as information units. Meta-communicative utterances are utterances where the speaker refers to or comments upon his or her own speech production (for example, 'What's it called?', 'I don't remember'). The proportions of information units and meta-communicative utterances in each truncated text are used as quantitative measures of content.

It is difficult, if not impossible, to list content expectations for the type of text elicited in a conversational interview. Oelschlaeger and Thorne (1999) explored the use of correct information units (CIUs) for analysis of naturally occurring conversation and concluded that reliable CIU measures could not be obtained. In recognition of this difficulty, we present extracts from the conversational interviews for each case with qualitative evaluations as part of the content analysis.

Small group analysis and effect sizes

The request for effect size calculation increases for all types of intervention research (Beeson & Robey, 2006). As we lack normative and/or comparable data from a larger clinical group for many of the Norwegian tests, the calculation of individual effect sizes was not feasible in this study. Hence, a similar procedure as the one used by Kirmess and Maher (2010) is applied where group effect size is calculated based on the difference of the mean of each test or variable divided by the mean standard deviation of the pre-therapy result for the group (three cases). Group effect sizes of 1.0 equal one standard deviation in normal distributed samples, and effect sizes of 0.5 and 0.8 reflect medium and large changes, respectively (Domholdt, 2005). In order to differentiate treatment effects from spontaneous recovery, Robey (1998) recommends a group effect size of minimum 0.63.

Results

Individual results on the standardised test battery

The results on the standardised tests indicate an overall improvement on speech production tasks compared to minor or no outcome changes on receptive tasks and writing. Individual variation should be noted. Table 2 presents a summary of the results from selected parts of the formal test battery.

Table 2 Results on the standardised tests (raw scores).

Assessment (number of items)	MX		LL		HP	
	Pre	Post	Pre	Post	Pre	Post
CILT baseline (180)	113	157	45	146	71	94
PALPA 54 - naming (80)	68	80	46	58	30	49
VOST sentence production (20)	12	19	15	17	3	12
NGA naming (41)	36	41	37	39	22	32
NGA repetition (40)	26	36	36	37	4	6
NGA comprehension (71)	69	71	59	58	70	69
NGA writing (10)	7	8	1	3	8	7
TROG-2 comprehension (80)	73	77	48	49	67	74

Individual results for text production

Table 3 summarises the results from the quantitative text production analysis, including the number of words and speech fluency (words per minute) for the whole text, and the MLU[7] for the truncated samples (200 words) for all three cases and test times.

[7] One utterance equals one syntactic unit.

Table 3 Overall quantitative measures of text production.

	MX		LL		HP	
	Pre	Post	Pre	Post	Pre	Post
Number of words	234	320	1302	745	582	222
Speech fluency (words per minute)	37.6	40.4	96.7	97.6	54.4	69.8
Mean length of utterance*	3.3	3.3	4.2	4.9	3.6	5.6

*One utterance equals one syntactic unit.

These results reveal individual variations on the different parameters. MX shows an increase in word production and speech fluency post-intervention in line with our assumptions, whereas his results remain stable for MLU. For LL and HP, on the other hand, the number of words produced post-therapy decreases tremendously for various reasons. For LL, there are different conversation partners pre- and post-test, and the pre-test sample contains an extensive help section to name a particular TV show. LL's speech fluency is consistent during the intervention, but she produces longer utterances post-intervention. HP's conversational interview data pre-test were acquired by extended support and interaction with the SLP to overcome word-finding problems, unintelligible utterances, and multiple attempts of self-repair due to apraxia of speech. Despite a shorter text production, HP's speech fluency increases, and she produces remarkably longer utterances post-therapy, which may be related to a reduction of false starts.

Noun production

On the basis of the treatment focus, we assumed positive outcome changes for nouns with more nouns (tokens and types) produced and more nouns occurring only once (*hapax legomena*) post-intervention. With an improved ability to find words (in particular nouns) we also assumed that the speakers would be less reliant on retrieving high-frequency items and items with a more general semantic meaning (Hickin, Herbert, Best, Howard, & Osborne, 2007). Hence, we expected fewer high-frequency nouns and more compound nouns post-intervention. Table 4 summarises the results of noun production for all three cases and test times in the conversational interview.

Table 4 Measures of noun production based on truncated text samples (200 words).

	MX		LL		HP	
	Pre	Post	Pre	Post	Pre	Post
Proportion of nouns (%)	10.5	11	3.5	7	10.5	12.5
Number of noun tokens	21	22	7	14	21	25
Number of noun types	15	19	7	13	16	18
Number of hapax legomena	10	16	7	12	13	14
Frequency (1-100) written (%)	13	16	43	38	31	39
Frequency (1-100) spoken (%)	13	11	14	31	25	44
Number of compound nouns	2	5	0	0	1	2

Noun production parameters vary across the three cases, but in general there is an increase of different noun types and noun tokens in the post-intervention conversation. Both the non-fluent cases (MX and HP) produce more nouns at all the measuring points than the fluent case (LL), even though LL presents the greatest improvement by doubling her noun production. Despite the small number of nouns produced, LL also has a higher lexical variation with, relatively speaking, more different noun types. Lexical richness (the number of *hapax legomena*) increases for all three speakers in the conversational interview.

For the proportion of high-frequency nouns, we see rather a lot of variation across speakers and the corpora used for measuring frequency. MX shows a tendency to produce fewer high-frequency nouns post-therapy when the measure is based on a spoken corpus, whereas there is an opposite tendency when the measure is based on a written corpus. LL presents the opposite pattern, with a decrease of high-frequency nouns post-intervention based on the written corpus and an increase of high-frequency nouns based on the spoken corpus. HP uses more high-frequency nouns post-therapy independent of the corpus.

The number of compound nouns in the texts varies across cases. MX shows a clear increase in the number of compound nouns. The compound nouns that he uses post-therapy are also less frequent and more complex than the ones used in the pre-therapy sample, for example, pre-test *utsiden* 'the outside' and *enebolig* 'detached house' (pre-test) versus *kvalitetsanalyse* 'quality analysis' and *tippeligakamp* 'premier league match' (post-test). HP also shows a

tendency to use more compound nouns post-intervention, although she has very few tokens all together. LL, who has the lowest proportion of nouns at both test points, does not produce compound nouns in these data at all.

Verb production

As the CILT treatment targeted noun activation specifically and involved only a limited amount of verb production, we did not expect particular outcome changes in verb production post-therapy.[8] In table 5, the results of verb production are presented for all three cases and both test times in the conversational interview.

Table 5 Measures of verb production based on truncated text samples (200 words).

	MX		LL		HP	
	Pre	Post	Pre	Post	Pre	Post
Proportion of verbs (%)	18.5	21.5	19	18	18.5	15
Number of verb tokens	37	43	38	36	37	30
Number of verb types	12	12	17	11	16	13
Number of hapax legomena	5	8	11	5	10	10
High frequency verbs (%)	75	75	71	73	56	46
"Light" verbs (%)	33	17	29	9	31	15

As assumed, none of the speakers show a clear improvement in verb production post-therapy. The proportion of verbs as well as the lexical variability reflect individual variation across cases and test times. For HP there is a decrease of high-frequency verbs post-intervention, whereas there is no change and a slight increase on this measure for MX and LL, respectively. In general, there is a high proportion of high-frequency verbs in all the text samples. For all three cases there is a pronounced decrease of light verbs in the conversational interview. In other words, despite an overall relatively stable proportion of verbs, more specific verbs are produced after the intervention in the conversational interview. Clear differences in the use of light verbs for fluent and non-fluent aphasia as proposed by Gordon (2008) are not confirmed by these results. Contrary to previous studies (*cf.* Goral &

[8] Given a therapeutic focus on verbs, the same types of expectations could in principle be made for verbs as for nouns, that is, a higher proportion of verbs, higher lexical variability, more verbs occurring only once, fewer high-frequency verbs, and fewer semantically light verbs.

Kempler, 2009), all three cases produced a higher proportion of verbs than nouns at all measuring points.

Content analysis

The relevance of improvement in word production also relates to the improvement of informativeness and expression of meaningful content. With more words available for the speaker we assume that more content can be expressed and/or more detailed information presented. Truncated samples of the conversational interview (200 words) were used to explore the percentage of information units and meta-communicative utterances as a measure of content across cases. Table 6 summarises the findings.

Table 6 Content analysis based on truncated text samples (200 words).

	MX		LL		HP	
	Pre	Post	Pre	Post	Pre	Post
Information units %	34	48	29	44	47	64
Meta-communicative utterances %	5	5	31	15	18	6

All three speakers show a clear increase in the percentage of information units post-intervention, supporting our assumption. Meta-communicative utterances decrease noticeably for LL and HP. However, a substantial percentage of syntactic units are not accounted for by these two categories, including single-word utterances, often in the form of interjections, and sentence fragments with deictic reference, for example, *den der* 'this there'. In the dialogical context of the conversational interview these types of utterances are potentially related to the influence of the communication partner, a point which we will return to in the discussion.

Qualitatively, we note that all three speakers produce relevant answers to all of the questions at all of the test times, but with varying amounts of information. The amount and specificity of information provided are independent of the type of question (closed or open). Appendix B presents the content themes for each case pre- and post-intervention in an anonymised format. Despite aphasic language difficulties, all three speakers attempt a speaking style with syntactically complex utterances orientated at pre-stroke communicative behaviour, see text examples in the appendix and comments in the following section.

To provide further insight from a qualitative perspective, text extracts from the conversational interviews are presented for illustration; see Appendix C. The texts by MX are characterised by attempts of self-correction, because of his apraxia of speech, and he benefits from semantic prompting provided by the SLP. Post-intervention, he is more successful at correct completion of the produced utterance. His responses to the questions by the SLP are more elaborate; hence, he provides more information.

LL's speech production reflects her word-finding problems. She often produces general answers as a first response, for example, 'nothing in particular', and her contributions consist of circumlocutions and repetitive attempts. Post-intervention, she expands her general responses to a higher degree, and the increased production of content words enhances the informativeness of her texts. On the basis of the complete text, the provision of more specific question by the SLP supports LL's communicative effectiveness.

HP seems to make the clearest progress in relation to informativeness. Apparently, she covers similar content in both text samples, although after the intervention her responses contain more specific information. She also produces more intelligible and complex utterances post-therapy, and seem to be less dependent on supporting questions by the communication partner.

In summary, MX, LL and HP provide more information post-intervention, and their contributions also contain more specific information after treatment, indicating relevant benefit from the CILT intervention for everyday communication. It has to be noted that none of the topics in the conversational interview were treated in the CILT intervention. Individual talking styles also have to be considered, and improvement may reflect changes on different levels in speech production. Whereas MX and HP improve informativeness to a large degree by producing more intelligible utterances, LL profits on more noun activation in her speech production.

Group outcome

In recognition of the small number of participants in this study, we emphasise that the results should be interpreted mainly on the individual level. However, careful calculation of effect sizes on group level can provide indication of treatment effects beyond spontaneous recovery. Table 7 lists the effect sizes for the presented data for the group of three cases. For easier

interpretation of the results, effect size signs are inverted, so that a positive sign reflects an increase from pre- to post-test, and a negative sign reflects a decrease.

Table 7 Group effect size calculation for all presented measures.

Assessment	M Pre-test	M Post-test	M Std error Pre-test	SD Pre-test	d*
CILT average	76.2	131.8	19.8	34.4	1.6
PALPA 54-naming	48	62	11.0	19.1	0.8
VOST-sentence construction	10	16	3.6	6.2	1
NGA-naming	31.5	36.7	2.6	4.6	0.6
NGA- repetition	22.3	27	9.7	16.9	0.3
NGA- comprehension	66	66	3.5	6.1	0
NGA- writing	5.3	6	2.2	3.8	0.2
TROG-2	62.7	66.7	7.5	13.1	0.3
NGA-conversation (200 words truncation)					
MLU	3.7	4.6	0.3	0.5	2
Information units	36.7	48.7	5.4	9.3	1.3
Meta-communicative units	18	8,7	7.5	13	-0.7
Proportion of nouns	8.2	10.2	2.3	4.0	0.5
Noun tokens	16.3	20.3	4.7	8.1	0.5
Noun types	12.7	16.7	2.8	4.9	0.8
Hapax legomena (nouns)	10	14	1.7	3	1.3
Frequency (nouns); written corpus	29	31	8.7	15.1	0.1
Frequency (nouns); spoken corpus	17.3	28.7	3.8	6.7	1.7
Compound nouns	1	2.3	0.6	1	1.3
Proportion of verbs	18.7	18.2	0.2	0.3	-1.7
Verb tokens	37.3	36.3	0.3	0.6	-1.7
Verb types	15	12	1.5	2.6	-1.1
Hapax legomena (verbs)	8.7	7.7	1.9	3.2	-0.3
Frequency (verbs)	67.3	64.6	9.2	16.0	-0.3
Light verbs	31	13.7	1.2	2	-8.7

*Effect size was calculated by the following formula: $d = \frac{Mpre - Mpost}{SDpre}$

The data show medium to large effect sizes for all but one of the verbal expressive tasks of the standardised test battery and the effect sizes exceeds those of spontaneous recovery alone as reported by Robey (1998). Receptive tasks indicate small changes, thereby supporting a treatment-specific outcome for improvement of spoken language.

Group data from the conversational interview support the general impression of increased verbal speech production measured in MLU and number of informative units, both of which surpass the effect size of spontaneous recovery alone. The contradiction in frequency use for nouns based on the spoken corpus is also captured in the rather strong effect size (d = 1.7) and will be commented on in the following section. The difference of the treatment focus on nouns versus verbs in this CILT intervention is reflected in the group effect sizes, which are increasing and of medium to large size for noun variation and specificity and strongly decreasing for verbs. Light verbs as a relevant measurement variable for verb specificity are supported by a very large effect size.

Because of the limited number of cases presented here, even small changes in either direction may influence the outcome of such a calculation. Therefore, the results should be considered with caution and are used only to support the discussion of outcome results for the particular group of cases that we present in this article.

Discussion

On the basis of these predominately positive improvements on various speech production tasks in the quasi-experimental test context, the main focus of this study was to explore the possible generalisation to oral text production tasks. This may eventually indicate a potential for generalisation to spontaneous speech production in an everyday context of communication. The use of oral text production for measuring treatment outcome is challenging and calls for further discussion of several aspects.

Treatment effects versus spontaneous recovery

In general, treatment intervention in the early phase always has to consider the influence of spontaneous recovery as a main reason for outcome change (Robey, 1998). Because this study focuses on the usefulness of parameters for text analysis for treatment outcome, the

relevance of spontaneous recovery is acknowledged, but not discussed in any detail.[9] Spontaneous recovery is assumed to have a more general overall effect (*cf*. Pedersen, Vinter, & Olsen, 2004); hence, we would have expected a similar activation pattern for nouns and verbs post-intervention. However, this hypothesis was not supported by the presented cases. Thus, when effects are observed, they can be attributed to treatment rather than to spontaneous recovery. To what extent the effects last is a question beyond the scope of the present article.

Quantitative versus qualitative changes

The interpretation of improvement in speech production is not straightforward. For example, word production could increase as the positive result of enhanced word activation as well as decrease because of fewer error-ridden activation patterns (Bauer & Auer, 2009). Armstrong (2000) argues that producing less text does not necessarily reflect a negative change. For instance, the use of syntactically simpler structures can be a good way for a speaker with aphasia to enhance the informativeness of their text production (*cf*. the interpretation of linguistic resources in conversational contributions by speakers with aphasia as strategic adaptations (Beeke, Wilkinson, & Maxim, 2007; Wilkinson, Beeke, & Maxim, 2003)). In the case of MX, it can be argued that introducing him to the strict syntactical structure of the CILT procedure resulted in simpler but more syntactical correct utterances and content. He described himself as a speaker who was used to talking in long and complex sentences, which partially limited his communicative effectiveness after acquiring aphasia.

Changes in informativeness are difficult to assess quantitatively because of the influence of the individual's interaction with the communication partner (Armstrong & Ferguson, 2010). One indication of improvement can be a change in turn taking and interactional behaviour, as when a speaker takes on a more active role compared to purely responding to the questions from the interlocutor. For example, when asked to talk about his family post-therapy, MX initiates a repair sequence – *skal du ha den gamle eller?* 'do you want the old one or?' – before proceeding with his response to the question. This aspect warrants further exploration in future studies.

The discourse or text type

[9] For an extended discussion of spontaneous recovery related to this CILT intervention, see Kirmess and Maher (2010), which is supported by the line of arguments in Links, Hurkmans, and Bastiaanse (2010).

Armstrong (2000) addresses the influence of the text-sampling procedure for different discourse genres, acknowledging higher efficacy scores and cohesive harmony in spontaneous discourse than for picture description. Further, Doyle, Goda, and Spencer (1995) report a higher percentage of informative words produced in conversational discourse compared to structured discourse tasks. Previous CILT studies applying assessment of semi-spontaneous text production have indicated mixed outcomes (Faroqi-Shah & Virion, 2009; Maher et al., 2006; Naeser et al., 2010), whereas analysis of spontaneous texts has indicated positive results for generalisation of outcome measures (Goral & Kempler, 2009). In our data, all three cases present quantitative and qualitative improvement of speech production in the conversational context, which further supports the use of spontaneous text samples as a relevant outcome measure.

In general, the ideal treatment outcome for language intervention implies generalisation to everyday communication. The conversational interview relates closer to natural conversation, and using it as a treatment outcome measure thus strengthens the ecological validity of the results. However, an obvious advantage of more structured tasks is the opportunity for comparison of performance related to a stable type of stimuli across speakers and times (McNeil et al., 2001). Overall, in the same way that connected speech production is said to complement other types of test and assessment methods (naming tasks, single-sentence production, etc.), different types of connected speech production may complement each other.

The communication partner

The amount and type of individual support by different, non-aphasic communication partners have to be considered a relevant factor for the amount and content of speech production for all of the text samples (Armstrong & Ferguson, 2010; Simmons-Mackie & Kagan, 1999). While having different communication partners reflects a more real-life setting and thereby enhances ecological validity, it entails methodological challenges for the text analysis. This is illustrated in the conversational interviews with LL. LL produced substantially different text lengths (*cf.* table 3) pre- and post-intervention, which may be related to the fact that she had different communication partners on the two occasions. The length and complexity of the syntactic units may also be influenced by the communication partner, in the sense that more interruptions and repair questions from the communication partner may result in more one-word utterances from the speaker with aphasia.

Frequency

Both type and token frequency of lexical items and grammatical constructions are considered crucial for language processing in functionalist approaches to linguistics (Bybee, 2007, 2010). Frequency of usage is furthermore a factor which is used as a variable in aphasia assessments developed within the framework of linguistics and cognitive neuropsychology (Bastiaanse, Maas, & Rispens, 2000; Kay, Lesser, & Coltheart, 1992). When the ability to retrieve lexical items from the mental lexicon is impaired, as is the case with most aphasic speakers, there is a general expectation that low-frequency items will be more affected than high-frequency items. This will be particularly evident in language-processing conditions that lead to a cognitive overload for the individual with aphasia (contexts in which the individual is supposed to perform multiple tasks simultaneously, such as participating in a conversation or producing a description of a complex scene) (Simonsen & Lind, 2002).

Hickin et al. (2007) propose a general expectation of a decrease in high-frequency nouns' activation as a positive outcome measure for lexically and functionally based treatments. In our data the results regarding frequency were not clear cut. There are extensive individual variations and differences depending on the corpus used (*cf*. table 4). Some of the variation may of course be due to the low number of speakers in our study.

Limitations in the types of corpora used for measuring frequency and the decision where to draw the line between high- and low-frequency items may also influence the results. For nouns we based our measurements on the 100 most frequent lexemes in the most recent written and spoken corpora available for Norwegian, and it is of course debatable whether this is too narrow a limit. However, we also examined our data with the limit drawn at the 3000 most frequent nouns without getting any clearer results.

There may also be another interpretation of the varying results that we obtained regarding frequency of nouns. This interpretation depends on the initial number of nouns available to the speakers. LL and MX are opposite examples in this respect. For LL in the conversational interview, only 3.5% of the words in the truncated text sample were nouns pre-test, and the increase to 7% nouns post-test was due first and foremost to an increased activation of high-frequency nouns. On the contrary, MX showed a much higher and rather stable proportion of nouns both pre- and post-intervention (21% and 22%, respectively). He had a small decrease of high-frequency nouns and an increase of compound nouns post-therapy though, in

accordance with our expectations. To what extent one should expect a decrease of high-frequency items following intervention seems therefore partially to be related to or dependent on the number of items from the relevant word class which are available to the speaker at the outset.

The fluent or non-fluent aphasia type

In the intervention study by Kirmess and Maher (2010), expectations for treatment outcome were based on general expectations across cases irrespective of the individual features of impairment. However, the type and severity of aphasia and individual characteristics of the language impairments have to be considered interactive factors (Code, Torney, Gildea-Howardine, & Willmes, 2010). Faroqi-Shah and Virion (2009) reported better improvement chances for more severe aphasic speakers, whereas our participants were characterised as mild to moderate aphasic speakers and still showed remarkable changes post-intervention.

Further, speakers with fluent, anomic aphasia have previously been reported to have specific difficulties with noun activation (Laine & Martin, 2006), and LL's results support this finding. Acknowledging the limitations of text lengths, LL produced a markedly lower proportion of nouns than MX and HP, who were classified as non-fluent speakers. As discussed above, the relative level of activation of nouns pre-therapy may be an influential factor when determining expectations for treatment outcome, and this level is furthermore related to the aphasia type. In other words, when treatment outcome is evaluated, the aphasia type seems to be an important factor in addition to individual characteristics.

Additional factors

Personal characteristics such as age, motivation, and previous training experience are described as influential factors on treatment outcome (Holland, 1989). All three participants were highly motivated for participating in the study; however, the two female participants (LL and HP) were much older than MX, who had the best overall outcome. MX also survived an intracerebral haemorrhage, which is assumed to have better rehabilitation potential than vascular strokes (Murray & Clark, 2006). Individual daily variation because of factors such as fatigue and home leave permissions may also influence performance of verbal speech production. Further, concerning the intensity of CILT, quantitative differences in the received sessions of treatment are assumed to have an impact on the outcome. For various reasons, HP received fewer hours of therapy (20 hours) than MX and LL (27 hours each). The absence of

apraxia of speech was expected to be an advantage for treatment outcome; hence, LL was assumed to make better progress. However, there was no marked difference between the presented cases, and the structure of the particular type of intervention which was conducted even seemed to be helpful for reducing the apraxia of speech itself.

Conclusion

In conclusion, the applied measures of oral text analysis have provided a helpful structure for interpreting changes in the use of lexical resources by speakers with aphasia in this intervention study. We evaluate the measures to be feasible for use in a clinical context. This particular CILT intervention puts more emphasis on noun activation than on verbs, which seems to be captured in the results for the oral text analysis. The usefulness of oral texts as a supplement to standardised tests for the analysis of treatment outcome is thus supported. Individual differences for treatment outcome should be expected according to the heterogeneity of the population of speakers with aphasia and their individual talking styles based on subject and communication partners. However, further research is warranted, especially for the generalisation of a strict treatment structure such as CILT.

The proposed measures of semantic specificity (compound nouns and proportion of light verbs) seem to capture this variable in a better way than the previous suggestion by Lind et al. (2009). Further research is necessary, particularly with regard to the measurement of semantic specificity of nouns. Further, content analysis is considered a necessary addition to purely lexical and syntactic analyses with reference to the communicative aspects of the texts.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Appendix A Criteria for transcription and coding

- In cases of whole word repetition the occurrences are counted as separate words, even when the repetition includes a neologism or a phonological paraphasia, for example, *oppvasken vasken* 'dishwashing washing' (two words) or *fisitt visit* rounds (two words). (*Fisitt* is a non-word in Norwegian, possibly the result of a phonological substitution.)
- In cases of a single sound or syllable repetition the production is counted as one word only unless there is a marked prosodic break between the repeated parts, for example, *e-ett* 'o-one' (one word) and *dytt-dytta* 'push-pushed' (one word).
- Unintelligible words are marked with X (or X = for longer utterances), but are not counted as words.
- Neologisms are not included in the word count for the lexical analysis because of their limited validity and reliability.

Appendix B Content themes provided by each case during the conversational interview

NGA question	MX		LL		HP	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1.Occu-pation	Firm, work place, education	Title, firm, work place, work content, head quarter, business development	Previous working place (type and name), followed by next place and why	Previous working place(type an title), activity, discusses the non-specific title	Title (relevant extension to family) Work with children	Title, activity, place
2. Living place	City, area, housing	City, area, distance	Street name & number	Street name & number, city	City and com-munity	Now and previous address, building the place
3. TV program	Movies, sports: explains why and includes personal experience	Documentary, No football	Entertainment and quiz-shows. Discussion about certain TV-show: time , channel and program order	Quiz-shows and entertaining	Actualities, news	News, movies
4. Family	Spouse, children (age) & relationship	Spouse (name), children (name, age) siblings, order, responsibi-lities	Mother, childhood, personal characteristic, relatives	Mother, father, childhood, personal characteristic s, relatives Quotes others, Own children (name)	Number of children, short description of some of them (age, occupation)	Number of children. Family development
5. Things done earlier on the same day	Training, seeing a doctor	Therapy, meal	Personal hygiene (3 tasks), eating, tries to name a therapeutic activity	Wake-up situation, preparations evening before and personal characteristic s	Wake-up time, personal hygiene (3 tasks)	Treatment, what and amount (twice a day)
6. Summer activity	Cottage, place. Recognition of place in other situation	Fishing-extension to type and how, Boat	General answer. Extends to travelling abroad with family.	General answer. Extends to backyard activities, social relations. Reflection about previous times	Work with people	Mountain trips, work, pets, being a host

Appendix C Examples from the conversational interview

MX

Pre-test

SLP:	*du*	*hvilket*	*yrke*	*har*	*du*	*eller*
	you-SG	which	occupation	have-PRES	you-SG	or
	har	*du*	*hatt?*			
	have-PRES	you-SG	had?			

'tell me which occupation you have or had?'

MX:	*jeg*	*har*	*vært*	*/lom-l/*	*ja*	*/ip-pa pe-py/*	*nei*	*jeg*
	I	have-PRES	been	/lom-l/	yes	/ip-pa pe-py/	no	I
	klarer		*ikke*	*å*	*si*	*det*		
	manage-PRES		not	to	say	it		

'I have been /lom-l/ yes /ip-pa pe-py/ no I can't say it'

SLP:	*du*	*klarer*	*ikke*	*å*	*si*	*det*	*i*	*dag*
	you-SG	manage-PRES	not	to	say	it	in	day

'you can't say it today'

MX:	*nei*
	'no'

SLP:	*du*	*har*	*jobba*	*på*	*f...*	*Norsk I?*
	you-SG	have-PRES	worked	on	f…	Norwegian I?

'you have worked at f… Norwegian I?'

MX:	*Industri*
	'Industry'
SLP:	*Norsk Industri*
	'Norwegian Industry'
MX:	*ja*
	'yes'

Post-test

SLP:	*det*	*første*	*jeg*	*lurer*	*litt*	*på*	*her*	*hvilket*	*yrke*
	it	first	I	wonder-PRES	little	on	here	which	occupation
	har		*du?*						
	have-PRES		you-SG?						

‘the first thing I wonder about now which occupation do you have?’

MX: *jeg er /lam-lab la-le-le-by labyrant/ er en*
I am /lam-lab la-le-le-by labyrant/ am a
‘I am a /lam-lab la-le-le-by labyrant/ am a’

SLP *kanskje du kan starte med å si hvor du*
maybe you-SG can start with to say where you-SG
jobber?
work-PRES?
‘maybe you can start by saying where you work?’

MX: *jeg jobber på Norsk Industri og det er jeg*
I work-PRES on Norwegian Industry and it is I
er ja labo-laborant mhm
am yes labo-laboratory assistant mhm
‘I work at Norwegian Industry and it is I am yes a labo-laboratory assistant mhm’

SLP: *ja går det an å si noe mer om*
yes go-PRES it [particle] to say something more
about
hva en laborant gjør?
what a laboratory assistant do-PRES
‘yes could you say something more about what a laboratory assistant does?’

MX: *tja det er jo f-kvalitets-ff-analyse*
well it is yes f-quality-ff-analysis
‘well it is you know f-quality-ff-analysis’

SLP: *akkurat av hva da?*
precisely of what then
’right of what then?’

MX: *ja det er alt på fr-fra fra fs-tom-tømmer*
yes it is everything on fr-from from fs-tom-timber
til ja ferdig ferdig f- tre tremasse
till yes finish finish f- wood *mechanical wood pulp*
‘yes it is everything on fr-from from fs-tom-timber till yes finished finished f- wood *mechanical wood pulp’*

LL

Pre-test

SLP: *hva* *pleier* *du* *å* *gjøre* *om* *sommeren?*
what use-PRES you-SG to do during summer-the
'what do you usually do during the summer?'

LL: *og* *nei* *ikke* *noe* *spesielt*
and no not something special
'and no nothing in particular'

SLP: nei
'no'

LL: *jeg* *gjør* *ikke* *det* *jeg* *er* *ikke* *no* *sånt* *jeg*
I do-PRES not it I am not something such I
er *ikke* *noe* *sånn* *aktiv* *i* *noe* *som* *helst* *jeg*
am not something such active in something which any I
er *flink* *sånn* *men* *jeg* *er* *vanlig* *bare*
am good such but I am ordinary just
'I don't I'm not such I'm not like active in anything I'm like good but I'm just ordinary'

SLP: *ja* *hjemme* *og* *kose* *deg* *litt* *i* *sola*
yes home and enjoy you-SG little in sun-the
'yes at home enjoying yourself a little in the sun'

Post-test

SLP: *hva* *pleier* *du* *å* *gjøre* *om* *sommeren?*
what use-PRES you-SG to do during summer-the
'what do you usually do during the summer?'

LL: *ja* *ikke* *noe* *spesielt* *bare* *liksom* *em* *hvis* *for*
yes not something special just like em if for
eksempel *i* *vi* *satt* *mye* *hjemme* *i* *gården* *hos*
example in we sat much home in backyard-the at
meg *her*
me here
'yes nothing special just like em if for instance in we sat at home in my backyard a lot'

SLP: mm

'mm'

LL:	*og*	*der*	*eh*	*da*	*hadde*	*vi*	*rene*	*cafeen*		*der*	*vi*	*en*
	and	there	eh	then	had	we	like	café-the		there	we	a
	dame	*og*	*jeg*	*og*	*vi*	*tok*	*dette*	*her*	*og*	*og*	*og*	
	lady	and	I	and	we	took	this	here	and	and	and	
	arrangerte		*det*	*hele*	*og*	*og*	*vi*	*og*	*så*	*kom*	*noen*	
	arranged		it	whole	and	and	we	and	then	came	someone	
	med	*kaffe*	*og*	*så*	*kom*	*noen*		*med*	*litt*	*sånn*	*ja*	*med*
	with	coffee	and	then	came	someone		with	little	such	yes	with
	en	*kake*	*eller*	*sånne*	*ting*	*og*	*så*	*lagde*	*vi*	*et*	*helt*	*eh*
	a	cake	or	such	things	and	then	made	we	a	whole	eh
	jeg	*vet*	*en*	*sankthans*				*så*	*lagde*	*vi*	*eh eh*	*ja*
	I	know	one	midsummer night's eve				then	made	we	eh eh	yes
	jeg	*tror*	*det*									
	I	think	it									

'and there eh then we had like a café there we a lady and I and we took this here and and and arranged all of it and and we and then some brought coffee and then some brought a little such yes a cake or such things and then we made a whole eh I know one midsummer night's eve we made eh eh yes I think so'

HP

Pre-test

SLP:	*hva*	*pleier*	*du*	*å*	*gjøre*	*om*	*sommeren?*	
	what	use-PRES	you-SG	to	do	during	summer-the	

'what do you usually do during the summer?'

HP:	*vet*		*da*	*(uforståelig)*		*varmt*	*da*	*er*	*jeg*	*i*	*vel*
	know-PRES		then	(incomprehensible)		warm	then	am	I	in	well
	i	*/dan/*	*bare*	*jeg*	*(uforståelig)*		*jeg*	*gjør*		*jeg*	
	in	/dan/	just	I	(incomprehensible)		I	do-PRES		I	
	jobber										
	work-PRES										

'know then (incomprehensible) warm then I'm in well in /dan/ I just (incomprehensible) I do I work'

SLP: *du* *jobber?*
you-SG work-PRES?
'you work?'

HP: *ja*
'yes'

SLP: *med* *hva* *da?*
with what then
'doing what?'

HP: *med* *alle* *mennesker* *som* *kommer* */huer/* *tyve* *ti* *hvor*
with all people-PL who come-PRES /huer/ twenty ten how
mange *er* *det* *ti* *hunder* *hver* *dag*
many is it ten hundred every day
'with all the people who come /huer/ twenty ten how many are there ten hundred every day'

SLP: *mange* *mennesker* *som* *kommer* *innom?*
many people-PL who come-PRES by
'a lot of people who come by'

HP: *ja*
'yes'

SLP: *lager du mat eller?*
make-PRES you-SG food or
'do you cook or?'

HP: *nei men se alt alt går bra*
no but see-INF everything everything go-PRES good
'no but see everything everything goes well'

Post-test

SLP: *hva* *pleier* *du* *å* *gjøre* *om* *sommeren?*
what use-PRES you-SG to do during summer-the
'what do you usually do during the summer?'

HP: *om* *sommeren* *er* *jeg* *masse* *på* *fjellet* *og* *da*
during summer-the am I much on mountain-the and then
masse *å* *gjøre* *der* *oppe* *der* *er* *masse* */juster/* *og*
much to do there up there are much /juster/ (guests?) and

	f-	*og*	*mange*	*work*	*(uforståelig)*	*kikke*	*på*	*alle*	*dyrene*	
	f-	and	much	work	(incomprehensible)	look	at	all	animals-the	
	våre									
	our									

'during summer I'm a lot in the mountains and then a lot to do up there there are a lot of /juster/ (guests?) and f- and a lot of work (incomprehensible) looking at all our animals'

SLP: *mhm*

'mhm'

HP:	*så*	*veldig*	*jø-*	*det*	*må*	*gjerne*	*vær*	*være*	*/justen/*	*da*	*da*
	so	very	jø-	it	must	well	be	be	/justen/	then	then
	er	*jeg*	*vertinne*		*der*						
	am	I	hostess		there						

'so very jø- it must very well be be /justen/ then then I'm the hostess there'

SLP:	*der*	*er*	*du*	*vertinne*
	there	are	you-SG	hostess

'there you're the hostess'

HP:	*og*	*ja*	*det*	*er*	*jeg*
	and	yes	that	am	I

'and yes so I am'