

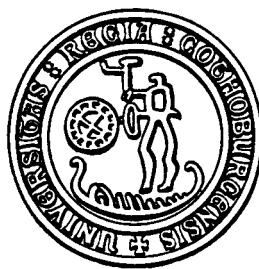
INFERENCE
AND
CONVERSATIONAL INTERACTION

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INFERENCE
AND
CONVERSATIONAL INTERACTION

Pragmatic language disturbances related to stroke

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INFERENCE AND CONVERSATIONAL INTERACTION

Pragmatic language disturbances related to stroke

Abstract

Language use at a discourse level, or in conversational interaction, puts high demands on human cognition. Brain damage can often result in pragmatic language disturbances, even if different language functions taken separately seem to be intact. In this thesis, post-stroke pragmatic ability in inferencing and in conversational interaction is explored.

The ability to make inferences for comprehension and its association with sustained attention and verbal working memory capacity are studied in two experimental group studies with 14 right-hemisphere-damaged (RHD) individuals, 14 left-hemisphere-damaged (LHD) individuals, and a control group consisting of 14 non-brain-damaged individuals, matched for age, sex, education and reading habits. Change in the ability to interact in conversation and the degree of negative impact of this change are also investigated in a group study, using a questionnaire distributed to the brain-damaged individuals and their conversational partners (CP). The impact of pragmatic language disturbances at the individual level is explored in four case studies where the quantitative and qualitative results of the experimental cognitive tasks and the questionnaire are supplemented by an analysis of video-recorded natural conversation.

The key findings show that the groups have somewhat different patterns of results in the inference tasks. The LHD group primarily had trouble with tasks requiring an ability to revise inferences, and their results on those tasks tended to be associated with verbal working memory. The RHD group also had problems with tasks requiring the ability to revise inferences, but their results were associated with sustained attention. The RHD subjects also had problems making inferences about characters' attitudes or motives but no associations were seen between results on these tasks and verbal working memory or sustained attention. It was found that the LHD individuals and their CP tended to report more post-stroke changes and negative impact of these changes in conversational interaction than the RHD subjects and their CP. However, several of the RHD subjects and their CP who *did* report changes perceived a high degree of negative impact of these changes. The LHD and RHD groups often reported similar pragmatic areas as being affected in conversation and this was observed in the video-recorded conversational interaction as well. It is inferred from the results that expressions of pragmatic disorders post-stroke may be subtle and expressed in ways that are not traditionally related to language disturbances. Furthermore, even subtle pragmatic language disorders have an impact on, and also depend on, the role of the conversational partner.

The results are approached from a perspective in which pragmatic ability in association with brain damage is seen as the outcome of interaction between several different cognitive functions, personality and compensatory strategies in the brain-damaged individual as well as in his or her conversational partners.

KEY WORDS: Right-hemisphere brain damage, Pragmatics, Cognition, Subtle language disorder, Attention, Working memory, Inference, Conversational interaction

The thesis is written in English.

INFERENS OCH SAMTALSINTERAKTION

Pragmatiska språkstörningar i samband med stroke

Abstract

Språkanvändning på diskursnivå, eller i samtalsinteraktion, ställer höga krav på mänsklig kognition. Hjärnskada kan ofta resultera i pragmatiska språkstörningar, även om olika språkfunktioner var för sig tycks vara intakta. I denna avhandling undersöks pragmatisk förmåga i form av förmåga att dra slutsatser om betydelse och att interagera i samtal efter stroke.

Sambanden mellan förmågan att dra slutsatser för förståelse, att bibehålla uppmärksamheten över tid (sustained attention) och verbalt arbetsminne studeras i två experimentella gruppstudier med 14 högerhemisfärskadade (HHS) individer, 14 vänsterhemisfärskadade (VHS) individer och en kontrollgrupp med 14 icke hjärnskadade individer, matchade med avseende på ålder, kön, utbildning och läsvanor. Förändringar i förmåga att interagera i samtal och grad av negativ påverkan av denna förändring undersöks också i en gruppstudie med hjälp av ett frågeformulär som distribuerades till de hjärnskadade individerna och deras samtalspartners (SP). Påverkan av pragmatisk språkstörning på individnivå undersöks i fyra fallstudier, där kvantitativa och kvalitativa resultat från de kognitiva uppgifterna och frågeformuläret kompletteras med analys av videoinspelad samtalsinteraktion.

De viktigaste fynden visar att gruppernas resultat på förståelseuppgifterna skiljer sig åt. VHS-gruppen hade primärt problem med uppgifter som krävde förmåga att revidera en slutsats och deras resultat på dessa uppgifter tenderade att korrelera med kapacitet i verbalt arbetsminne. HHS-gruppen hade också problem att revidera slutsatser, men deras resultat korrelerade med förmåga att bibehålla uppmärksamhet över tid. HHS-gruppen hade även problem med att dra slutsatser om en karaktärs attityd eller motiv men det fanns ingen korrelation mellan resultat på dessa uppgifter och verbalt arbetsminne eller förmåga att bibehålla uppmärksamhet. Det visade sig att VHS-individerna och deras SP tenderade att rapportera fler förändringar efter stroke och mer negativ påverkan från dessa förändringar på samtalsinteraktionen än HHS-individerna och deras SP. Samtidigt upplevde flera av de HHS-individer och deras SP som rapporterade förändring en hög grad av negativ påverkan från dessa förändringar. VHS-gruppen och HHS-gruppen rapporterade i hög utsträckning samma pragmatiska områden som påverkade och detta kunde också observeras i den videoinspelade samtalsinteraktionen. En slutsats som dras utifrån dessa resultat är att symtom på pragmatiska störningar efter stroke kan vara subtila och ta sig uttryck som traditionellt inte har relaterats till språkstörning. Det kan också konstateras att även subtila pragmatiska språkstörningar påverkar, och är beroende av, den roll samtalspartnern tar i interaktionen.

Fynden i dessa studier betraktas utifrån ett perspektiv där pragmatisk språkstörning i samband med hjärnskada ses som resultatet av interaktion mellan flera olika kognitiva funktioner, personlighet och kompensatoriska strategier hos den hjärnskadade individen såväl som hos hans eller hennes samtalspartners.

NYCKELORD: Högerhemisfärskada, Pragmatik, Kognition, Subtil språkstörning, Uppmärksamhet, Arbetsminne, Inferens, Samtalsinteraktion

Avhandlingen är skriven på engelska

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1. INTRODUCTION AND BACKGROUND TO THE THESIS

The main topic of this thesis is pragmatic language disturbances related to stroke. It comprises four studies¹ investigating the effects of brain damage on comprehension and conversational interaction. The main aim of the studies was to explore certain aspects of the elusive problems affecting right-hemisphere-damaged individuals' communication. The thesis adopts an interactional approach to cognition and communication. This means that the production and comprehension of discourse are believed to emerge from the interaction of different language-specific and non-linguistic cognitive processes and also from the interaction between conversational partners.

An experimental method is used to investigate possible associations between inferences in the comprehension of discourse, verbal working memory and sustained attention. To investigate possible effects on conversational interaction, a questionnaire about post-stroke changes in communication was distributed to a group of brain damaged individuals and their conversational partners. Those results were complemented by case studies including analyses of video-recorded conversational interactions. Although the main focus is communication disorders associated with right hemisphere damage, left-hemisphere-damaged and neurological healthy individuals are included for comparison.

This introduction to the thesis will provide basic definitions and describe the topic investigated. This is followed by a presentation of the theoretical background where acknowledged cognitive models and relevant current research on this topic are presented. The chapter concludes with an outline of how the four studies that compose the thesis will be presented.

¹ Ethical considerations of the studies included in the thesis have been scrutinized and received approval of the ethical committee at the faculty of medicine at Gothenburg University.

1.1 Pragmatic aspects of language

Traditionally, language has been considered as a human cognitive function, along with others such as memory, attention and thought. Still, as stated by Deacon (1997), for example, language has evolved over the course of human evolution and it has also affected the development of the human brain and cognition. This means that brain structures involved in language processing are anatomically intertwined with various other structures that handle the other cognitive functions of the brain. Research into the functions of the brain has come to question any attempt to try to separate language functions from other cognitive abilities, (McNeil and Pratt, 2001). In light of what we know today about human cognition, is it wise to consider language functions as separate modules or domain-specific systems in relation to other cognitive functions? This question is especially relevant when it comes to the actual use of language in social interaction.

In this work the view of language follows Pierces definition (1903). Language is considered as a conventionalized system of arbitrary symbols used for communication (see also Ahlsén, in press). Following this definition the modality of the symbol conveyed, that is if it is produced, for example, in the form of a spoken word or a gesture, does not determine whether it is considered as language or not.

The concepts of language and language ability can be described and analysed in terms of different aspects such as phonetics, syntax, lexicon and pragmatics. Phonetics describes the production and perception of phonemes and prosody. Syntactic aspects include grammar and structure in language, for example, word order at the sentence level. The lexicon and semantics deal with the meaning and use of language at the word level. Pragmatics comprises and describes the principles of language use in context. However, the boundaries between semantics and pragmatics are not at all clear-cut. For example, metaphors, proverbs, idioms and more or less idiosyncratic expressions and slang are considered to be expressions of pragmatic aspects of language, as the production and interpretation of this kind of language is

especially dependent on the context.² The semiotic conception of pragmatics presented by Morris (1938) describes pragmatics as the study of the relation of signs to interpreters. This definition does not restrict pragmatics to the study of the production and interpretation of spoken output in the form of words. Besides the use of prosody and non verbal body-language, other pragmatic aspects of language are the intrinsic regulations, for example in turn-taking, that make conversational interactions smooth and the adaptation of language use to facilitate communication in social interaction. In this way pragmatics is an important aspect in every communication situation.

Penn (1999) suggested that pragmatic ability consists of three types of knowledge which are fundamental for the adaptation of communication in context:

1. knowledge of language and its structure,
2. knowledge of the world and objects as well as events and actions within the world,
3. social knowledge of the rules for conversation and behaviour in the speaker's society.

The ability to adapt one's use of the language system to specific contexts, specific conversational partners and general world knowledge is essential for the successful use of language for social interaction.

This view of the pragmatic aspects of language calls for recognition of the role played by cognitive capacities such as memory, attention, inference and theory of mind in language use. Over the years, there has been a growing interest in the function of pragmatic aspects of language within the science of neurolinguistics. However, as stated by Perkins (1998, 2005a, 2005b), clinical pragmatics needs to

² The term 'nonliteral-language' is sometimes used to summarise the types of expressions and meanings that are considered to be especially dependent on pragmatic aspects of language. The term is avoided here as the nature of those kinds of expressions, for example metaphors and irony, is considered to be full of nuances and more complex than what is conveyed by the term 'non-literal'.

focus on the cognitive and neurological factors in addition to more theoretical perspectives.

Still, there is no agreement on how to conceptualise pragmatics in relation to language. Pragmatics does not necessarily have to be considered as an essential component of language: as discussed by Myers (2001) and Tirassa (1999), some researchers consider that only language used for intentional communication is dependent on pragmatic ability. Myers (2001) describes the cry of an infant as an example of intentional communication that is dependent on pragmatic ability but not on language. Myers (2001) also mentions body communication such as rolling the eyes or shrugging as examples of communication that are dependent on pragmatic ability but not on language. However, those examples are not valid if one considers that the definition of language as ‘a system of symbols’ might very well include body communication like gestures and facial expressions.

Language and communication at the discourse level often make high demands on pragmatic ability. In the context of this thesis, discourse is defined as *extended verbal expression in speech or writing*. When one participates in conversation, reads a book or listen to the news, there are requirements for fast and simultaneous processing and the interaction of numerous cognitive systems. The recognition of pragmatics as an important element of human language abilities has also revealed problems related to the pragmatic aspects of language that affect communication in people with neurological brain damage. Individuals with well-defined left-or right-hemisphere damage, as well as individuals with more diffuse traumatic brain damage or progressive neurological diseases may have well-preserved language abilities in several linguistic components, such as phonetics and syntax, but may nevertheless experience problems with both comprehension and language production in more complex communicative situations.

1.1.1 Subtle and pragmatic language disorders

As discussed by McNeil and Pratt (2001), new knowledge of how the human brain works has consequences for the definition of the concept of language as well as of language deficits like aphasia. If it is not possible to separate language from other cognitive functions, then how should aphasia best be defined? And what about the pragmatic aspects of language, which are so obviously dependent on other cognition? How should pragmatic deficits be defined in relation to aphasia? Joannette and Ansaldo (1999, 2000) proposed that these deficits should be termed ‘pragmatic aphasia’, but there is no agreement on the matter (see, for example Myers, 2001).

Aphasic individuals can depend on their pragmatic language ability to support communication when other components of language, e.g. phonetic, semantic and syntactic abilities, are disturbed. Still, the distortion of semantic and phonetic aspects of language has consequences for the pragmatic aspects.

More subtle language disorders associated with left-hemisphere damage (LHD) and subcortical lesions are sometimes termed higher-level language (HLL) disorders; however, the assumption that different aspects of language can be separated into different hierarchically ordered *levels* may be questioned. Those more subtle language disorders have been described by Crosson (1996) as interfering with these individual’s social and professional lives because of difficulties in assimilating more complex, or large, units of information as well as in conveying personal thoughts and needs to others. The subtle language deficits described in association with, for example, LHD can often be related to the lexical and syntactic aspects of language and communication, although the impairment becomes noticeable when one considers the pragmatic aspects of language and it affects the ability to participate in communicative activities. Research in aphasia has made it possible to look upon these problems as *a consequence* of dysfunctional semantic or phonological processing or deficits in other cognitive systems involved in language, for example, verbal working memory. That is, a dysfunction in certain linguistic or other aspects of cognition manifests itself at the pragmatic level in language. For example, difficulties finding

the correct word for an intended meaning result in the choice of a word that creates an un-intended nuance of the meaning expressed. In another example, limitation on the capacity of verbal working memory makes it difficult to comprehend long sentences with many subordinate clauses. There are also certain effects on the pragmatic aspects of language of certain adaptations and compensatory strategies associated with language disturbances, for example, syntax, turn-taking and body communication.

The concept of *pragmatic deficit* is often used to label impaired ability to maintain theme and topic, to appreciate context relevance and to adjust to socially appropriate language use in discourse, despite well-functioning phonetic, syntactic and general semantic aspects of language (Myers 1999b). Pragmatic deficits may involve deviant use and interpretation of the lexicon. An inability to understand humour and irony and other more complex uses of language, such as proverbs and idioms, might also be described as pragmatic deficits, as would the dysfunctional production and interpretation of prosody and body language.

All the manifestations of pragmatic deficits mentioned above have been described in right-hemisphere-damaged (RHD) patients by, for example, Tompkins (1995), Myers (1999b), and Martin and McDonald (2003). It is difficult to assess the incidence of language disturbance associated with RHD. The number of patients affected presumably varies across different estimates, as does the number of individuals suffering from aphasia, depending on the definitions and methods of assessment used. In a study performed by Benton and Bryan (1996), the incidence was estimated at about 50% in the patients with well-defined RHD (see also Joanne and Goulet, 1994). Pragmatic deficits like the ones described above have also been described in association with traumatic brain injury, dementia and other progressive neurological diseases and in association with autism; however, the scope of this thesis is pragmatics in association with RHD.

The emergent perspective described by Perkins (2005a and 2005b) has been adopted in this thesis. Perkins (1998, 2005a, 2005b) addresses the problem of grasping the concept of pragmatics in association with dysfunction. He calls for a

holistic and *emergentist* account of pragmatic ability and disability. The term ‘emergence’ is used to describe a process in which a complex entity comes out of interactions between ‘lower-level’ entities. Although the approach proposed falls within an ‘interactionist’ tradition, it emphasises that pragmatics is not a discrete entity that exists independently of other entities such as language, social cognition, memory, attention and inferential reasoning. Instead pragmatics is described as what emerges when such entities come together in a socio-culturally situated human interaction. This view of pragmatics focuses on the processes within the individual as well as between the individuals in interaction. The emergent perspective also claims that there is often no direct link between an underlying deficit and a resulting pragmatic impairment. The symptom may very well be the consequence of compensatory adaptations. Furthermore, Perkins (2005b) describes the entities between which interactions take place as belonging to linguistic and non-linguistic *cognitive* systems and *sensorimotor* systems. Cognitive linguistic *elements* in the model are phonology, prosody, morphology, syntax, discourse and lexis. Examples of cognitive non-linguistic elements are inference, memory, attention, social cognition, theory of mind, executive function and affect. Sensorimotor elements, Perkins’ (2005b) concept, take the form of either motor output like voice, gesture, gaze and posture, or sensory input like auditory and visual perception.³ In the emergentist perspective, pragmatic impairment is the result of a restriction on the choice of elements available for encoding or decoding meaning. Perkins (2000) also proposes a classification system for pragmatic disorders depending on whether they are due to a solely non-linguistic cognitive function (primary pragmatic disability), or due to a linguistic or sensorimotor dysfunction (secondary pragmatic disability), or due to both linguistic and non-linguistic dysfunctions (complex, or compound, pragmatic disability).

In this thesis, both linguistic and non-linguistic abilities are investigated. The ability to make inferences at a discourse level is investigated along with basic aspects

³ Elements of motor output such as gestures and gaze, might in some views, equally well be included among the linguistic elements.

of non-linguistic cognitive functions like sustained attention and verbal working memory. Furthermore, production and comprehension in discourse are viewed as the result of a process that emerges out of the interaction of different cognitive functions within the individual, as well as from the interaction between the individuals involved in conversation.

Since the expression and interpretation of meaning in discourse involve the use of lexical and semantic aspects of language, the analysis of reported changes in conversational interaction in study 3 and the analysis of natural conversational interaction in study 4 touch upon the status of those aspects of language in association with brain damage. As described by Tompkins (1995) and Myers (1999b), deficits of the lexicon and semantics might play a role in pragmatic performance in association with RHD. However, standard methods for evaluating the lexicon in association with LHD may not capture the problems affecting communicative ability in association with RHD. When access to the dominant and common meanings of words is evaluated in RHD individuals with standard aphasia batteries, those individuals' semantic processing is usually considered to function well. Nevertheless, anomia is a common symptom associated with any kind of brain damage. Clinical experience shows that many individuals with RHD also experience word-finding difficulties, especially when specific word nuances are desired. Performance on semantic processing tasks that require the activation of a wide range of alternate meanings and associations to a single concept (sometimes called *divergent* semantic processing) can be affected. This kind of task might, for example, depend on sensitivity to relationships among items. RHD individuals might have trouble producing appropriate category names for groups of objects and making lexical judgements and they might also have reduced verbal fluency; see Myers (1999b) for an overview. While tasks in standard aphasia batteries usually require activation of the *denotation* of a word, that is, its exact meaning, divergent tasks might require the activation of associations to a specific word, or that word's *connotations*. For example, the words *skinny* and *slim* used in describing a person's appearance might both denote the shape of his or her body, but the connotations of

the word *skinny* might differ from the connotations of the word *slim*, and have a more unpleasant ring. Connotations can be quite personal. A connotation of the word *dog* might be 'loyal friend' or 'slobbering beast' depending on one's personal experiences with the animal signified. At present, the extent to which deficits in semantic aspects of language can be considered as a common cause of some of the pragmatic language deficits seen in both RHD and LHD individuals with subtle language disorders has not been sufficiently investigated. The scope and methods used in this thesis were developed to study language use at a discourse level in natural conversational interactions. Therefore, the results of these studies do not permit one to draw any conclusions about specific lexical and semantic aspects of language associated with RHD, although certain speculations are unavoidable: any deficit in lexical-semantics inevitably manifests itself at a discourse level and in the pragmatic aspects of language.

In an individual, functions that depend on more effortful cognitive processing, as well as more automatic cognitive processes, for example, activation of a semantic system, might be affected if more fundamental aspects of cognition are dysfunctional. Attentional disorders, e.g. sustained attention, have been proposed as a cause of the pragmatic and other deficits seen in association with RHD; see Tompkins (1995) and Myers (1999b) for a review. The pragmatic deficits seen in association with RHD are often referred to as cognitive-communicative impairments. Sustained attention might be considered as an essential and basic cognitive ability underlying understanding and interaction in social contexts. Level of arousal is even more basic for all cognitive activity. There may also be lack of awareness of deficits or *anosognosia* in RHD. Anosognosia is comprehended as a somatosensory agnosia and has mostly been described in association with a motor disability, which the patient is unaware of or denies, following large right-hemisphere parietal-lobe lesions. The actual cause of the syndrome is not known although there are theories; see, for example, Ramachandran (1995).

Several of the symptoms described in the communication of RHD individuals can be viewed as reflecting an impaired ability to draw adequate inferences from the

context or an inability to grasp the communicative intentions of a conversational partner, as discussed by Sabbagh (1999). Socially inappropriate or off-topic remarks may result from an incorrect inference about the actual topic of the conversation or the conversational partner's intent. Humour, irony, metaphors and the use of idioms as well as prosody and facial expressions receive their intended meaning in a certain context. RHD has sometimes also been associated with dysfunctional processing of expressions of emotional and attitudinal content, which is often an important element in human interaction; see Borod (2000) for an overview. Prosody and body language often also convey unintended information about an individual's attitude and emotional state.

Problems in making appropriate inferences about the intentions, attitudes or motives of others have also been described as a deficit in theory of mind, (Brownell and Martino, 1998, Happé, Brownell, and Winner, 1999). General world knowledge and knowledge of the conversational partner are part of the context that one must infer from, as well is knowledge of the language system, for example, in the form of multiple word meanings, their associations and the relations between them.

In the study of pragmatic language disorders, linguistic pragmatic theories have contributed useful instruments and labels to analyse and describe the symptoms. Still, as discussed by Perkins (1998), Body, Perkins, and McDonald (1999) and Martin and McDonald (2003), there is now a call for an understanding of the mechanisms that cause those pragmatic dysfunctions, and this requires a contribution from cognitive theories. The processing of information for understanding and interacting with language in complex communicative contexts is dependent on more basic cognitive functions, such as sustained attention and verbal working memory, as well as on more complex and compound cognitive abilities such as inference and adaptation of language use at a discourse level. Although basic cognitive functions are exercised in all language and communication activities, at least to some extent, more complex communicative contexts can be expected to make higher demands on those functions. The methods used in the studies that constitute this thesis are applied in the goal of

contributing to the search for an understanding of the cause and consequences of pragmatic language disturbances in association with RHD.

1.2. Theoretical background

The studies in this thesis focus on pragmatic aspects of communication. They examine comprehension, in the form of the ability to draw inferences from implicit information in discourse, and the ability to interact in conversation. In the context of this thesis, discourse is defined as extended verbal expression in speech or writing. Since pragmatics is viewed as the outcome of the interaction between several different elements within the individual, an attempt is made to integrate different important theoretical aspects of cognition and communication in discussing the results of the studies. This chapter presents the theoretical background to the methods used and the discussion of the results in the thesis.

First Kintsch's (1988, 1998) construction-integration model of comprehension will be described and the concept of *inference* will be defined. This is followed by a presentation of current research on inference in association with RHD, subdivided into research on revised inference and on social inference. Theories of the processing of social cognition, theory of mind and affective information are also presented, as are current theories of sustained attention and verbal working memory. A review of concepts related to the pragmatic aspects of discourse is also presented and the chapter concludes with a brief presentation of current research on the consequences of pragmatic disabilities for discourse production and conversational interaction in association with RHD.

1.2.1 Kintsch's model of comprehension

This section presents Kintsch's construction-integration model and the term *inference*. RHD individuals often show symptoms of comprehension deficits. Those deficits often become marked in situations where the individual has to generate inferences from information. Those inferences might take the form of filling in any missing parts, as in bridging inference, or working out which of several different possible interpretations is correct. To understand the inference problems described in RHD individuals, Kintsch's (1988, 1998) model of comprehension will be used and

the notion of inference will be defined, starting with Kintsch's viewpoint of the concept.

1.2.1.1 The construction-integration model

Although it has not been fully explored, Kintsch's (1988, 1998) construction-integration model has often been referred to in discussions of comprehension in discourse and in some studies of RHD individuals' inferencing ability (Chantraine, Joannette, and Cardebat, 1998, Beeman, Bowden, and Gernsbacher, 2000, Lehman and Tompkins, 2000, Harris Wright and Newhoff, 2001). The benefit of this specific model of comprehension is that it is a cognitive model that makes it possible to consider all the different elements involved in the comprehension process including perception, concepts, ideas and emotion (Kintsch, 1998). These different elements may come from perceptions of the external world as well as from the perceiving organism itself in the form of memories, knowledge, beliefs, body states or goals. Compared to, for example, the theory of *capacity-constrained comprehension*, introduced by Just and Carpenter (1992), Kintsch involves long-term memory (LTM) in the actual processing of working memory for comprehension. Kintsch's notion of working memory and its relation to LTM will be further discussed in sections 1.2.1.2 and 1.2.3.2.

According to Kintsch (1988, 1998), traditional models' account of comprehension often includes a control process guided by a pre-existing schema. The schema in these models is supposed to work like a perceptual filter that accepts material that fits and blocks out inconsistent information. At the same time, such schema can work as an inference machine, filling in any gaps in the stimulus material that prevent it from matching the pre-existing schema. Kintsch (1998) rejects such a top-down process. Instead, he conceives of comprehension as a loosely structured bottom-up process that is sensitive to context and flexibly adjusts to shifts in the environment. In this view, comprehension might be chaotic in the early stages and the coherence and order we experience is achieved only by the time it reaches consciousness.

Kintsch's (1988, 1998) model of comprehension, like several other models, for example, those of van Dijk and Kintsch (1983) and Gernsbacher (1990), views the comprehension process as structure building. Comprehension involves the building of a mental model. A mental model is constructed by forming connections between disparate information in the ideas expressed and relevant prior knowledge in an associative net. Kintsch (1998) describes a step-by-step process by which spoken or written language is transformed into a mental representation in the mind of the listener or reader. One important adaptation of the model, compared to, for example, the model presented by van Dijk and Kintsch (1983), is the increased role of knowledge stored in LTM in the comprehension process.

Knowledge representations in discourse are often analysed as idea units called 'propositions'. A proposition, in Kintsch's view, includes one *predicate* and one or more concepts called *arguments*. Arguments can take the form of *agents*, *patients* or *instruments*, which all fulfil distinct semantic functions in that proposition. In natural discourse, though, not all semantics is in the form of complete sentences including propositions. Comprehension in natural conversation also includes the processing of contributions that in isolation do not involve complete explicit propositions. However, the comprehension process in discourse involves the integration of implications from several contributions to the current conversation as well as LTM knowledge.

The process of comprehension of stimuli is modelled by a construction process, only weakly controlled, where all potential significant information and even contradictory associations are activated. This view of activation in the comprehension process can be compared to that of Glucksberg, Kreuz, and Rho (1986), who argue that context can constrain lexical access in word recognition. In a strong application of this notion, only the contextually appropriate meaning of an ambiguous word is processed at all. According to the construction-integration model, however, *all* possible interpretations of an ambiguous word are activated but meanings irrelevant to the context will then be suppressed or inhibited, as the activation of these meanings will not be strengthened to the same extent as context-relevant meanings. The

comprehension of the contextually appropriate meaning results from the integration process where inappropriate constructions will be deactivated, leaving the majority of elements activated in the process meaningfully related to one another. The benefit of such sometimes apparently irrelevant activation is, according to Kintsch (1988), that the process can be both context-sensitive and flexible at the same time.

In the *construction phase*, a coherent propositional network is constructed. Besides the propositions, or idea units, explicitly expressed in the discourse, it includes associations with those ideas, activated knowledge and inferences and generalisations that contribute to the coherence of the ideas expressed. Once a network of propositions has been constructed, the *integration phase* follows and activation is accumulated and strengthens in those propositions that are most interconnected with one another. Inconsistencies and contextually inappropriate concepts are deactivated. This modified propositional network now creates an LTM representation of the text.

From each of the repeated construction-integration cycles, some important elements of the current clause or propositions are held active in the capacity-limited working memory for further processing. The items that are held in working memory might also activate idea units retrieved from LTM knowledge through association, and in this way extend the limited working memory capacity. This elaboration of working memory capacity is referred to by Kintsch (1998), Ericsson and Kintsch (1995) and Ericsson and Delaney (1999) as *long-term working memory*.

The comprehension process described above ends up in *the episodic text memory*, which is a mental representation of the discourse. The episodic text memory consists of two components: *the text base*, which consists of those elements and relations that are directly derived from the text itself, and *the situation model*. The situation model consists of the text base together with the listener's or reader's own knowledge and personal experience. The extent to which a reader will actually perform the work of transforming a text base into a situation model varies. The text base may be more or less coherent and complete, and the situation model may be more or less adequate and precise. If the information expressed in the discourse is

perfectly explicit, the text base is also a good situation model. In some cases, the reader or listener may have understood the discourse well and formed a good situation model without being able to remember the text itself. The opposite case, where subjects remember the text without having been able to understand it and to form a situation model, is also possible.

Kintsch's theory of comprehension, like most theories of comprehension, focuses on reading comprehension. This is where most of the empirical work on comprehension has been done. Conversational interaction involves a completely different situation than reading a text. For example, conversational discourse allows consistent revision of the speech plan and theme of the conversation to adapt to the listener's comprehension or perhaps simply because an absentminded speaker. Spoken discourse also diverges from a visually presented text in many other ways, for example, in being a transient medium but also, when it comes to conversational interaction, in the conveyance of other sources of information such as body communication and other sources of information in the immediate context of the conversation. Although Kintsch (1998) seems to recognise those types of elements as part of the comprehension process, he does not present empirical data that support the applicability of the model in analysing that kind of discourse. With those reservations, Kintsch's construction-integration model is here considered as a useful tool in the understanding of pragmatic dysfunctions in association with RHD.

1.2.1.2 Inference in comprehension

Kintsch's (1993, 1998) construction-integration model, calls for a classification of inferences according to their function and the processes involved. Kintsch (1998) is actually rather reluctant to use the term *inference* for the process of making LTM contents available via automatic or controlled retrieval structures. In cognitive science this term has not been well defined and the global use of the term has yielded more questions than answers, in Kintsch's view (1998). Many classification systems for inferences have been proposed but Kintsch (1993, 1998), favours an analysis performed and presented by Guthke (1991) who characterises inferences both by their

end results and by the nature of the processes involved. Kintsch follows Guthke's analysis and distinguishes between inferences that add information through retrieval from LTM versus inferences that generate new information. Both retrieval of information from the LTM and generation of new information can be differentiated according to whether the process involved is automatic or controlled. These should be considered as the end points of a scale rather than discrete categories. Kintsch (1998) elaborates Guthke's analysis by differentiating between inferences that *add* information and those that *reduce* it. Bridging inferences, or coherence inferences, add information by retrieving information that already exists in LTM. This takes place in either an automatic or a controlled manner. In the case of automatic knowledge elaboration, the text contains the necessary cues to link up with relevant information in LTM. One example of this, cited from Kintsch (1998), is *John nailed down a board* as a sufficient retrieval cue for *hammer*. In controlled knowledge elaborations, there are not enough retrieval cues in the text so they must be supplied by a search for bridging knowledge in LTM. Consider another example from Kintsch (1998): *Danny wanted a new bike. He worked as a waiter*. In this case, automatic, associative knowledge elaboration alone would not necessarily produce the inference that Danny worked in order to obtain money to buy the bike. Instead, the controlled search for a causal connection between the two statements may evolve the retrieval of the information that *working may bring in money to buy things with*. In understanding narratives, one routinely searches for causal links between actions and events and this memory search is a strategic, controlled and resource-demanding process. Context and personal experience influence it and what is automatic for one person might require controlled search for another. Although in some situations two concepts together may form a compound cue for the automatic retrieval of a linking relation, under other conditions more elaborate controlled processes would be required to detect some underlying coherence relationship between different components of a text.

Generating new information instead of retrieving of existing information from LTM may also be automatic. This is the case in making inferences from the following

example quoted by Kintsch (1998): the sentence *Three turtles rested on a floating log, and a fish swam beneath them* results in the inference that the turtles are above the fish. This information cannot be retrieved from LTM but has to be computed through the transitivity of terms like *above* and *beneath*. This computation is done from the information given in the text and certain generation rules. When the rules for generating new information from a given text become very complex, they may require controlled resource-demanding processing. This is what Kintsch calls a *true inference* and it includes analogical inferences in the same way as the inferences discussed in logic include inductive and deductive inferences. However, the generation of new information may also require the retrieval of information from LTM in addition to textual information.

As stated by McKoon and Ratcliff (1992) and Graesser, Singer, and Trabasso (1994), elaborative inference that expands upon or embellishes the information presented has been shown to be time-consuming and demanding of processing resources. Theme generation, outcome predictions and character attitude or motivation attributions are examples of elaborative inferences. Recency of mention is also related to the time course of inference generation. Those kinds of inferences correspond to what Kintsch (1993, 1998) refers to as either a retrieval process in the form of controlled bridging inference or, on some occasions, inference generation. Controlled bridging inference and inference generation may be influenced by the contextual bias. Consistency of contexts affects the reliability of the inferences made. An inconsistent context is more resource-consuming in making predictive or coherence inferences.

Kintsch (1998) argues that a controlled process of adding information, *information accretion*, may occur any time during and after the original comprehension of a text. It may occur in response to specific task demands such as test questions. A test question may suggest the retrieval of additional knowledge not previously considered. It may also require the use of rules for generating new information or condensing old information.

According to the *long-term working memory model*, presented by Ericsson and Kintsch (1995), large portions of LTM are turned into an expanded working memory in all kinds of cognitive processing, including text comprehension. All items in LTM can become functional parts of working memory, the *long-term working memory*. When a concept is contained in working memory, the associated concepts in LTM become potential knowledge elaborations without having to be transferred from one memory store such as LTM, to another such as working memory.⁴ No inference needs to be made because the information is already part of working memory.

*

In studies 1 and 2 in this thesis, parts of the stimuli consist of spoken discourse in the form of an audio recording of narratives read aloud to the subjects. The term ‘inference’ is used for the conclusions drawn about meaning or implications in the narratives or, as in Kintsch’s terminology, elaborative inferences that are presumed to require controlled retrieval processes. However, these are not restricted to the generation of new information and are therefore not necessarily what Kintsch would call ‘true inferences’.

1.2.2 Inference and right-hemisphere damage

In this section, the research on inference and comprehension in association with RHD will be presented. Inference is often discussed in association with RHD and also constitutes part of the current theories about the cause of pragmatic language disturbance that will be presented here. Studies 1 and 2 in this thesis investigate the ability to revise inferences and to make inferences about attitudes and motives for action. Research on the ability to revise inferences and on inferences involving emotional or affective stimuli, or what is sometimes referred to as *mental inference* or *social inference*, will be presented separately. First, a review will be given of some

⁴ Kintsch’s notion of long-term working memory is further discussed in section 1.2.3.2

methodological issues concerning the research methods involved in the study of inference in association with RHD.

1.2.2.1 How to study inference

In Kintsch's (1993, 1998) classification of inference, only what is commonly considered as logical inference is a true inference. RHD individuals' ability to handle logical inferences has been examined by Hamel, Giroux, and Joannette (2003), and the RHD subjects usually do not show any impairment in their processing of syllogisms at the sentence level. However, in the research on inference, this term is often used for both controlled and automatic retrieval processes.

Lehman and Tompkins (2000) criticise studies of inference abilities in RHD individuals for not always controlling for inference type and stimulus characteristics in the tasks used. In a study with RHD individuals, Lehman-Blake and Tompkins (2001) showed that their participants managed minimal inference, e.g. pronoun mapping. Furthermore, the RHD individuals also generated elaborative inferences if the stimuli facilitated the target inference in short written passages.

It seems that problems affecting RHD individuals' ability to make inferences are not revealed if the stimuli require simple automatic inferences. Nor do they appear if complex elaborative inferences, like logic syllogisms, are requested at the sentence level.

Beeman (1993) investigated the ability to make coherence inferences in a group of RHD individuals and a control group of non-brain-damaged elderly men. He concluded that the RHD individuals' problems were not due to an impaired ability to build a macrostructure or mental representation of a text. Rather, he suggested that they lacked semantic activation of the information they needed to draw the inferences.

Several studies using lexical decision tasks have shown that RHD individuals do seem to activate several different meanings of ambiguous words, such as Tompkins and Baumgaertner (1998). These authors also criticise the method used in Beeman's study (1993), where subjects had to divide their attention between several tasks

simultaneously, and suggest that the mixture of these tasks might overload the subjects' processing systems, preventing them from performing well on one or more of the tasks.

Tompkins and Baumgaertner's (1998) criticism is well-founded. In the drive to use experimental settings where possible to control for what is actually measured, it is necessary to single out specific processes and reduce the demands on limited cognitive resources. This, and procedures using on-line measures, for example, in the form of reaction time in lexical decision tasks, can tell us a lot about specific functions in the comprehension process, for instance. On the other hand, those situations and settings do not have much in common with communication in real life. In everyday conversations, or when reading a newspaper or a novel, there are demands for simultaneous, flexible processing of different kinds of information which *do* tax the individuals' processing systems. The impact of limited processing resources in RHD individuals have been examined by Monetta, Champagne, Desautels and Joannette (2003) in a study where the subjects performed a dual task. The results were found to be compatible with the suggestion that impaired ability to process 'non-literal' utterances could be caused by limited cognitive resources.

The issue here is not whether RHD individuals can generate inferences, because they obviously often do, but the fact that in certain conditions some individuals with RHD seem to have difficulties doing this.

1.2.2.2 The coarse semantic coding theory and coherence

The problems seen in RHD individuals, for example in grasping the inferred meaning in discourse, understanding the punch line of a joke or identifying the central theme of short narratives, have been conceptualised by Hough (1990) as deficits in the ability to integrate information and infer from context. Beeman (1993, 1998) puts forward a theory, based on Rumelhart and McClelland (1986) and Gazzaniga (1995), that the right hemisphere might be necessary for drawing coherence inferences. *The coarse semantic coding theory* proposes that the right hemisphere perform relatively coarse semantic coding while the semantic processing in the left hemisphere is

performed as relatively fine semantic coding in small semantic fields. Processing in the left hemisphere is focused on a few concepts that are closely related to the input words in that given context.

The notion of asymmetrical semantic coding between the right and left hemispheres have been questioned by Livesay and Burgess (2003). In their experiment with mediated priming, which involves two-step priming where the relation between the prime and target is distant, the results suggested that the lexical representation of the two hemispheres is equivalent.

However, the coarse semantic coding theory is supported by research of, for example, Chiarello (1998). Beeman (1993, 1998) argues that the left hemisphere rapidly restricts access to one possible meaning, either the dominant one or the one most consistent with the preceding words. This is functional in an individuals' aim to rapidly integrate the meaning of successive words, as in an utterance. Conversely, the right hemisphere maintains activation of many possible meanings for a longer period of time. As a result, the right hemisphere increases the semantic overlap among multiple semantic fields. It may also function to maintain activation for peripherally related information, already eliminated by the more selective left hemisphere's semantic processes. This information might either facilitate or interfere with other processes, depending on the task requirements. It is ineffective for the process of understanding straightforward language but useful when there is a need to integrate parts of discourse that are distantly related. To generate inferences in discourse, comprehenders may have to observe less salient semantic features of words in order to detect semantic overlap and draw the inferences for coherence. According to Beeman, Bowden and Gernsbacher (2000) the RHD individuals' comprehension problems may arise when multiple interpretations are possible or when an initial interpretation must be revised. In a study with non-brain-damaged young individuals, Beeman et al. (2000) propose that although the information necessary to draw correct inferences may be primarily active in the right hemisphere, the left hemisphere may capitalise on this information to actually generate or connect it with the representation of discourse and complete the coherence inference. That means that

when the left hemisphere's discourse representation lacks coherence, it can adopt information from the right hemisphere to restore coherence.

This is in line with the notion of a left-hemisphere interpretive system, first introduced by Gazzaniga and LeDoux (1978). Gazzaniga and Cooney (2003) describe the interpretive system lateralised in the left hemisphere as being dependent on access to information from both hemispheres to draw adequate and coherent conclusions about the world as it is experienced. This also corresponds to Ramachandran's (1995) notion of the right hemisphere as functioning as the 'devil's advocate' by questioning the consistency imposed by the left hemisphere. Those notions have both been proposed to explain the syndrome of anosognosia in association with RHD. The basic thought behind Ramachandran's (1995) suggestion is that the left hemisphere is inclined to create a coherent interpretation of the experienced world to ensure consistency and avoid uncertainty and indecisive behaviour, which in this context is considered to be inefficient from a cost-benefit perspective of cognition. Doing this might involve rationalisation and discarding and distortion of evidence that does not fit into the pre-existing model. The right hemisphere, having the capacity for holistic processing, then functions as an anomaly detector that monitors the level of discrepancy and reacts with the appropriate paradigm shift when the discrepancy reaches a given threshold.

1.2.2.3 Revised inference and suppression deficit hypothesis

Several studies have indicated that RHD individuals may have trouble with inferences that require resolving an initial interpretation. Brownell, Potter, Bihrlé and Gardner (1986) proposed that RHD individuals have difficulty revising previously acquired knowledge in light of new information. They suggest that this deficit might impair several components of discourse. But, as discussed by Brownell and Martino (1998), since RHD individuals are able to integrate information across sentences and to draw many inferences, it is not sufficient to characterise their impairment as a general inference deficit. Brownell and Martino (1998) support Beeman's (1993) perspective that the RHD individuals' problems revising an inference might be

caused by insufficient access to the weaker associations normally provided by the healthy right hemisphere. The correct interpretations might rely on interpretations that are suppressed.

On the other hand, Tompkins, Lehman, and Baumgaertner (1999), basing themselves on the work of Gernsbacher and Faust (1991), formulated a *suppression deficit hypothesis*. The results of studies by Tompkins, Baumgaertner, Lehman, and Fassbinder (2000) and Fassbinder and Tompkins (2001) using ambiguous lexical-semantic stimuli supported the hypothesis, since RHD individuals showed prolonged interference by context-irrelevant meanings of the stimulus words. The RHD group's comprehension problems might, according to the authors, be related to difficulties suppressing contextually incompatible meanings due to limited working memory capacity. Larger working memory capacity would allow them to maintain simultaneous, competing inferences without compromising their ultimate interpretations.

1.2.2.4 Right hemisphere hypothesis and inferences of affective information

'Affect' can refer to an inner emotional state as well as an outward manifestation of that state. In communication, emotional or affective behaviour may manifest itself in facial expressions, gestures and tone of voice. Furthermore, as argued by Van Lancker and Pachana (1998) emotional and attitudinal nuances tinge most linguistic expressions used in discourse. 'Attitude' here denotes a mental position, involving both affect and cognition, held by a person toward some idea, or object, or another person. The emotional information associated with the words chosen signals the speaker's attitude and adds implicit information to the referential meaning.

Tompkins, Bloise, Timko, and Baumgaertner (1994) investigated the ability to generate inferences about a character's attitude in narratives two to four sentences long. Half of the narratives used as stimuli were worded in a way that made the last sentence inconsistent with the preceding narrative. To make the whole narrative coherent, the subjects had to make correct inferences about the attitude of the main character and, for example, interpret a statement as a sarcastic utterance. However, it

turned out that performance of the RHD individuals did not differ from the performances of a group of LHD individuals or healthy controls.

It has been hypothesised, for example, Borod, Bloom, Brickman, Nakhutina, and Curko (2002), that the right hemisphere organises its lexicon according to contextual and affective principles. In a retrospective analysis of literature on emotional processing deficits, Borod et al. (2002) find support for the hypothesis that the right hemisphere plays an important role in the processing of emotion. One reason for this is that emotional processing, at the behavioural level, is thought to be dependent on non-verbal aspects of communication, ability to synthesise information, holistic processing strategies and visuospatial organisation. These are strategies and functions that the right hemisphere is considered to be well suited for. Although some studies put forward a left hemisphere involvement, Borod et al. (2002) conclude that the majority of studies showed selective deficits in individuals with RHD relative to individuals with LHD or non-brain-damaged controls. This pattern is, according to Borod et al. (2002), consistent in studies of perception and expression of emotion in terms of lexical items, prosody and facial expressions.

The impairment of the ability to process emotion in facial expressions and prosody in RHD individuals is well confirmed, (Borod et al., 2002; Brownell and Martino, 1998). This impairment may of course, affect an individual's ability to interact in conversation. However, there is also evidence, for example, from a study by Brownell, Carroll, Rehak, and Wingfield (1992), that RHD individuals might have an impaired ability to identify affective information in linguistic descriptions of the emotional state of a character, such in a narrative. According to Brownell and Martino (1998), RHD individuals show less than normal use of affective information to generate inferences in short narratives. Cicero et al. (1999) also found that RHD individuals had problems in identifying emotional content in words and sentences.

In studies by Bloom, Borod, Obler, and Gerstman (1992, 1993) using picture story tasks, RHD individuals showed a selective deficit in using emotional content in their discourse production.

Several of the participants in the studies presented in this thesis have brain damage involving subcortical structures (see section 2.2.1). Individuals with LHD or RHD involving subcortical structures might, according to Karow, Marquardt, and Marshall (2001), be especially vulnerable when it comes to processing affective stimuli in the form of facial expressions, prosody and words. In the Karow et al. (2001) study, the subcortical lesions involved were lesions to the basal ganglia. The notion that subcortical structures play a role in language processing is not entirely new and was discussed by for example Crosson (1999), Nadeau and Crosson (1997) and Crosson and Nadeau (1998). The role of basal ganglia in the processing of prosody is well confirmed; see Myers (1999b) for an overview. However, the Karow et al. (2001) study also included stimuli consisting of affective facial expressions as well as verbal linguistic material. The groups of brain-damaged participants with lesions including the basal ganglia in general had more trouble with the tasks than the control group and the groups with brain damage restricted to cortical areas of either hemisphere. Importantly, though, none of the participants in the study had lesions restricted to subcortical areas and the authors suggest that the connection between cortical and subcortical structures may be important in processing messages that are affectively coded.

According to Crosson and Nadeau (1998), the language processing problems seen in association with damage to the basal ganglia are likely to be related to either the involvement of white matter pathways surrounding the basal ganglia or a dysfunction in other non-linguistic cognitive systems. However, as always, these conclusions are partly dependent on the view of language in relationship to other cognitive functions, as well as on methods used to investigate any presumed language disturbance. Still, according to Crosson and Nadeau (1998), numerous studies have demonstrated aphasia after left-hemispheric thalamic lesions. One common symptom of aphasia after thalamic lesions is word-finding problems with semantic paraphasias and, according to Crosson and Nadeau (1998) the thalamus may play a significant role in semantic processing, perhaps in the translation and selection between a specific lexical output and the stored semantic information. However, research on the

role of subcortical structures, as well as the cerebellum, in language and communication is evolving and will surely provide new insights and better understanding of different aspects of pragmatics in association with different types of brain damage.

1.2.2.5 Social inference and theory of mind

Understanding or being able to make predictions about the behaviour or intentions of others requires *social inferences*, as discussed by Brownell and Martino (1998) and Martin and McDonald (2003). The ability to form representations of other people's mental states in judging utterances and understanding of their behaviour might be referred to as theory of mind (ToM) and is thought to be an essential component of social inference. This ability is essential to an individual's ability to engage in functional communication. Traditionally 'false belief tasks' have been used to assess ToM in normally developing children and adults diagnosed with autism. The ability to infer the mental states of others has also been studied in individuals with RHD, for example by Winner, Brownell, Happé, Blum, and Pincus (1998). In that study some RHD individuals were found to have difficulties in processing another person's belief about the world (first-order belief); they were even more likely to have difficulties in apprehending another person's belief about a third party's knowledge (second-order belief).

According to Brownell, Pincus, Blum, Rehak, and Winner (1997) and Brownell and Martino (1998), RHD individuals' problems in the use of personal reference can be interpreted as problems using ToM as guidance on how to refer in a certain social context. To refer appropriately to another person requires consideration of the status and knowledge of both the person referred to and the listener. RHD individuals' deficits in the ability to draw more complex mental inferences from short stories have also been described by Happé et al. (1999) as a specific impairment related to ToM.

Siegal, Carrington, and Radel (1996) did in a study use traditional ToM tasks with short vignettes where the subjects are required to represent the false belief of a character and predict the actions of that character accordingly. A typical vignette

might be worded as follow: *Sam thinks his puppy is in the garage, but his puppy instead really is in the kitchen. Where will Sam look for his puppy?* Based on the results of this study, Siegal et al. (1996) hypothesised that at least some of the errors produced by the RHD individuals in the false belief tasks might be the effect of a misinterpretation of the questioner's intentions. When the question was worded *Where will Sam look first for his puppy?* several of the participants managed to respond correctly.

In association with this proposal, it is worth mentioning that Joannette, Boeglin, Goulet, and Hannequin (1990) also discuss the significance of general motivation among RHD individuals participating in research studies. The subjects' interpretation or apprehension of the meaning of the tasks they are supposed to carry out is important for the outcome.

In a study by Surian and Siegel (2001), subjects were given a test of their ability to assess pragmatic violations in utterances. In addition, traditional ToM vignettes included in the study were adapted and completed with visual cues to enhance visuospatial memory and facilitate the encoding of the relevant information. That is, instead of using the traditional names of the potential locations of actions, e.g. *the garage* or *the kitchen*, these locations were named *the blue room* and *the white room*. While saying the test sentences, the test leader demonstrated the verbal information visually by pointing to a blue and a white piece of cardboard and also by putting a picture of a dog under the cardboard that was the same colour as the appropriate location. In these conditions, the RHD individuals performed well on the ToM tasks, supported by the visual aids. The results indicate, according to the authors, that an important source of RHD subject's errors in traditional ToM tasks evaluating first-order belief might involve difficulties in interpreting the stimuli owing to impairments of visuo-spatial buffers in working memory. The results on the task evaluating of communicative adequacy that was also administered nevertheless showed reduced sensitivity to pragmatic violations, although the reduction in sensitivity was not dramatic. The authors conclude that RHD individuals' failures in communicative situations may be more related to deficits in attentional and working

memory mechanisms than to a specific loss of knowledge of pragmatic constraints or mental representational deficit.

There are several different hypotheses concerning which cognitive structures are involved in ToM. Plaut and Karmiloff-Smith (1993) consider that language provides a structure that is essential for reasoning about mental states. Shallice (2001) and Stuss, Gallup, and Alexander (2001), emphasise the involvement of bilateral frontal lobe structures in the solving of ToM tasks. The frontal lobes are associated with *executive function*, which can be defined as the mental operations, including planning, flexibility and attention, that guide an individual's behaviour. On the other hand, Happé et al. (1999) stressed the potential role of the right hemisphere as a whole.

Executive function in RHD individuals has been examined by, for example, McDonald (2000) without finding any correlations with pragmatic performance. However, in a study presented by Champagne, Desautels, and Joannette (2003), two individuals with pragmatic deficits, in addition to having problems with tasks evaluating the ability to form a ToM, were also impaired in tasks evaluating executive functions, especially flexibility.

In a review of findings from imaging and lesion studies, Siegal and Varley (2002) conclude that ToM reasoning is not dependent on language, at least not when language is defined as the possession of grammar. Nor can it be reduced to executive function. However, according to Siegal and Varley (2002), there is converging evidence that the amygdala system and its interconnections with prefrontal and temporal lobe structures may provide the basis for a variety of socio-cognitive behaviours and that this system is at the core of the capacity to interpret other people's mental states. The integrity of the amygdala system's circuitry is, according to Siegal and Varley (2002) a necessary, though not a sufficient, condition for ToM. For the development of ToM in children and the performance of a particular ToM task by adults, the amygdala system is supported by a widely distributed neural system. For example, language functions, executive function and specific visuospatial functions should be viewed as functional, co-operative components in a compound

system for the computation of mental states. In this view, a ToM impairment in brain-damaged adults may be the result of deficits in the amygdala core system or the failure of one or more parts of the compound system that is necessary for performance on a particular task.

Another theoretical perspective, presented by Adolphs (1999), views the ability to make social inferences, or to recognise and reason about other people's state of mind, as an example of experience projection, through simulation or empathy. To imagine what it would be like to be another person via simulation is a way to obtain information about that person's internal state. According to Adolphs (1999), the ToM theory might be best suited to explain the processing of information that is lexically encoded. The notion of simulation might be an alternative when the stimulus is idiosyncratic or when it is not easily encoded in language. In those cases, an individual might, by imagining what it would be like to be the other person, run the cognitive processes that the other person is running in his or her own brain. Adolphs (1999) refers to infants' ability to mimic facial expressions and to the findings regarding 'mirror neurons', which appear to participate in simulating the actions of other individuals, to support his theory of social cognition. He describes three structures that are supposed to play a key role in guiding social behaviour: the right and left amygdala and ventromedial frontal cortex and the right somatosensory-related cortex and the insula. These structures are thought to operate in parallel: the amygdala provides a first automatic contribution to the evaluation of a potentially threatening situation and/or the allocation of processing resources to stimuli that might be important but are ambiguous. The ventromedial frontal cortex associates the perceived situation with the person's previous experience of elements in the situation and triggers the corresponding emotional state. The right somatosensory-related cortex is necessary to provide a comprehensive representation of the body state associated with the emotional or social behaviour that needs to be made available in this process. The notion of the importance of the right somatosensory-related cortex is further discussed in the work of Adolphs and Damasio (2000) and Damasio (2003).

Although Adolphs (1999) and Siegal and Varley (2002) diverge in their description of the processes involved in social inference, at least they seem to broadly agree on the anatomical base for the process.

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Although the primary concern in the theories described up to now is comprehension in RHD individuals, those theories might also be extended to explain deficits in the production of discourse. The theories concerning the cause of the pragmatic dysfunction described here focus on either of two different main issues. The first group comprises theories that try to explain general deficits in comprehension in RHD individuals by postulating a general deficit in coherence, or a general dysfunction in more complex inference processes. This group includes *coarse semantic coding theory* (Beeman, 1993, 1998; Beeman et al., 2000), and the *suppression deficit hypothesis* presented by Tompkins et al. (1999). The other group might be described as primarily occupied with the emotional or attitudinal problems described in RHD individuals' communication: the *right hemisphere hypothesis* (Borod, 2000; Borod et al., 2002) and theories of social inference, such as ToM. Happé et al. (1999) and Siegal et al. (1996) belong in this group. Adolphs' (1999) theory of social cognition has not yet been used as the theoretical background for an analysis of pragmatic communication problems in association with RHD.

In the studies presented here brain-damaged individuals' ability to produce adequate inferences from implicitly stated information in discourse is investigated. The experimental tasks require either more complex inference processes, such as the revision of an earlier inference, or inference of a character's attitude or motive. The stimuli and method used in these studies are elaborations and adaptations of methods used and discussed, primarily by Tompkins and colleagues (Tompkins et al., 1994 and 1999; Tompkins and Baumgaertner, 1998). For example the narratives used in the present studies have been extended to make higher demands on cognitive processes involved. The stimuli used are also controlled with reference to the type of inference process required. Kintsch's (1998) definition of the concept of inference

was used as guidance in constructing the stimuli used in the discourse comprehension tasks and his construction-integration model is used to apprehend the cognitive processes involved in the processes of comprehension.

Although the results of studies 1 and 2 will be discussed in relation to the current theories of pragmatic deficits described here, the main purpose of these studies is not to verify any of those theories. Instead, the intention is to investigate associations between the ability to infer from complex discourse and cognitive measures such as verbal working memory and sustained attention. Those basic cognitive functions might be essential in when it comes to the pragmatic aspects of language and might also play a crucial role in the mechanisms involved in the various theories presented above.

1.2.3 Verbal working memory

In this section, current views of the concept of working memory will be described, and in particular Kintsch's notion of long-term working memory. The problem of how to measure the capacity of verbal working memory will also be introduced.

1.2.3.1 The concept of working memory

Working memory is a theoretical construct which, according to Shah and Miyake (1999), refers to the mechanisms or processes underlying the maintenance of task-relevant information during the performance of a cognitive task. It might be viewed as a separate concept from *short-term memory* (STM), which has been described as a more passive storage mechanism, but this distinction is not always made.

In studies of aphasia, Baddeley's (1986, 1992a, 1992b) model of working memory has been widely applied. In Baddeley's view, the concept of working memory refers to a system with a limited capacity which is used for the temporary storage and manipulation of information. He describes working memory as a compound system which in Baddeley's classical model of working memory can be divided into three component parts: a central executive, which functions as an

attentional controller, and two sub-components referred to as the visuospatial sketch pad, which processes visual stimuli, and the phonological loop.

The phonological loop is involved in storing and rehearsing verbal speech-based stimuli and this component of working memory has made it particularly interesting for research on aphasia. As suggested by, for example, Gazzaniga, Ivry, and Mangun (2002), a left hemisphere network consisting of the lateral frontal and inferior parietal lobes is thought to subserve the phonological loop. Deficits in working memory for auditory verbal stimuli might, according to Caspari, Parkinson, Lapointe, and Katz (1998), be involved in some symptoms of language deficits following left hemisphere brain damage.

Although there are many different models of working memory with different perspectives, there seems to be an emerging general consensus regarding the fundamental nature of working memory. Miyake and Shah (1999) recognise six common themes that cut across ten well-established models of working memory, where there appears to be some agreement about the nature of working memory. One theme is the view that working memory or short-term memory is not a certain 'place', or a structurally separate 'box' in the mind or in the brain. Rather, various areas, including the prefrontal cortex, work together to produce working memory phenomena. There is also agreement that working memory is not only relevant to memory, but also to the regulation and control of cognitive action. Executive control or some kind of controlled attention is considered as an essential part of working memory. Another point of agreement seems to be that the capacity limitations of working memory reflect multiple factors instead of one single mechanism. On the other hand, there are still disagreements about what those capacity-limiting factors are, e.g. interference, limits in speed of processing, lack of long-term knowledge, or skills or information decay; some theories emphasise one factor above the others. One other point of agreement is that working memory is not a completely unitary and domain-general mechanism. That is, processes involved in working memory are at least partly dependent on domain-specific factors, like properties of the stimuli processed. Finally, there is also agreement that long-term memory knowledge and

skills play an important part in working memory performance. Even Baddeley (2000) has now complemented his classical working memory model with a complementary episodic buffer.

Engel, Kane, and Tuholski (1999) define working memory as STM, consisting of long-term memory units activated above threshold, plus controlled attention. In their view, the capacity of working memory is constrained by the individual's capacity for controlled sustained attention, required for maintaining temporary goals in the face of distractions and interference. Even though Engel et al. (1999) also consider some aspects of LTM in the working memory process, they focus on the attention mechanisms in working memory. Kintsch and colleagues, on the other hand, focus on the LTM mechanisms and retrieval structures in their model of working memory.

1.2.3.2 Long-term working memory

Ericsson and Kintsch (1995; see also Ericsson and Delaney, 1999) consider Baddeley's (1986) classical definition of working memory as the *temporary storage* of activated information, to be insufficient to account for the role of working memory in cognitive processes. Kintsch (1998) argues in favour of a role for what is referred to as *long-term working memory (LT-WM)* in language comprehension.⁵ Kintsch argues that although the capacity of working memory is limited it can be elaborated since nodes in a knowledge network in LTM are connected with links in working memory. Through such retrieval structures, information in LTM is quickly activated and becomes part of the processes involving working memory.

Kintsch (1998) defines LTM as consisting of semantic, episodic and procedural memory. Everything a person knows and remembers is stored in LTM. Based on research on expert performance in, for example, chess and mental calculation, Ericsson and Kintsch (1995) infer that working memory processes involve an LTM component. This LTM component is *not* viewed as an *expanded temporary storage* in

⁵ Kintsch's concept of long-term working memory was mentioned in sections 1.2.1.1 and 1.2.1.2

short-term memory. Instead, they argue, parts of LTM can be used as working memory.

LT-WM is considered as the part of LTM that at a given time is linked to activated items in STM by certain retrieval structures. The activated items in the capacity-limited STM serve as cues for the retrieval of that information in LT-WM. The information available in working memory consists of items already in STM *and* items reachable in LTM.

To be able to build retrieval cues and use LT-WM, the individual must have certain knowledge and encoding skills in the suitable specific domain. Skills required for building retrieval structures in comprehension do not have to be acquired specifically, contrary to the encoding strategies necessary in specific domains like, for example, in playing chess. Kintsch (1998) considers stories about human goals and actions to be domains where most people have good knowledge. In this view, comprehension constitutes structure building and thus entails generating a coherent mental structure that represents the meaning and message of the text. This mental representation serves as a retrieval structure and generates LT-WM. The text representations are built from the explicit information in discourse paired with the contribution made by the comprehender's LTM. To construct a coherent mental representation during comprehension, certain knowledge of language and general world knowledge must be available in the process.

In the process of understanding discourse, an LT-WM is created as a result of a construction-integration cycle, letting a new proposition enter into the STM. The new proposition is linked to other propositions that are already in working memory, through different types of relationships. They may be associated through the sharing of an argument or because of temporal or causal associations. In this way, the new proposition is associated with previously processed elements in working memory which in turn are already linked to items in LTM. By association through this network, the new proposition can now retrieve propositions, or activate idea units, that have been generated earlier in the process, and that now remain as parts of a network stored in LTM.

1.2.3.3 The Hemispheric Encoding Retrieval Asymmetry model

Kintsch's (1998) model of comprehension places great demands on the ability to retrieve information stored in LTM. LTM includes episodic memory and a model of encoding and retrieval processes in the brain, first presented by Tulving, Kapur, Craik, Moscovitch, and Houle (1994), emphasises the role of the right hemisphere in the process of retrieval.

According to the Hemispheric Encoding Retrieval Asymmetry model (HERA), as presented in Habib, Nyberg, and Tulving (2003), the right pre-frontal cortex is biased for the retrieval of verbal and non-verbal materials from episodic memory⁶. Lepage, Ghaffar, Nyberg, and Tulving (2000) accounted for this right lateralisation of episodic retrieval in terms of 'retrieval mode'. Retrieval mode is conceptualised as a basic and necessary condition for remembering past experiences. Lepage et al. (2000) conducted a multi-study analysis of data from PET studies, and found active areas correlating with maintenance of episodic memory retrieval in both the right and left hemispheres. However, there was an asymmetry that, according to the authors, supports the role of the right hemisphere in the retrieval of episodic memory. On the other hand, it has been proposed that many of the activations seen in neuro-imaging and attributed to specific cognitive processes, such as retrieval, might actually reflect general cognitive operations, such as attention (Cabeza, 2003).

1.2.3.4 Measuring verbal working memory capacity in studies of inference

How to measure and assess working memory capacities depends on the model of working memory chosen. Working memory mechanisms may be considered as more or less domain-specific. That is, different activities imply specific demands on the processes involved in working memory. According to Miyake and Shah (1999), there seems to be general consensus on this point in current working memory models.

⁶ The HERA model was first introduced by Tulving, Kapur, Craik, Moscovitch and Houle (1994), and Nyberg, Cabeza and Tulving (1996) but has been slightly modified since then. The version of HERA referred to in this context follows the model presented in Habib et al. (2003).

Although Engel et al. (1999) actually *do* highlight a unitary nature of working memory, their unitary view is restricted to the attention-related component of working memory mechanisms.

Tompkins et al. (1994) examined the association between ability to revise inferences and verbal working memory (VWM) in RHD individuals, LHD individuals and normal aging adults. The only association between discourse comprehension and VWM was found in the RHD group on questions requiring elaborative inference. VWM capacity was assessed using a modified version of the Daneman and Carpenter (1980) reading span task. Lehman and Tompkins (1998) evaluated the reliability and construct validity of this VWM test. The test-retest results indicate that the VWM measure is fairly stable over time for both non-brain-damaged individuals and RHD individuals. Based on their results, the authors also suggest that, with non-brain-damaged participants, the task can differentiate working memory from simple STM when compared with the results from, for example, the forward digit recall as described by Wechsler (1987). However, there was a moderate relationship between the STM task and the VWM task, which the authors relate to the simplicity of the stimuli in the current VWM task.

The VWM task revised by Tompkins et al. (1994) was also used in a study by Harris Wright and Newhoff (2001), where ability to revise inference was examined in healthy young individuals. In that study, no relationship was found between responses in the inference tasks and VWM measure. The authors propose that the task used was not cognitively demanding enough to tax the VWM capacities of the young healthy participants.

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The studies presented in this thesis investigate the comprehension of more complex discourse and interaction in conversation. It is, for example, expected that in conversational interaction in discourse, a lack of activation of relevant associations with information stored in LTM may result in insufficient retrieval structures causing constraints in the LT-WM. The comprehension processes investigated are expected to

make high demands on VWM processing in a way that is best described by the notion of working memory presented by Kintsch (1998) and Ericsson and Delaney (1999) although Engel et al.'s (1999) view of the importance of attentional mechanisms in working memory is acknowledged.

However, in accepting this notion of working memory, one also acknowledges the difficulty of trying to obtain general measures of working memory capacities in isolation from other cognitive abilities. Furthermore, evidence from the use of neuropsychological models and tests and functional imaging of the human brain and single-unit physiology in monkeys has, as described by Duncan (2001) and Kiefer, Ahlegian, and Spitzer (2005), contributed to the mapping of cognitive functions and an examination of the nature of frontal lobe specialisations. In *the adaptive coding model*, presented in Duncan (2001), working memory, selective attention and executive control are simply three different perspectives on the same underlying processing function. Kiefer et al. (2005) conclude that working memory, executive control and focusing on semantic retrieval share a common neural substrate and are functionally linked.

Nevertheless, it is presumed that measures of different components of working memory can be obtained. In the present studies an adapted version of the Tompkins et al. (1994) VWM task is used. This task is, however, considered to tax primarily the limited capacity of the STM component of working memory although LTM activation is required too. As it is at least partly dependent on the ability to rehearse and temporarily store verbal stimuli, it is assumed to primarily reveal LHD individuals' VWM deficits.

The inference tasks used in studies 1 and 2 have been elaborated to induce demands on the working memory capacities of the participants. In Kintsch's (1998) model of comprehension, the ability to retrieve stored information is important in the process of comprehension. The HERA model (Habib et al., 2003) emphasises the importance of the right hemisphere in the retrieval of episodic memories which might be especially important in the comprehension of some aspects of the narratives used to investigate the ability to make inferences in study 1.

1.2.4 Sustained attention

This section brief presents the human attention system and theories of the function and anatomical base for the construct of sustained attention and how to measure it. The concept of *neglect syndrome* is also briefly described, considered as a symptom of an attentional deficit.

1.2.4.1 Networks in the human attention system

Several models of the human attention system exist. Although these models subdivide and label different aspects of attention slightly differently, there is a consensus that the human attentional system is made up of several separate neural networks with discrete anatomical bases. Following the model presented by Posner and Petersen (1990; see also Sturm, 1996; Fernandez-Duque and Posner, 2001), the human attention system can be subdivided into three main systems. In this model, the ability to achieve and maintain an *alert state* functions through a fronto-parietal system mainly in the right hemisphere. The ability to *select* which sensory information to attend to depends on the right hemisphere's *orienting system*. The attention systems of intensity in alertness and orienting or selectivity are complemented by an *executive attention* system in charge of effortful control or coordination of cognitive activities.

According to the model described by Sturm (1996), *alertness* should be subdivided into *phasic* and *tonic* alertness. Tonic alertness is the stable basic level of activation which only changes slowly and involuntarily. Phasic alertness, on the other hand, is the enhanced level of activation that is reached in readiness to respond to expected stimuli. *Sustained attention* or *vigilance* is the ability to maintain a higher level of alertness to detect and respond to sources of information over time. The intensity system in *alertness* can be subdivided into a voluntary, top-down-driven system, that is dependent on structures in the precentral gyrus of the frontal lobe and

an automatic, bottom-up-driven system that is dependent on parietal lobe structures (Fernandez-Duque and Posner, 2001).

The *orienting system for selectivity*, as described by Sturm (1996), involves the ability to *focus* on certain features of a task and voluntarily suppress responses to irrelevant features. Another aspect of this system is the ability to *disengage and shift* the focus from one aspect to another of the stimuli. A third aspect of the *orienting system for selectivity* is the ability to share or *divide* the attentional resources between two different sources of information.

In the model as presented by Fernandez-Duque and Posner (2001), *the executive attention system* is anatomically based on distributed structures, such as the anterior cinguli and supplementary motor area, orbitofrontal cortex, dorsolateral prefrontal cortex, portions of basal ganglia and the thalamus. The executive system is necessary for the allocation of attentional resources. It is essential for planning and non-automatic processing of stimuli, the ability to switch between different tasks, inhibitory control, conflict resolution, and error detection.

The executive attention system is thought to be regulated by the dopaminergic transmitter system and alertness by the noradrenergic system while the orienting system is dependent on the cholinergic transmitter system, all of which are ascending activation systems arising in the brain stem.

Still, there are other models of the human attention system and there are no clear-cut boundaries between the different aspects of attention. For example, in the model presented by Fernandez-Duque and Posner (2001), vigilance and executive function interact as a supervisory attentional control that regulates the capacity for endogenous modulation of alertness. An inability to maintain an alert state leads to an increase in inhibitory failures, which is often considered as a measure of executive control (Robertson, Manly, Andrade, Baddeley, and Yiend, 1997a; Engel, Kane, and Tuholski, 1999; Fernandez-Duque and Posner, 2001). It also seems that deficits of the executive network can interact with parietal areas and, even in the absence of posterior parietal lesions, produce abnormalities in orienting behaviour. Furthermore, since alertness may be increased by signals generated internally by the frontal lobes

or automatically by external stimuli; in either case, the posterior orienting system is also involved.

Another example of the complexity of the human attention system is Sarter, Givens, and Bruno's (2001) notion that the limbic system and cortical afferent projections of basal forebrain neurons provide information about the significance of stimuli based on previous experience, motivation and behavioural context. This also influences several aspects of the attention system.

1.2.4.2 Sustained attention – the ability to stay alert

The psychological construct of sustained attention, or vigilance, is considered to be a basic attentional function that is motivated by stimulus anticipation and important for the efficacy of cognitive capacity in general (Sarter et al., 2001). Sustained attention or vigilance might be conceptualised as the state of intensified attention or alertness necessary for processing intermittent and sometimes infrequent stimuli and the maintenance of such alertness over time. In the model described by Sturm (1996), vigilance is a special condition of sustained attention where the occurrences of relevant stimuli are very rare and unpredictable. Reduced metabolic activity in subjects performing vigilance tasks has, as shown by Posner and Petersen (1990) and Posner and Raichle (1994), been interpreted as a sign that the individual is suspending activity while waiting for low-probability signals to avoid internal interference with the detection of the external signal.

Sarter et al. (2001) also state that human imaging studies have demonstrated that sustained attention is associated with activation of the anterior cingulate in medial frontal, and dorsolateral prefrontal cortical regions as well as parietal cortical areas, primarily but not exclusively in the right hemisphere. However, as the definition of sustained attention in relation to other components of the human attention system varies, other researchers have claimed that more restricted areas are involved. For example, Mirsky, Pascualvaca, Duncan, and French (1999), state that sustaining attention is the responsibility of rostral midbrain structures, including the reticular formation and midline and reticular thalamic nuclei. Those structures are otherwise

often referred to as subserving the arousal component of human attention. Sarter et al. (2001) claim that the anterior cingulate in the medial frontal part of the brain is associated with a network that subserves sustained attention. Still, this structure is more often associated with selectivity and executive attention (Fernandez-Duque and Posner, 2001).

Sarter et al. (2001), claim that the following variables, among several others, tax sustained attention performance:

1. Successive, as opposed to simultaneous, presentation of signal and non-signal features,
2. High event rate combined with unpredictability of signal versus non-signal,
3. Demands on working memory, as occurring in tasks with successive event presentation,
4. Presentation of signals with conditioned or symbolic significance which require additional processing to produce an accurate response. Such signals are considered to increase the allocation of resources consumed.

A high event rate and spatial uncertainty about the locus of event presentation affect the decrease in vigilance. So does the presentation of dynamic, as opposed to static, stimuli such as signals with variable salience or duration. This is, according to Sarter et al. (2001), partly because the presentation of dynamic stimuli is associated with decreased discriminability.

When it comes to the studies presented in this thesis, these variables have to be considered in the processing of discourse. Especially in a conversation, there is a high event rate of unpredictable occurrences of relevant versus irrelevant stimuli in the form of auditory and visual signals. The frequent occurrence of visual stimuli in the form of facial expressions, body posture, gestures and gaze involve a spatial uncertainty about the locus of relevant event presentation. The signals are of symbolic significance and demands on working memory as well as on the simultaneous activation of semantic and episodic memory units are high, as the

speakers attempt to interact based on linguistic and social knowledge as well as general world knowledge. The signals are also of variable salience and duration as information might be presented in the subtle form of a choice of words with certain associations, a raised eyebrow or a slight modification of tone of voice. The stimuli in conversational interaction can actually be expected to make higher demands on sustained attention than an experimental sustained attention task. According to Sarter et al. (2001) subjects performing a sustained attention task are aware of what type of signal to expect and how to respond in accordance with acquired response rules. Expectations concerning the probability of signals and strategies for responding to relevant stimuli versus false alarms are developed.

As stated by, for example, Posner and Petersen (1990), right-hemisphere lesions are often associated with impaired performance on vigilance tasks. Because of the possible impact of deficits in vigilance or sustained attention on the individuals' ability to comprehend and stay focused and interact in conversation, it is hypothesised here that a measure of sustained attention correlates with RHD individuals' performance on tasks that require adequate inferences from complex narratives. It is also expected that ability to sustain attention has an impact on the performance of individuals in conversational interactions.

1.2.4.3 How to measure sustained attention

As there are no clear-cut boundaries between different aspects of attention, it is impossible to construct a task that measures a single component of the human attention system in isolation from other components. Nevertheless, both researchers and clinicians do try to obtain measures of different aspects of attention with more or less established methods. One common way of measuring sustained attention is in tasks where the subjects have to stay alert for a long time to detect unpredictably occurring signals or changes in pattern and, for example, press a button when a target symbol or a change is presented. In study 2 of this thesis the Sustained Attention to Response Test is used (SART; Robertson et al., 1997a). According to Robertson et al. (1997a), ceiling effects are often seen in sustained attention tasks due to the

automatisation of the tasks. In the SART, this is prevented because the automatic response set is transferred to the non-targets. This enhances the need for controlled processing to avoid producing an erroneous response. Since this task taxes sustained attention more heavily, it can obtain a measure of the ability to maintain sustained attention in as short a time as approximately four minutes, according to the authors.

Robertson et al. (1997a) and Manly, Robertson, Galloway, and Hawkins (1999) have shown of the SART to predict of everyday attentional failures and action slips in patients with traumatic brain injuries (TBI) and controls without brain injury and to discriminate between a group of TBI patients and normal controls. The validity and reliability of the test have been investigated. Robertson et al. (1997a) analysed the relationship between the SART and other tests of sustained attention as well as tests of other attentional processes. In particular, they analysed the SART in relation to tests where response inhibition is important, such as the Stroop task (Trenerry, Crosson, DeBoe, and Leber, 1989), and the Wisconsin Card Sorting Test (Nelson, 1976). They also compared the SART with the Visual Elevator subtest of the Test of Everyday Attention (Robertson, Ward, Ridgeway, and Nimmo-Smith, 1994). On the basis of those comparisons, they argue that the SART is sensitive to sustained attention and not simply to impaired ability to inhibit a response. The SART results were also shown to be stable over time. The potential effects of age, gender and education were investigated by Chan (2001) and found to be minimal.

1.2.4.4 Unilateral neglect and attention

Unilateral neglect is a common symptom in the acute stages of brain damage to the right hemisphere (Heilman, Watson and Valenstein, 1985; Mesulam, 1985). The term refers to a patient's problems detecting stimuli on the side opposite the site of the lesion. These problems can be observed in the neglect of external space or features on one side of an object. In severe cases, the patient may be entirely unaware of stimuli on the neglected side including his or her own body. The phenomenon may involve visual as well as auditory and somatosensory modalities. Although it does occur after

LHD, it is usually more persistent and severe in association with temporo-parietal RHD.

Fernandez-Duque and Posner (2001) described the phenomenon of neglect as an abnormality of orientation since the subject has difficulty disengaging from cues presented on the same side as the lesion in order to respond to stimuli presented on the opposite side.

Lesions in the parietal lobe can influence both the orienting system and the alertness system. Dysfunctions in both of these systems might contribute to neglect syndrome. Robertson et al. (1997b) showed that there is a strong association between performance on various tests of spatial neglect and vigilance performance, as measured with an auditorily presented sustained attention task. The results of the study of 44 RHD individuals with lesions involving right temporo-parietal regions are considered to be evidence of a close link between the presence of visual neglect and impaired sustained attention.

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In the studies presented here, both ability to sustain attention and VWM are considered to be important in comprehension. Basic attentional function is important for the efficacy of cognitive capacity in general. Furthermore, it is believed that access to and retrieval of episodic memories in the form of stored information about personal experience might be important to form an adequate and complete situation model as a component of episodic text memory. This may be especially important in the processing of information concerning characters' attitudes and motives, or emotionally tinged situations. In study 1, two gross neglect tests are included to apprehend symptoms of neglect which could indicate the presence of a spatial attentional disorder and also to control for any interference by neglect with the other tasks in the study.

1.2.5 Pragmatics in discourse

In this section, research on the pragmatic aspects of discourse production and conversational interaction between individuals will be presented, along with methodological issues.

The communication disorders described in association with RHD are often conceptualised as pragmatic disorders. In addition to problems understanding humour and metaphors and making adequate inferences in isolated experimental tasks, problems with the production of language such as structuring of discourse and conversational interaction, have been described; see Tompkins (1995) and Myers (1999b) for an overview.

Discourse must be coherent to be comprehensible. The listener or reader must be able to identify meaningful relationships between the different units expressed in the discourse. One way of analysing discourse coherence is the principle of *given information - new information* (Clark and Haviland, 1977). The listener has to make out what the given and new information is, identify a referent for the given information and then be able to link the new information to that referent. Pragmatic competence, as defined by Penn (1999), aids the listener in doing that (see section 1.1). The speaker uses pragmatic competence to structure and alter the information in a way that makes it suitable to what he or she believes about the listener's knowledge of the topic and also to the content of the previous discourse.

In a review of research on comprehension in discourse, Zwaan and Singer (2003) describe the identification of given information. In understanding discourse, the listener establishes that the given idea and its referent both refer to the same entity in the world. Such co-reference can be signalled by different linguistic devices and semantic relations. Definite noun phrases can function as anaphors, which means that they refer back to something previously mentioned or at least denoted in the discourse. Pronouns may signify their referents ambiguously or unambiguously. A pronoun that unambiguously signifies a specific referent is understood more quickly

(Frederiksen, 1981). The distance between the pronoun and its referent also influences pronoun resolution (McKoon and Ratcliff, 1980). Semantic factors interact with surface factors in pronoun resolution (Caramazza, Grober, Garvey and Yates, 1977). Consider the sentences *The bird had noticed the cat. It suddenly flew away over the trees.* The implicit causality of the verb guides pronoun resolution: general knowledge includes the fact that birds can fly, but cats cannot.

According to Schober and Brennan (2003), one important finding in spoken language production studies is that speakers try to produce descriptions or expressions for referring that appear to be tailored to the particular person they are speaking to. The form and content of the utterances may be based on the speakers' beliefs about the knowledge of the conversational partner or on judgements of his or her need for explicit information in the current context (Lockridge and Brennan, 2002). According to Schober (1998), adaptation to the conversational partner's prerequisites for interpretation relies to a great deal on memory and inference. The speaker may make word choices, alter articulatory and prosodic features, adjust syntactic structure and select topics based on his or her beliefs about the conversational partner or about their common knowledge.

As described by Schober and Brennan (2003), language processing proceeds in parallel automatic and controlled processes. The updating and assessment of the conversational partner's needs for information are controlled and require time and effort. When restraints are present, such as reduced attentional capacity or time pressure, speakers or listeners may instead rely on fast automatic processes and fail to take their partner's mind and knowledge into account. Furthermore, to adjust appropriately, a speaker and an addressee must not only assess each others knowledge. As discussed by Schober and Brennan (2003), the speaker must also know what the appropriate adjustments are. Speakers who are under a great cognitive load, and thus have fewer attentional resources available, might not be able to adapt to the conversational partner's needs. Others might, as a personality trait, be more egocentric or they may have reduced general perspective-taking skills. Motivation to

adapt to the conversational partner's perspective is also crucial (Giles, Coupland, and Coupland, 1991).

In natural conversation misinterpretations and failures to adapt to the conversational partner are often exposed in or before the next contribution (Krauss, 1987; Wilkes-Gibbs, 1995). That is, the speaker can often infer from the conversational partner's response how his or her contribution was interpreted. Requests for clarification, feedback and backchannel sounds like 'mm' or 'huh' or prosody, as well as body communication such as facial expressions, gaze and body posture, signal whether the previous utterances were adapted to the conversational partner's knowledge and need for information. In this way the conversational partners collaborate to make the utterances comprehensible.

In conversation, the participants collaborate in the construction of *topical coherence*; see Levinson (1983) for a discussion of this matter. Since linked transitions from topic to topic are preferred, sometimes topics either have to be withheld or the participants have to find a way to tie the new topic to the previous ones. The closure of one topic is usually a joint decision and preceded by pauses or gaps that signal that neither of the participants wishes to develop the topic further and there is an opportunity to introduce a new one. An alternative is to mark the transition to an unlinked topic in some way, e.g. with the phrase *by the way*.

Speakers may revise their utterances when they recognise a misinterpretation by the addressee. The speaker might, for example, add more explicit information or modify a word choice. Other reasons for the need for repairs include word-finding troubles, semantic paraphasias and articulatory errors. In cases of failed adaptation, repair organisation might be a question of co-operation between conversational partners as the speaker is dependent on feedback from the addressee to be able to recognise the need for revision. However, Schegloff, Jefferson, and Sacks (1977) used *Conversational Analysis* methods (see below) to establish that *self-initiated* repair, where the speaker himself or herself recognises the need for repair and is able to perform it is more common and in that sense preferred over *other-initiated* repair, or repair carried out by the conversational partner. Based on their analysis Schegloff

et al. (1977) proposed that in normal interaction self-initiated repair is most often carried out within the same turn in which the trouble appears. In cases of other-initiated repair, the problem is most often resolved within three turns.

Lesser and Milroy (1993) describe one of the major approaches to the study of pragmatic aspects of language in discourse as a 'top-down' approach. It can be described as a linguistic or philosophical approach as it often takes its starting point in pragmatic theories like Austin's (1962) speech act theory. Speech act theory emphasises the *act* that is performed by making a certain utterance, such as the act of warning or of requesting. Speech act theory is also concerned with how the speaker and listener can relate the semantic and syntactic form of an utterance to specific acts. This 'top-down' approach works with some kind of organisational principle or *conversational principle* such as *the co-operative principle* proposed by Grice (1975, 1978). In Grice's theory, conversational partners are assumed to apply four different maxims in producing and interpreting discourse. The maxim of *quality* requires the speaker to make a contribution that is true; the maxim of *quantity* requires that the contribution not provide more information or less information than what is required for the current purpose; the maxim of *relevance* requires that the contribution actually is relevant; the maxim of *manner* requires clarity, and more specifically, briefness, order, and avoidance of obscurity and ambiguity. *Speech acts*, as described by Searle (1979), and *relevance*, as in Sperber and Wilson's (1995) theory of relevance, are also examples of conversational principles. Attempts are often made to apply those theories to the analysed data or to collect data suitable for this kind of categorisation.

Those approaches, for example, the Gricean maxims that together express a general *co-operative principle*, have been used in several studies of discourse in association with LHD, (Ahlsén, 1993) and RHD. For example, Bloom et al. (1999) explored the psychometric aspects of a verbal pragmatic rating scale that was developed from Grice's (1975, 1978) maxims. The rating scale was used to assess emotional and unemotional narratives in RHD and LHD patients as well as healthy normal controls. The authors conclude that the results support Grice's theoretical assumptions that there are distinct pragmatic rules that operate on discourse. Further

examples of studies using Grice's maxims are given in section 1.2.6.1. Sperber and Wilson (1995) in their theory of *relevance* argue that in processing information, the human cognitive system aims to gain the greatest possible benefit for the least cost in terms of processing efforts. In communication, that means that we can expect that everything explicitly or implicitly expressed, or not expressed, somehow has relevance. Thus, *relevance* is the only guiding principle that is needed. Relevance theory has also been used in studies of communication in RHD (Dipper, Bryan, and Tyson, 1997), and in autism (Happé, 1993).

However, such 'top-down' approaches may be criticised for not enough taking account of the collaborative aspect of natural conversation (Leech, 1983). In their utterances and pauses, as well as body communication, the conversational partners interact in creating coherent conversation. This view of conversation as a joint responsibility of both or all conversational partners is especially important in the clinical analysis and treatment of communication disorders.

Compared to the approaches mentioned above, *Conversational Analysis (CA)*, which originates in the ethnomethodology tradition, offers a 'bottom-up', data-driven approach. In this method, attempts are made to avoid preset ideas of what communication is. That is, no set of analytic or organisational principles is postulated. Instead the methodology inductively seeks patterns and structures in naturally occurring data. The CA approach has generated a number of insights and detailed descriptions of how common conventions control the conversational interaction. For example, principles for the organisation of turn-taking and repair have been described by Schegloff (1972), Sacks, Schegloff and Jefferson (1974) and Schegloff, Jefferson, and Sacks (1977). Structures for topic manipulation have also been described by, for example, Button and Casey (1984), and the use of body communication such as gaze and body positioning by Goodwin (1984) and Heath (1984).

CA has been criticised for not considering factors in the external context of the conversational interaction (Allwood, 1992). In the urge to avoid generalisations that might conceal what actually happens in the interaction, an interpreter, who uses the

CA method alone, might not be able to achieve a full understanding of an utterance or a pause. Gumperz (2001) instead proposes an interactional sociolinguistic perspective on communication. In this approach, it is assumed that the interpretation of utterances in communication is always dependent on context-specific background knowledge embodied in presuppositions that might shift during the conversational interaction. The participants in a conversation constantly generate inferences out of their general world knowledge, and their knowledge of the situation and the individuals involved, about the intentions of their conversational partners. They also adapt the utterances they plan and produce in response to these inferences. In *Activity Based Communication Analysis* (ACA), Allwood (1995) developed a framework that takes account of influencing background factors in the actual communicative context. Ahlsén (1995) has adapted this framework to the analysis of communication disorders.

Still, the detailed descriptions of conventional conversation structuring generated by CA are useful for the understanding and treating communication disorders. Different more or less modified versions of CA have also been described as useful methods for capturing, describing and understanding the problems that might arise in conversational interaction in association with aphasia (Lock et al. 2001; Oelschlaeger and Damico, 2000).

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Studies 3 and 4 in this thesis focus on the ability to interact in conversation. In study 3, the perceptions of post-stroke changes in several pragmatic aspects of conversational interaction are investigated in groups of brain-damaged individuals and their conversational partners. Study 4 comprises four case studies where results from both bottom-up and top-down analysis of video-recorded conversational interaction are integrated with the results of the cognitive tasks administered in studies 1 and 2. *ACA* (Allwood, 1995; Ahlsén, 1995) is employed in the analysis of the conversational interactions in study 4.

1.2.6 Discourse production in association with right-hemisphere damage

This section presents research about discourse production and conversational interaction in association with RHD. There are several fairly anecdotal descriptions of excessive verbal behaviour, production of statements that are out of context, tangential, irrelevant or inappropriate in the given context in the discourse of RHD individuals (Myers, 1999b; Tompkins, 1995). However, quantitative evidence of impaired discourse has also been presented, although there are more published studies of procedural and narrative discourse than of conversational interaction in association with RHD.

1.2.6.1 Narrative and procedural discourse and task-oriented conversation

Problems in adapting to the needs of a conversational partner and understanding the implications of discourse have been studied in RHD individuals, following Grice's (1975, 1978) notion of the cooperative principle and conversational maxims (Kasher, Batori, Soroker, Graves, and Zaidel, 1999; Rehak, Kaplan, and Gardner, 1992).

The level of detail in discourse also depends on adaptation to the listener. Script knowledge and the ability to produce sufficiently detailed discourse have been assessed in association with RHD (Lojek-Osiejuk, 1996); Roman, Brownell, Potter, Seibold, and Gardner, 1987). Roman et al. (1987) found that RHD individuals have trouble producing verbal scripts of the sequences of steps in common activities, such as 'visiting a restaurant'. Still, as they seemed to be able to judge importance and temporal order when choosing between two possible responses, the authors suggest that RHD individuals do have preserved script knowledge. Rather, the difficulty of the tasks, according to these authors, is evidence of processing deficits such as an inability to inhibit personalisation and tangential remarks.

Problems in using reference have been established in association with RHD. For example, deficits in referential cohesion, logical coherence and accuracy of narration have been found in RHD stroke patients. In one study by Davis, O'Neil-Pirozzi, and Coon (1997), problems in referential cohesion were found in the retelling of auditory-

verbal presented stories and logical coherence was only impaired in conditions where pictures were present. According to the authors, these results point to the multiple levels of processing in discourse production. Any explanation of discourse production deficits must consider the relationships between possible primary dysfunctions, such as difficulties in the processing of coherence in visual stimuli in association with RHD, and the particular discourse measure chosen as the dependent variable.

Lack of consideration of the listener's familiarity of the referent was also found by Brownell et al. (1997), in RHD patients' use of personal reference. Brownell et al. (1997) used stimuli in the form of vignettes describing a conversational situation and manipulated the occupational status and familiarity between the characters in the narratives. The participants had to choose the most appropriate way for one character to refer to another character from among three suggestions.

In a study of task oriented conversation by Chantraine, Joannette, and Ska (1998), RHD individuals had to instruct a research associate on how to display a series of visual stimuli in a certain order. Some, but not all, of the ten participants were found to have referential and/or other qualitative difficulties. It is important to bear this heterogeneity among RHD individuals in mind. Not all of them have communicative impairments and not all RHD individuals with communicative impairments have the same symptoms.

1.2.6.2 Natural conversation and right-hemisphere damage

In examining pragmatic skills in the spontaneous conversations of RHD individuals, Prutting and Kirchner (1987) mainly found deviance in eye gaze, prosodic pattern and variation, turn-taking contingency, turn-taking adjacency, and quantity. On other parameters, e.g. topic selection, topic introduction, topic change and cohesion, only a few of the RHD individuals were found to be deficient. However, all the participants were receiving treatment at the time of the study and it is not clear whether the treatment focused on any of these pragmatic parameters.

Management of topics and turns in first-encounter conversations has also been assessed: in a study by Kennedy, Strand, Burton, and Peterson (1994), eight minutes

of conversation were transcribed turn by turn and each turn was coded to identify topic management. No significant difference was found between a group of RHD individuals and a group of non-brain damaged-individuals. However, the RHD individuals did ask fewer questions than the non-brain-damaged individuals. In another study, Kennedy (2000) found that RHD individuals produced larger proportions of topic scenes during the termination phase than non-brain-damaged individuals. The author suggests that this may evidence a reduced ability to understand the conversational partner's signals of that he or she wishes to end the conversation. Topic use in semi-structured conversation has also been investigated, for example, by Brady, Mackenzie, and Armstrong (2003). These authors conclude that, although the use of *main* topics did not diverge between a group of RHD individuals and a group of LHD individuals, the use of subdivision into *sub-topics* did. The RHD group used fewer subdivisions and also fewer discourse features such as repetition, topic shading and fillers, which might function as discourse manipulators. This, the authors argue, might explain why a listener may perceive the discourse as disorganised and difficult to comprehend. Since all topic elements are presented on a similar level of importance, the discourse might be perceived as excessive or focusing on minor or irrelevant details. The investigation of topic management and coherence in procedural discourse produced similar results, with only small differences between RHD individuals and LHD individuals (Brady, Armstrong, and Mackenzie, 2005).

The collaborative planning of a conversation is dependent on the recognition of the other participants' intentions. This was investigated by Hird and Kirsner (2003), who analysed discourse structures in natural conversations with RHD individuals. In the RHD individuals, a reduced or eliminated use of prosody to guide the listeners through a change in discourse structure was found. Furthermore, they did not seem to assume equal responsibility for development and maintenance of the discourse structure. The RHD individuals introduced fewer topics and gave their conversational partners fewer opportunities to elaborate the topics. According to Hird and Kirsner, these results might indicate a reduced capacity to maintain intentional focus, as

described in work emerging from computer linguistics by Lochbaum, Grosz, and Sidner (2000). This kind of impairment, perhaps due to attentional deficits, would make it difficult to keep a record of the discourse structure and the relationships between the different contributions and their relevance to the discourse. This might, according to Hird and Kirsner (2003), explain RHD individuals tendency to ‘maintain the floor’ and the reduction of their contributions to marginally relevant associations. This in turn might force the conversational partner to compensate by taking a more passive role within each discourse segment and simply producing feedback. When the impaired speaker runs out of associated ideas, the conversational partner is required to take responsibility for the introduction of new topics.

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In studies 3 and 4, brain-damaged-individuals’ ability to interact in conversation and their capacities for reference use, turn-taking, topic coherence, level of detail and prosody in discourse are investigated. Strategies for repair in cases of problems in communication and word retrieval difficulties are also investigated.

1.2.7 Summary of theoretical background

Fundamental to the studies in this thesis presented is a view on cognition and communication where language, and more specifically pragmatic aspects of language, are seen as dependent on, and interacting with, other cognitive aspects as well as strategies within and between individuals. Another important element, touched upon in the background, is that current models of cognitive processes and functions are simply reflections of inferences made from the knowledge we have today. Therefore, these models, and the perceptions of the relationships between different aspects of cognition, are constantly changing and by no means static. The methods used in the four studies were put together and developed from previous research on pragmatic deficits in association with RHD and current theories of the human mind.

Kintsch's (1998) construction-integration model of comprehension serves as a background to the entire thesis but is explicitly discussed mostly in studies 1 and 2. The models of sustained attention and VWM, including Ericsson and Kintsch's (1995) and Ericsson and Delaney's, (1999) notion of LT-WM are relevant in studies 1 and 2 as well as in the discussion of individual results in study 4. The current theories of the cause of pragmatic deficits in association with RHD, especially the *coarse semantic coding theory* (Beeman, 1998), *suppression deficit hypothesis* (Tompkins et al., 1999) and theories about *social inference* (Adolphs, 1999), will be discussed in connection with the results obtained from studies 1, 2 and 4. The notions about the pragmatic aspects of discourse production become relevant and will be discussed in the light of the method used and results obtained from study 3 and 4, where conversational interaction will be investigated.

1.2.8 Outline of the thesis

The four studies that constitute this thesis have been separated into two parts. Part I consists of studies 1 and 2, where the pragmatic aspects of *comprehension* in association with acquired brain damage are explored.

Studies 1 and 2, presented together, are experimental group studies that investigate the comprehension of discourse involving a need to revise inferences and make inferences about a main character's attitude and motives. In study 1, the performance of a group of RHD individuals is compared to that of a group of LHD individuals and a control group on the inference tasks and neglect tests. In study 2, the associations between performance on the inference tasks and the results on a test of VWM and a task measuring capacity for sustained attention are explored. The results from studies 1 and 2 are first summarised and discussed with the presentation of each set of results. Part I then concludes with a general and more theoretical discussion of studies 1 and 2, where the results will be discussed together and related to current research on pragmatic deficits in association with RHD as well as to Kintsch's construction-integration model of comprehension.

Part II of the thesis consists of studies 3 and 4 which are more exploratory studies where pragmatic aspects of *conversational interaction* are investigated.

Study 3 is a group study where the effects of RHD and LHD on pragmatic aspects of language and communication are investigated with a questionnaire distributed to the brain-damaged individuals and their conversational partners. The perception of post-stroke change and the possible negative impact of this change on conversational interaction are examined on a number of pragmatic parameters.

Study 4 consists of four case studies. Individual features and results from studies 1 to 3 of two men with RHD and two men with LHD are presented and discussed in relation to an analysis of video-recordings of their conversational interaction in a dyad. In the analysis of the conversational interaction, individual features of the RHD individuals are compared to the LHD individuals in terms of word retrieval difficulties, turn-taking and repair. Part II of the thesis concludes with a general discussion of results of study 3 and study 4.

The thesis is completed with a brief summary and conclusions about the results of the four studies in the thesis and their implications for future research and clinical management of pragmatic problems, especially in relation to acquired RHD.

2. PART I: DISCOURSE COMPREHENSION

In this part of the thesis, comprehension in the form of ability to make *revised inference* and a type of social inference, *inference of a character's attitude or motive*, and connection with VWM and sustained attention is investigated. Study 1 and study 2 are experimental group studies and the results will be presented and discussed together.

2.1 Introduction and outline to studies 1 and 2: Inference and associations

First the research questions and hypotheses underlying the two studies will be presented. In the next section, the subjects and methodology for the data collection and analyses used in studies 1 and 2 are described. This is followed by a presentation of the results of the comparison between groups, correlation and regression analyses. The results will be presented along with brief discussions; a more theoretical general discussion will follow. In the general discussion of results of studies 1 and 2, the results are discussed in relation to each other and in light of Kintsch's construction-integration model as well as current theories of the causes of pragmatic deficits associated with RHD. Methodological issues will be critically examined.

2.1.1 Research questions and hypotheses

In study 1 and study 2, the possible associations between the impaired ability to make adequate inferences from implicit information in discourse, sustained attention and VWM will be explored.

The studies have two main purposes. In the first study, the ability to infer from implicit information in discourse is investigated and the research questions are:

- 1a) Is it possible to establish a difference in the ability to infer from implicit information in verbal discourse, defined as extended verbal expression in speech

or writing, between a group of RHD individuals with suspected pragmatic language disorders, a group of LHD individuals with subtle language disorders and a group of non-brain-damaged individuals?

1b) Are there differences in the comprehension of discourse, depending on the type of inference required, between a group of RHD individuals and a group of LHD individuals?

It is hypothesised that it is possible to distinguish groups of brain-damaged individuals from a group of healthy subjects based on their ability to infer from implicit information in verbal discourse. Building on current research, see for example Borod et al. (2002) and Brownell and Martino (1998), and theories of brain function and cognition, it is also hypothesised that there are qualitative differences between the groups of brain-damaged individuals in terms of their comprehension of discourse and that RHD individuals will have more problems than LHD individuals in comprehending discourse that involves inferences concerning a character's attitude or motive.

In the second study, the aim is to investigate possible associations between the ability to infer from implicit information in verbal discourse and the two cognitive abilities – VWM and sustained attention – which might have an impact on discourse comprehension. The research questions are:

2a) Is it possible to establish any associations between either sustained attention or VWM and the ability to comprehend implicit information in verbal discourse in two groups of individuals with either RHD or LHD?

2b) Does any association between RHD individuals' ability to comprehend implicit information in discourse and sustained attention or VWM diverge from the equivalent association in LHD individuals?

Based on current research and theories of the brain, language and cognition, for example, Caspari et al. (1998) and Fernandez-Duque and Posner (2001), it is hypothesised that there are associations between discourse comprehension and the measures of sustained attention and VWM but that they will diverge between the two groups of brain-damage individuals. In the group of RHD individuals, the strongest association is expected to be found between sustained attention and comprehension. In the group of LHD individuals, it is hypothesised that the strongest association will be between VWM and comprehension of verbal discourse.

2.2 Method: Studies 1 and 2

In this section, the study subjects will be described followed by a presentation of the experimental stimuli and tasks. After that, the experimental procedures will be described. The section concludes with a presentation of the analyses carried out on the results; the statistical analyses performed are described separately.

2.2.1 Participants

Studies 1 and 2 include 14 individuals with RHD, 14 individuals with LHD, and 14 individuals with no history of brain damage or neurological disease (the Control group). Tables 2:2:1-2:2:3 display subject data and group means for the three groups. Seven women and seven men were included in each group. All participants were native speakers of Swedish. The three groups were matched in terms of age, educational level and pre-onset reading habits. The participants' age range was between 39 to 80 years (mean: 63.4 years old, S.D.: 11.19). Their educational levels were assigned to three different categories:

Category 1: Compulsory school without subsequent educational achievement (6 – 9 years in school).

Category 2: School to certificate level or further education equivalent to at least this level.

Category 3: Higher (university-level) certificate.

Information about reading habits – books and other reading material, e.g. magazines and newspapers – was collected. The individuals' reading habits on books are considered as a measure of a basic cognitive level and were assigned to five different categories according to how many books (fiction and non-fiction), they used to read, pre-stroke, during one year:

0 = No books at all; 1 = 1-3 books in a year; 2 = 4-7 books in a year; 3 = 8-13 books in a year; 4 = >13 books in a year.

The brain-damaged individuals were recruited from rehabilitation centres in the west of Sweden on the basis of the following inclusion criteria: (1) at least six months post-onset of the cerebrovascular incident; (2) unilateral cerebral brain damage⁷ confirmed by CT or MRI scan or clinical examination; (3) no history of substance abuse; (4) no presence of dysarthria, neglect syndrome or visual- or hearing impairment, so severe that it cannot be compensated for in the test situation; (5) age between 25 and 80 years; (6) native speaker of Swedish; (7) post-cerebrovascular incident problems affecting the communication ability. The occurrence of problems that was considered to have impact on the communication could either be experienced by the individuals themselves or noticed by their communication partners.

The inclusion criteria were distributed to speech- and language therapists working in rehabilitation centres in western Sweden. Individuals that were suggested as possible subjects were then contacted and informed by the test leader. They also received written information about the studies and were controlled against the inclusion criteria by the test leader. Subjects who fulfilled the inclusion criteria, and gave their written informed consent to participate, were included in the studies. The recruiting ended when there was an equal distribution of individuals in the two

⁷ This includes lesions in the diencephalon, and in one case, the pons, as the diencephalon in particular is considered to be intertwined with the cerebrum, both anatomically and functionally.

groups of brain-damaged individuals. Forty-five right- or left-hemisphere brain-damaged individuals were suggested as possible subjects. Of these 45 patients, 17 were excluded for the following reasons: four LHD individuals declined to participate; one RHD and one LHD subject were excluded due to severe hemianopia; four individuals had bilateral brain damage; two individuals had a damaged cerebellum; one individual had suspected dementia; three individuals were either left handed or ambidextrous; one individual was too old. The RHD individuals included are presented in table 2:2:1.

Table 2:2:1: RHD individuals: Subject data and group means

Subject	Sex	Age in years	Edu- cational level	Reading habits	Months post-onset	Site and type of lesion according to CT/MRI scan or clinical examination
R1	Male	77	2	4	49	CT scan: infarction, putamen
R2	Female	76	3	2	33	CT scan: haemorrhage, pons
R3	Female	75	2	4	59	CT scan: lacunar infarctions
R4	Male	74	1	0	6	CT scan: frontal infarction
R5	Female	69	2	3	6	CT scan: infarction capsula externa
R6	Male	67	2	3	52	CT scan: infarction Sylvian fissure, towards the basal ganglia
R7	Male	66	3	3	100	CT scan: infarction frontal and parietal
R8	Female	64	1	1	120	CT scan: subarachnoidal haemorrhage + infarction in the basal ganglia
R9	Male	63	1	4	111	CT scan: arteria cerebri media infarction frontal
R10	Female	62	2	4	116	MRI scan: subarachnoidal haemorrhage + infarction temporal
R11	Female	58	3	4	34	CT scan: infarction capsula interna
R12	Male	51	3	3	8	MRI scan: infarctions, basal ganglia towards Sylvian fissure
R13	Male	45	2	2	11	CT scan: haemorrhage
R14	Female	43	2	4	8	CT scan: subarachnoidal haemorrhage temporal
Mean (S.D.):	7 female 7 male	63.6 (11.0)	2.1 (.73)	2.9 (1.3)	50.9 (43.9)	

Among the participants with RHD, the medical charts mention symptoms of visuospatial neglect in only four out of the 14 patients. Three additional participants stated that they either had had or still had mild symptoms of neglect.

All the brain-damaged individuals included described themselves as right-handed. Among the LHD subjects, eight individuals reported some degree of persistent sensorimotor dysfunction in the right hand but only two of them perceived this dysfunction as so disturbing that they chose to use their left hand in writing and test tasks; see table 2:2:2.

The LHD individuals all performed well on A-ning, a neurolinguistic aphasia test developed by Lindström and Werner (1995). That is, the subjects included had an A-ning index that was higher 4.75 out of a possible 5.0. One subject was judged to perform far above the levels investigated in A-ning by the speech-language therapist at the rehabilitation clinic. His language abilities were therefore assessed with a test battery designed for the assessment of subtle language disorders, the TBSS (Laakso, Brunnegård, Hartelius, and Ahlsén, 2000), instead of the A-ning. All the LHD individuals were assessed by experienced speech-language therapists and diagnosed as either not aphasic or mildly aphasic at the time of their participation in the study.

All the brain-damaged participants had been able to return to living with their spouses or by themselves after rehabilitation. All brain-damaged individuals, except one LHD subject, were able to walk after their stroke rehabilitation. Two LHD subjects had been able to return to work with adjusted duties and working hours. Three LHD subjects and two RHD individuals were still in post-stroke rehabilitation programs and decisions about their future working life were still to be made.

Table 2:2:2: LHD individuals: Subject data and group means

Subject	Sex	Age in years	Edu- cational level	Reading habits	Months post- onset	Site and type of lesion according to CT/MRI scan or physical examination	A-ning index (max. 5)	Sensori- motor impairment right hand
L15	Female	80	3	4	16	Clinical examination: Weakness in right side of body and anomia	4.85	
L16	Female	76	2	4	68	CT scan: haemorrhage thalamus and capsula interna	5.0	X
L17	Female	74	2	0	9	CT scan: infarction posterior	4.83	X
L18	Female	73	1	3	98	CT scan: infarction frontal	4.80	X
L19	Male	67	1	4	7	CT scan: infarction lentiformis	4.80	X
L20	Male	67	2	3	35	CT scan: infarction, temporal and capsula interna	4.80	X
L21	Male	62	1	1	48	Neuropsychological examination: central posterior lesion	4.90	
L22	Female	58	2	4	16	CT scan: infarction parietal	4.80	
L23	Male	57	2	1	6	MRI scan: infarction temporal-occipital	4.80	
L24	Female	56	3	4	30	CT scan: lacunar infarctions close to thalamus and occipital	4.85	X
L25	Male	56	3	4	13	CT scan: haemorrhages frontal-temporal-parietal	4.75	X
L26	Male	54	2	1	62	CT scan: infarctions frontal and temporal	4.80	X
L27	Male	43	3	4	14	CT scan: haemorrhage	95% in TBSS*	
L28	Female	39	2	1	11	CT scan: subarachnoidal haemorrhage involving Sylvian fissure	4.8	
Mean (S.D.):	7 female 7 male	61.6 (12.1)	2.1 (.73)	2.7 (1.5)	30.9 (28.1)		4.83 (.06)	

Note.* = One subject was assessed with a test battery designed for subtle language disorders (TBSS). In those tests, he successfully performed 95% of the tasks.

The individuals in the Control group were recruited from different educational courses, personal contacts and activity groups for elderly people; see table 2:2:3. According to self-report, they had no known brain damage or neurological disease and no history of substance abuse.

Table 2:2:3: Individuals in the Control group: Subject data and group means

Subject	Sex	Age in years	Educational level	Reading habits
C29	Male	77	2	1
C30	Female	74	3	4
C31	Male	73	3	3
C32	Male	71	2	1
C33	Female	70	2	1
C34	Female	70	2	3
C35	Female	67	3	4
C36	Female	68	3	2
C37	Female	67	3	4
C38	Male	66	2	4
C39	Female	63	2	2
C40	Female	61	1	3
C41	Male	43	3	4
C42	Male	39	2	1
Mean	7 female	64.9	2.4	2.6
(S.D.):	7 male	(11.0)	(.63)	(1.3)

Individuals were recruited for the Control group until the group was matched to the groups of brain-damaged individuals in terms of age, sex and education.

Of the 23 individuals interested in participating in the Control group, nine had to be excluded: four individuals reported suspicion of brain damage; one was not a native speaker of Swedish; one was excluded due to a technical breakdown; one due to a severe hearing impairment; and two because they were too old.

All subject data about personal matters as well as test results were coded to guarantee the anonymity of the participating individuals.

2.2.2 Experimental tasks

In this section, the methods and types of stimuli used to collect data on discourse comprehension, VWM, possible symptoms of visuospatial neglect and ability to sustain attention are described. The experimental procedures will be described in section 2.2.3.

2.2.2.1 Stimuli in discourse comprehension

The Discourse Comprehension task is an adapted and extended version of the stimuli used by Tompkins et al. (1994). It consists of eleven short narratives, 61 to 72 words long, presented as auditory stimuli and followed by questions about the content (see Appendix 1). The stimuli and questions were recorded in a studio, read in a neutral tone of voice. The narratives depict fairly everyday situations with interaction between the characters and were produced in such a way that they would require elaborative inferences generated from the content of the narratives as well as general world knowledge for full comprehension.

After listening to each narrative, the subjects had to respond to three questions about the content of the text. The questions can be subdivided into two groups depending on whether they are dependent on explicitly or implicitly stated content in the narratives: one of the three questions was about facts that were explicitly stated in the text; the two others demanded elaborative inference of implicitly stated matters and are considered to require more complex cognitive processing. After trying to answer the questions from memory, the subjects were allowed to read the texts at their own pace and control and change their answers if they so wished. The possibility of reading the texts and modifying the responses and the questions about explicitly stated facts were considered to be a method of controlling for the possibility that problems producing correct inferences might be a consequence of failure of more basic and automatic processes, such as automatic activation of the dominant meaning of words or, in

Kintsch's (1998) terminology, comprehension through automatic retrieval structures, instead of more compound linguistic and non-linguistic cognitive processing failure. The subject's decision on whether to read the texts and control the responses given might also be considered as an indication of insight of his or her own level of performance.

Six of the narratives depict quite negative, emotionally charged situations such as a quarrel between spouses, exam nerves and bullying in a school yard. They were worded – for example, by including adjectives and adverbs – such that the context more or less consistently induced a specific interpretation of the situation and the characters' attitudes and motives. Two of these narratives involve either an ironic comment or a lie which has to be understood as such to make the content coherent. In the remaining five narratives,⁸ the context of the first part of the narrative biases the reader in favour of one of the two possible interpretations of an ambiguous word. The final sentence provides information that, in accordance with a relevance theory of comprehension (Sperber and Wilson, 1995), implies another interpretation of the ambiguous word in order to make the last sentence coherent with the rest of the narrative. This means that the context of the narrative is only consistent if the correct interpretation of the ambiguous word is used. However, as the initial context induced a 'false' interpretation of the word, the subjects are forced to revise their initial interpretation.

Described in terms of Kintsch's (1998) construction-integration model, this task requires the following processes: as the last sentence is heard, the new information added makes the hitherto coherent situation model inconsistent. In integrating these new propositions, the subject has to retrieve the encoded memory of the text base and reactivate suppressed nodes in LT-WM. In *reading* the text, the subject can construct a new text base and situation model from the text, without having to retrieve the complete text base from memory. However, in the integration process, the subject must still

⁸ One of the initial six narratives with ambiguous words was excluded as both possible interpretations could be applied interchangeably.

retrieve information from LT-WM as the short-term working memory capacity is limited to dealing with a few active nodes at the time.

Revising an interpretation in this way is thought to be a controlled, capacity-consuming process. Since the subject has to assess which of the possible interpretations of the ambiguous word is the more relevant in the context, the process is considered to involve deductive reasoning, or in Kintsch's terminology, true inference.

Because of the inconsistent contexts the questions requiring *revised inferences* are expected to be more difficult than the questions requiring *inference of a character's attitude or motive*.

The ambiguous words in the narratives were picked out from a number of ambiguous words, categorised based on the frequency of the different meanings in spoken language and written texts. Frequency of use was investigated among 9.9 million words in concordance in the *Gothenburg Spoken Language Corpora* and three text corpora: *Romaner-80*, with text from novels, and *Dagens Nyheter-87*, and *Press-76*, containing newspaper texts (Corpora at Department of Linguistics, Göteborg University, 2002). In two of the narratives with ambiguous words, the first part of the text induced the less frequent denotation of the word and the last sentence forced the subjects to revise that inference and choose a more frequent denotation of the word to keep the content of the narrative coherent. For example, the interpretation of the Swedish word *fil* as meaning 'sour milk' had to be revised in favour of the denotation 'lane'. In two of the narratives, the first part of the narrative favoured an interpretation of the word with the more frequent denotation, for example the denotation 'book' of the Swedish word *bok*. This inference then had to be revised and the word had to be interpreted with its less frequent meaning: the denotation 'beech', (the tree). In the remaining narrative with an inconsistent context, the denotations of the ambiguous word were equally frequent.

As mentioned above, two of the three questions for each of the eleven narratives were worded in such a way that a correct response depended on the subjects' ability to process implicitly stated material in order to comprehend the text. To make it possible to

analyse the responses to those questions beyond their demands for processing of implicitly stated materials, the questions were categorised according to what kind of processing they required for a correct response; see table 2:2:4 for an overview. Ten questions on narratives with consistent contexts required coherence inference, or bridging inference, through inference concerning a character’s attitude towards something or someone or a character’s motives for performing a certain action. The information in the text consisted of stated facts about the situation or characters, but was also influenced by nuances or shades of meaning in the wording. Eight questions about narratives that contained an ambiguous word required a coherence inference through the revision of an initial inference.

Four of the original 33 questions did not fit into this classification. Two of those questions did require *bridging inferences* but without any demand for *inference of a character’s attitude or motive*. The other two questions required both inferences of characters’ motives *and* revision of an initial interpretation.

Hence, the different questions can be regarded as belonging to one of five different categories, four related to implicitly stated information and one to explicitly stated material.

Table 2:2:4: Overview of the different types of questions in the Discourse Comprehension task

Questions category	Questions about explicitly stated information	Questions about implicitly stated information			
		Inference of character’s attitude or motive	Revised inference	Simple bridging inference	Both inference of character’s attitude/motive and revised inference
Number of questions in each category (n=33)	11	10	8	2	2

The consistency and validity of this categorisation was checked by an external, independent observer, with a university degree, who analysed the requirements of the questions and categorised them according an operational definition scheme as belonging to one of the four different categories. The inter-observer calculating point-to-point agreement was 83%, which must be considered acceptable. The disagreement was due to difficulties with the operational definitions of the different categories, and there was no disagreement as to whether a given question required *inference of a character's attitude/motive* or *revised inference*.

To avoid providing the answers within the wording of the test questions, most of the questions were open, but for five of the 33 questions, a simple yes or no response was sufficient. Care was taken to word the questions in such a way that they would not provide information leading to a correct answer, although the question might stimulate the participant to make new inferences. During the test procedure, the use of additional questions to elucidate unclear points in the responses was avoided.

Data were collected on spontaneous responses (that is, responses made after the subjects had merely listened to the narrative) for further analyse. Data were also collected on modified responses (new or modified responses given after reading the narrative), although analysis of this data was restricted to a few comparisons to the results for spontaneous responses.

2.2.2.2 Stimuli in the verbal working memory task

The verbal working memory measure is a translation of an auditory task that Tompkins et al. (1994) had adapted from Daneman and Carpenter's (1980) Reading Span test. The stimuli were 42 simple active declarative sentences based on common knowledge, each ending in different common lexical items. The final words consisted of one- to three-syllable nouns, verbs or adjectives. The subject had to say whether the declarative sentences were true or false, and keep the last word of each sentence in memory for later recall.

The sentences were grouped into sets of increasing length, with three sets at each of four levels of difficulty. ‘Level 2’ sets each included two sentences; ‘Level 3’ sets each included three sentences, and so on to ‘Level 5’ where each set consists of five sentences. The number of words in each sentence was three to five across sets. This is an example from Level 2 (set 1):

‘You sit on a chair.’ (Swedish: *Du sitter på en stol*)

‘Trains can fly.’ (Swedish: *Tåg kan flyga*)

Subjects responded actively to each sentence immediately after hearing it, judging it as true or false. At the same time, they retained the final word of each sentence in each set for spoken recall immediately after the entire set had been presented. Subjects had two words to recall for each set at Level 2, three words per set at level 3, and so on.

In the example from Level 2 (set 1), given above, the subject was supposed to respond: ‘true’ after listening to the first sentence (‘You sit on a chair’), and then keep the word ‘chair’ in mind while listening to the second sentence (‘Trains can fly’), which should be followed by the response ‘false’. After that, the subject had to say the words ‘chair’ and ‘fly’.

To maximise the need for simultaneous processing and information storage, stimulus sentences were constructed so that their truth value was not obvious until the final word. Data were collected on both true/false errors and word recall errors, with word recall errors providing the primary estimate of auditory working memory. The time for task administration was about 5 to 15 minutes as the subjects varied in the time they took to produce their responses.

The adaptation from English to Swedish made it necessary to change some of the lexical items due to differences in sentence length and number of syllables. Some of the sentences were also slightly modified to avoid confusion about whether the right response was supposed to be ‘true’ or ‘false’.

2.2.2.3 Stimuli in neglect tests

To assess the possible influence of visuospatial neglect on the performance on the other tasks, two gross neglect tests were performed:

Albert's crossing out test (Albert, 1973) is commonly used in clinical contexts. The subject is presented with 2.5-cm-long lines evenly distributed over a 29.6 x 21 cm paper sheet, placed in the centre of the subject's visual field. The subject must respond as described in section 2.2.3.4.

Schenkenberg's line bisection test (Schenkenberg, Bradford, and Ajax, 1980) is also common in clinical practice. In this test, 20 lines with varying lengths and positions are distributed horizontally on a 29.6 x 21 cm paper sheet. Again, the subject must respond as described in section 2.2.3.4.

2.2.2.4 Stimuli in the Sustained Attention to Response Test (SART)

The Sustained Attention to Response Test (SART), presented in Robertson et al. (1997a) and Manly, Robertson, Galloway and Hawkins (1999), consists of a computerised task where 225 single digits are presented visually on a screen over 4.3 minutes. Twenty-five instances of each digit between 1 and 9 are presented and subjects respond with a key press to each one, except the digit 3 where the response should be withheld. The target digit (3) is distributed throughout the 225 digits in a pre-fixed quasi-random fashion. To enhance the demands for processing the numerical value, rather than searching for some peripheral feature of the target, the digits are presented in one of five randomly assigned font sizes (48, 72, 94, 100 and 120 points), representing between 12 and 29 mm. Each digit is presented for 250 ms, followed by a *mask* consisting of a crossed-over circle. The mask, which is presented for 900-ms, occurs after each digit presentation. The

period from digit onset to digit onset is 1150 ms. The reaction times for all key presses relative to digit onset are collected, as well as the number of errors out of a maximum of 25, i.e. pressing the response key on presentation of the target digit 3, and number of correct responses out of a maximum of 200, i.e. pressing the response key for any digit other than 3. This means that the number of correct responses is not necessarily proportional to the number of errors as it is possible to obtain a result with zero errors but just 30 correct responses, if the subject hardly ever presses the response key.

2.2.3 Experimental procedures

In this section, the setting and procedures for the data collection are described, along with the order of presentation of tasks.

2.2.3.1 Setting and order of presentation of tasks

To make sure the test situation was as comfortable as possible for the participants, they were free to choose whether they preferred to perform the tests in their homes or in a quiet room at a rehabilitation centre that was familiar to them. Care was taken to avoid noises or other disturbing elements when the tests were taken in the participant's home. To avoid results influenced by fatigue, the participants were also free to choose to take all the tests on one occasion or to distribute them over two sessions. Except for three subjects, all the participants chose to complete the tests in one session and the tasks were performed in the following order: the subjects first completed *Albert's crossing out test* and *Schenkenberg's line bisection test*. After that, they completed the SART, then the VWM test, followed by the Discourse Comprehension test. Those tests were completed within about one hour, depending on variations in how long the subjects needed to produce their responses.

2.2.3.2 Procedure in Discourse Comprehension task

In the Discourse Comprehension task the participants were seated with a portable tape recorder (Sony TCS-580V) with supplementary loudspeakers (Canman SP101) on a table in front of them. Each subject decided on a comfortable volume for the output. The text cards with written texts in large fonts were placed, upside down, in a pile in front of the subjects. The participants were instructed to listen to the narrative and then try to answer three questions about the content in the narrative at their own pace. Both texts and questions were played back from the tape recorder, except in two cases where the subjects were recruited from a planned pilot study. In these two cases, the questions were presented aloud by the test leader.

The subjects were told that some of the answers would be presented explicitly in the texts but that they sometimes would be forced to make inferences from the content of the texts in order to answer to some of the questions. They were also instructed to first try to respond to the questions from memory, but that after that they were free to turn the card over, read the content and then respond or, if they so wished, modify or change their answers. The two subjects from the pilot study had the texts in front of them while listening to the narratives. The occasions when these two subjects returned to the texts to respond to the questions were noted as modified responses. All the subjects were told that their decision to read the text or modify any answers would be noted but that it would not influence their scores. Subjects were given two practice items: one narrative with questions about attitude/emotion in a leading character and one narrative where correct responses demanded revised inferences. Corrective feedback was given on the practice items. During experimental testing, no feedback was given on the participants' performance.

2.2.3.3 Procedure in the verbal working memory task

In the VWM test, the stimulus was played back on a portable tape recorder (Sony TCS-580V) with supplementary loudspeakers (Canman SP101). The volume of the output was adjusted to the level each participant found comfortable. Participants were instructed to listen to the statements on the tape and, after each one, to say whether the statement was true or false. They were also told to keep the last word of each statement in mind until after the last statement in each set, when they would be asked to repeat the words recalled from that set. The subjects were told that they were free to recall the words in any order and at their own pace. Before each set was played back to the subjects, a voice on the tape alerted them and informed them of the number of statements that would be presented in that set as follows: ‘Now the next three statements will be presented’. The test procedure was practised with a three-statement set. Corrective feedback was given on the practice item and the participants were informed that no feedback on their performance would be given during the experimental testing.

2.2.3.4 Procedure in neglect tests

In *Albert’s crossing out test* of neglect, the paper is placed centred in front of the subject, who is instructed to cross out all the lines on the sheet with a pen. In *Schenkenberg’s line bisection test*, the sheet is placed in the centre of the subject’s visual field and the subject is instructed to mark the centre of every line with a pen.

2.2.3.5 Procedure in the SART

In the SART, all digits and masks were presented centrally in white against a black background on a computer screen, using a laptop PC (Dell Latitude), running Super Lab Pro™ software (Cedrus). The screen was 248 x 185 mm and positioned in front of

participants at a distance comfortable to them. Participants were instructed to press a selected response button on a Cedrus™ RB-410 response box resolution 1 ms or better), with their preferred hand. They were required to respond with the key press as fast as they could when a number between 1 and 9 was presented on the screen, with the exception of the number 3, which they were not to respond to. They were told that it was just as important to avoid pressing the response button when the number 3 was presented as it was to respond as fast as they could to the other numbers. Each session was preceded by a practice trial of 34 presentations of digits, six of which were 3s. The instructions were also presented in writing on the screen: ‘Press as soon as you see a digit. Do not press for the number 3’, both before the practice trial and before the experimental trial. Before participants started the experimental test by pressing a key, they were asked to make sure that they were comfortable with the screen position and their own seating. Except for general encouragement and general feedback to comments about the difficulty of the task, no feedback was given on the participants’ performance.

2.2.4 Analysis

In this section, the analysis performed on the results is described. First, the analysis of the general processing of the data obtained from the various tasks is described and then the statistical analysis.

2.2.4.1. Analysis of results

In the Discourse Comprehension task, the number of correct responses was obtained for both spontaneous and modified responses. Data on the number of texts that each individual read as well as the number of responses that were modified were also collected. Both omitted spontaneous responses and incorrect spontaneous responses were then classified as inadequate responses. This analysis was done because the participants knew that they had the possibility of suspending their responses until after

they had read the narratives. An omitted response might be the result of memory or comprehension failure or of the subject wanting to make sure that what he/she planned to say was actually correct. The inadequate spontaneous responses were classified as inadequate due to either *no inference expressed* or an *erroneous inference expressed*.

The procedure with open questions and the avoidance of additional questions meant that the different subjects' final responses to the questions varied in their degree of elaboration and specification. In order to judge the responses fairly, an assessment scheme was established, stating what information the answers to a specific question had to include if they were to be judged as correct. Examples from the assessment scheme are provided in Appendix 2. To investigate the consistency of the assessment scheme and the scoring of the subjects' responses, an independent, experienced speech-language pathologist did an external analysis of 10% of the subjects' responses. A calculation of the inter-observer reliability, using Cohen's kappa, resulted in very acceptable agreement ($k = .832$).

Although the narratives were designed to depict more or less everyday situations and correct responses to questions about the narratives relied on general world knowledge, some of the questions, especially about narratives 1, 2, 8, 9 and 10, were thought to be sensitive to personal experience. To control for the possibility that erroneous responses might be due to a lack of personal experience with the contexts depicted, an interview was done several days before the test session. The subjects were asked questions about their experience of such things as family life, children, pets, driving a car and living in a house without central heating. The answers to those questions were then compared with the subjects' responses on the questions about the different narratives. No effect of lack of specific personal experience was seen.

In examining the results of the Discourse Comprehension tasks that required a revised inference, the possible impact on results of the frequencies of the different denotations of the ambiguous words was analysed. Only responses to questions that depended on implicitly stated information were included in this analysis.

In the analysis of the results of *Albert's crossing out test*, the even distribution makes it possible to assess the number of neglected lines on both sides of the midline of the paper.

In Schenkenberg's line bisection test, each mark's deviation from the centre of the line is measured and the percent deviation score is calculated for each individual by means of the formula:

$$\text{Percent Deviation} = \frac{\text{Measured left half} - \text{true half}}{\text{True half}} * 100$$

Marks placed to the left of the true half will result in a negative score and marks placed to the right of the true half will result in positive scores.

Only lines located to the left or centred on the midline of the sheet were calculated, for a percent deviation score for each subject. The neglect tests were not administered to one LHD individual and one individual in the Control group for practical reasons. Therefore, the results for one randomly selected RHD individual were also excluded from the analysis.

From the VWM task, two measures were obtained for further analysis: number of word recall errors and number of true/false errors. Most of the individuals also reported qualitative data on the strategies they used to perform the task.

Several different measures were obtained from the SART and calculated for further analyses:

- *Mean reaction time in test,*
- *Difference between mean reaction time in the first and second halves of the test,*
- *Variations in reaction time during the test,*
- *Number of correct responses in the first and second halves of the test (responding to any digit other than 3),*

- *Number of erroneous responses* (responding to target digit 3),
- *Feedback time*.

Feedback time is calculated by subtracting the mean reaction time for four correct responses after an erroneous response from the mean reaction time for four correct responses before an erroneous response. It reflects the subjects' attempts to adjust their behaviours in terms of pace, meaning that they either slow down or speed up their responses to stimuli following an erroneous response. It was not possible to calculate *Feedback time* for all 14 individuals in each group because some either had too many omitted responses or made no erroneous responses.

The results for *Variations in reaction time during the test*, *Mean reaction time in test* and *Difference between mean reaction time in the first and second halves of the test* were not accounted for in the published studies of Manly et al. (1999) or Chan (2001). The analysis of the variance of *Mean reaction time in test* and the separate analysis of the first and second halves of the tests were done because variations in reaction times during the test might reflect a deficit in the ability to sustain attention. The measure of *Variation of reaction time in test* is constituted by the variance in the different reaction times obtained from 30 measuring points in the test for each individual. In the studies mentioned above, only the *reaction time before correctly withheld responses*, which is the mean reaction time for the four continuous correct responses before a correctly withheld response, and *reaction time before and after erroneous responses* were accounted for. That procedure was considered somewhat limited as it is sensitive to variations in the performance of different individuals. For a subject who makes few *Correct responses* and perhaps also few *Erroneous responses* as well, there are far fewer available measuring points than for an individual with many *Correct responses* but also many *Erroneous responses*. A mean reaction time calculated on only one or two measuring points might not be considered reliable. The measure of *Mean reaction time in test* was therefore calculated for each individual from three continuous reaction times

collected from 30 measuring points in the test. The measuring points were decided on based on the results of the subject who omitted the most responses. This was done to make it possible to collect the same number of measures from about the same places in the test for all subjects. This procedure resulted in the calculation of mean reaction times from at least 45% of the available data for each individual, which is more than was accounted for in the studies mentioned above.

2.2.4.2 Statistical analysis

In study 1, the Kruskal-Wallis test was used to detect any between-group differences in spontaneous responses in the Discourse Comprehension task. The results of the statistical analyses will be presented on data collected from questions dependent on *explicit information*, from questions requiring *inference of a character's attitude/motive* and from *revised inference*. As there were only two questions each that required either just *Bridging inference* or *Both inference of motive and revised inference*, those results will not be presented here.

On data where the Kruskal-Wallis test indicated significant between-group differences, the Mann-Whitney U test was used as post hoc test with an adjusted alpha level, based on Bonferroni's inequality (alpha .05 divided by 3 comparisons = alpha .016). On modified responses in Discourse Comprehension where the observations were normally distributed and had equal variance, an analysis of variance (ANOVA), and Tukey's HSD post hoc test were performed.

In study 2 analysis of between group differences in results on VWM-task and the SART were performed with the same procedure as for spontaneous responses in the Discourse Comprehension tasks. The Wilcoxon signed ranks test was used to analyse within-group differences in performance on different parts of the SART.

Since the main purpose of study 2 was to investigate the association of VWM and the ability to sustain attention with the performance on Discourse Comprehension, an

analysis of correlation was performed with Spearman's rho within the groups. Due to the limited sample size, only correlations exceeding $/.66/$ were considered to reflect an association. Correlation coefficients of this magnitude exceed the .01 significance level. Correlation coefficients exceeding $/.50/$ but not $/.66/$, and corresponding to a .05 significance level, are also reported but will be discussed as reflecting tendencies toward association rather than associations.

To examine the relationships between more than two variables at the same time, logistic regression analysis and multiple linear regression analysis were done. However, multiple regression analysis turned out to be more suitable for these data. The regression analyses were performed on results from either the RHD group together with the Control group or the LHD group together with the Control group. Scores on the Discourse Comprehension task formed the dependent variable and scores on the different measures from the SART, that is: *Mean reaction time in test*, *Difference between mean reaction time in the first and second halves of the test*, *Variations in reaction time during the test*, *Number of correct responses*, *Number of erroneous responses*, *Feedback time*, VWM scores and group (RHD, LHD or Control) were entered as possible predictor variables.

2.3 Results and discussion: Studies 1 and 2

In this section, the results of the different tasks will be presented, summarised and briefly discussed. First, the analyses of the results of the Discourse Comprehension tasks will be presented, as those results correspond to the research questions of study 1: *Is it possible to establish a difference in the ability to infer from implicit information in verbal discourse between a group of RHD individuals, a group of LHD individuals and a group of non-brain-damaged individuals and are there differences depending on type of inference required?*

This will be followed by the presentation of the results of the neglect tests and of the analyses of correlation and regression between the results for Discourse Comprehension and results for the VWM task and the SART. Those analyses correspond to the research question of study 2: *Is it possible to establish any associations between either sustained attention or VWM and the ability to comprehend implicit information in verbal discourse in two groups of individuals with either RHD or LHD and are there any differences in associations between the groups?*

2.3.1 Group differences in Discourse Comprehension

In the Discourse Comprehension task, the subjects first had to try to answer the questions based only on the text they had just heard. After giving their spontaneous responses, they were free to read the text and add to or modify their responses. In this study, the results for modified responses and responses to questions depending on explicitly stated material are considered to control for the possible impact of deficits on more basic linguistic abilities and on VWM, as well as to indicate possible insight problems. The results on tasks requiring inferences about implicitly stated matters are considered to depend on higher-level cognitive processing. The results for questions that

depend on explicit information will be presented separately from the results for questions requiring inference.

2.3.1.1 Tasks that depend on explicit information

All groups performed well on the questions that depended on *explicit information*; and although the LHD group had somewhat more trouble with spontaneous responses than the other groups, no significant difference was found between any of the groups ($p = .17$); see table 2:3:1 for the number of correct responses.

Table 2:3:1: Group results for mean number of correct responses and standard deviation on spontaneous and modified responses on questions dependent on explicitly stated matters in Discourse Comprehension tasks.

		Control (n=14)	RHD (n=14)	LHD (n=14)
Explicit information (max. =11)				
- Spontaneous responses	Mean:	10.21	9.79	8.57
	S. D:	.97	1.4	2.95
-Modified responses	Mean:	10.86	10.50	10.64
	S. D:	.36	.76	.63

The results for modified responses are presented in comparison to the subjects' results for spontaneous responses, as all three groups increased their scores on modified responses to some degree.

All groups benefited from the opportunity to modify their responses after reading the narratives. As can be seen in table 2:3:2, the LHD individuals as a group took the opportunity to read the narrative and modify their responses more often than both the other groups. The difference was not statistically significant for number of texts read ($p = .218$). However, there was a difference in the number of modified explicit responses between the LHD group and the RHD group that was close to significant on ($p = .019$). Some individuals in the LHD group seemed to avoid responding to the questions, no

matter whether they were about explicitly stated matters or implicit information, if they had only listened to the narrative and not yet read it.

Modification of a response means that the subject has changed it in some way, perhaps by adding or changing information. It does not necessarily mean that an inadequate response becomes adequate. In the LHD group, 11 individuals modified 36 responses to questions that depended on *explicit information*. However, two of the individuals in the LHD group produced 18 of these modifications. Furthermore, two individuals in the LHD group failed to change 3 of these responses into correct ones.

Table 2:3:2: Group means and standard deviations for texts read and responses changed into correct or still inadequate responses related to explicit information

Subjects	n	Number of texts read		Number of responses modified that related to explicit information		Number of responses changed into correct responses		Number of still inadequate responses after modification	
		Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Control	14	5.57	4.53	.86	.86	.86	.86	0	-
RHD	14	4.79	3.53	.71	.91	.71	.91	0	-
LHD	14	7.29	2.92	2.57	2.90	2.36	2.62	.21	.58

The Control group and the RHD group read and modified their responses to about the same extent: 9 individuals in the Control group modified 12 responses and 7 individuals in the RHD group modified 11 responses that related to *explicit information*. Members of both groups also managed to transform their inadequate responses into correct responses.

2.3.1.2 Spontaneous responses to tasks that depend on implicit information

The questions about the content of the narratives were subdivided according to the task's requirement for different kinds of inferences: coherence inference through *inference of a*

character's attitude or motive or coherence inference through *revised inference*. Table 2:3:3 display the results for tasks depending on implicit information and both spontaneous and modified responses by the three groups.

Table 2:3:3: Group results for mean number of correct responses and standard deviation on spontaneous and modified responses on questions dependent on implicitly stated matters in Discourse Comprehension tasks.

		Control (n=14)	RHD (n=14)	LHD (n=14)
Inference of attitude/motive (max. = 10)				
- Spontaneous responses	Mean:	9.00	7.29 ^{c†}	8.07
	S. D:	1.3	1.20	2.13
-Modified responses	Mean:	9.57	7.93 ^{c* I*}	8.93
	S. D:	.65	1.27	1.21
Revised inference (max. = 8)				
- Spontaneous responses	Mean:	6.86	4.79 ^{c†}	4.57 ^{c†}
	S. D:	1.03	1.81	1.60
-Modified responses	Mean:	7.0	5.43 ^{c*}	5.64 ^{c*}
	S. D:	1.11	1.79	1.15

Note: ^{c†} = Result differs significantly from Control group result at .01 level. ^{c*} = Result differs significantly from Control group result at .05 level, ^{I*} = Result differs significantly from LHD group result at .05 level.

On modified responses, both the LHD group and the Control group performed significantly better than the RHD group on tasks requiring an *inference of a character's attitude/motive*.

The tasks requiring *revised inference* were the most difficult ones for all three groups. The Control group managed to perform both kinds of tasks fairly well and their performance on *revised inference* was significantly better than both the RHD group's ($z = -3.238, p = .001$), and the LHD group's ($z = -3.463, p = .001$). The LHD group made slightly more inadequate spontaneous responses than the RHD group on this kind of task, but the difference was not statistically significant ($p = .624$). The LHD group's mean score on questions that depend on a *revised inference* 4.57, compared to 4.79 in the RHD group.

The RHD group made fewer spontaneous correct responses than either the Control group or the LHD group when the task required *inference of a character's attitude/motive*, and this difference is statistically significant between the RHD group and the Control group ($z = -3.105, p = .002$), although not between the LHD and RHD groups ($p = .038$).

Since several individuals in the LHD group performed so much better in their modified responses concerning *explicit information* after reading the texts, the spontaneous responses were further analysed: the inadequate spontaneous responses were classified as inadequate due to either *no inference expressed* or an *inadequate inference expressed*; see table 2:3:4. On questions that depended on *inference of a character's attitude/motive*, 60 responses in total were judged as to be inadequate. Thirty of those responses were inadequate due to *no inference expressed* and 30 due to an *incorrect inference expressed*.

Table 2:3:4: Group results as a percentage of responses where either no inference was made or an incorrect inference were made.

Inference of attitude/motive n=60 inadequate responses	Control group (11 inadequate)	LHD group (20 inadequate)	RHD group (29 inadequate)
No inference expressed, n=30	3%	53%	43%
Incorrect inference expressed, n=30	33%	13%	53%
Revised inference n=105 inadequate responses	Control group (16 inadequate)	LHD group (45 inadequate)	RHD group (44 inadequate)
No inference expressed, n= 31	9%	68%	23%
Incorrect inference expressed, n=74	18%	32%	50%

Note: Number of inadequate responses within each group in parentheses.

The RHD group made a total of 29 inadequate responses to questions depending on *inference of a character's attitude/motive*, the LHD group made 20 and the Control group made the remaining 11. The analysis showed that the RHD group produced more *incorrect inferences* than both the other groups: 53% of the 30 *incorrect inferences expressed*.

When it comes to questions that depend on *revised inference*, the pattern is the same. Although the LHD group made slightly more inadequate responses, the RHD group produced more of the responses that were inadequate due to an *incorrect inference expressed*. In the LHD group, responses were more often classified as inadequate due to *no inference expressed*. That is, the individuals in the LHD group were more likely to suspend their inference until after they had read the narratives than either of the other groups.

On questions that depend on explicit information the LHD group benefited a lot from the chance to modify their responses. However, the pattern is different when it comes to questions that depend on implicit information. As in questions depending on explicit information, the LHD individuals tend to modify their responses to a higher degree than both the Control group and the RHD group (see table 2:3:5), although the differences were not statistically significant ($p = .529$). In all three groups, a few individuals were responsible for most of the modifications. In the LHD, group 12 persons modified 52 responses to questions requiring inference. Two persons produced 28 of these modified responses.

Table 2:3:5. Group mean and standard deviations for texts read and responses changed into correct responses or still inadequate responses related to implicit information

Subjects	n	Number of texts read		Number of responses modified that related to implicit information		Number of responses changed into correct responses		Number of responses still inadequate after modification	
		Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Control	14	5.57	4.53	1.21	1.81	.93	1.64	.29	.61
RHD	14	4.79	3.53	1.93	1.54	1.64	1.28	.21	.58
LHD	14	7.29	2.92	3.71	4.62	2.48	2.95	1.29	1.90

Eleven individuals in the RHD group modified 27 responses on questions requiring inference. Three RHD individuals produced 17 of these 27 modified responses. In the Control group, three persons made 13 of the 17 modifications.

The individuals in the RHD group were more successful than the individuals in the LHD group when they actually tried to modify their responses. In the RHD group, only two persons failed to modify 3 inadequate responses to make them correct. That is, 85% of the modified responses were correct. In the LHD group, eight persons failed to change 17 responses into correct ones. This means that only 67% of the modified responses correct after modification, compared to 91% of modified responses on questions dependent on explicit information. Importantly though, only two persons produced 11 of these still inadequate responses. In the Control group, three persons failed to modify 4 responses into correct responses to questions requiring inference.

2.3.1.3 Impact of frequency of meaning in revised inference

In tasks requiring *revised inference*, two different directions of revision were anticipated: in two narratives, a less frequent meaning had to be revised to a more frequent meaning, and in two narratives, a more frequent meaning had to be exchanged for a less frequent meaning. As can be seen in table 2:3:6, the groups produced somewhat fewer errors (45 compared to 61 errors) when the revision involved replacing a less frequent meaning with a more frequent one than when they had to replace a more frequent interpretation with a less frequent one, which could be expected to be more difficult.

Table 2:3:6: Number of errors produced in spontaneous responses by each group for narratives containing an ambiguous word revised in one of two different directions

Direction of revision required	Number of inadequate responses			
	Control (n=14)	RHD (n=14)	LHD (n=14)	Total
Less frequent meaning revised to more frequent one (4 questions)	6	19	20	45
More frequent meaning revised to less frequent one (4 questions)	8	26	27	61

However, the difference in the number of errors in the two directions was not statistically significant ($p = .158$) and the material is limited to eight questions in all. The patterns within and between the groups are the same regardless of the frequency of the meanings.

2.3.1.4 Summary and discussion of results for Discourse Comprehension

Overall, the results obtained are in accordance with the preliminary hypotheses. The two groups of brain-damaged individuals and the Control group perform differently on Discourse Comprehension tasks. The successful performance by all three groups of tasks that depend on *explicit information* indicates that any problems in tasks that depend on implicit information are not due to deficits in more automatic linguistic processing, for example, access to the dominant meaning of words. Nevertheless, although the difference is not statistically significant, the individuals in the LHD group have more problems than either of the other groups with questions that depend on explicitly stated facts. All the LHD individuals performed well on a neurolinguistic aphasia test, but in the view adopted here of the interaction between different cognitive systems in complex cognitive processing, it is not fruitful to try distinguish between problems due to restrictions on semantic access and other cognitive problems such as VWM deficits in analysing the results of a comprehension task. Compensatory strategies also affect the

outcome of tests. The LHD individuals' responses on questions depending on explicit information were facilitated when they had an opportunity to read the texts. In their modified responses, the LHD group performed at approximately the same level as the RHD group on tasks that depended on *explicit information* and *revised inference* and slightly better than the RHD group on tasks dependent on *inference of a character's attitude/motive*.

The RHD group used the opportunity to read the narratives and modify the responses about as often as the individuals in the Control group. The difference is that the Control group performed well and did not need to modify their responses to the same extent as the individuals in the RHD group; their responses were mostly adequate already. The significantly poorer results on the tasks among the individuals in the RHD group, together with the number of texts read and modified, indicate that they were not fully aware that their responses were sometimes inadequate.

The Control group performed significantly better than both the LHD and RHD groups on tasks requiring *revised inference*. The Control group also performed significantly better than the RHD group on tasks depending on *inference of a character's attitude/motive*. This indicates that, as was hypothesised, there are qualitative differences in the comprehension of discourse between the groups of brain-damaged individuals depending on the type of inference required. That is, the RHD individuals have more trouble than the LHD individuals comprehending discourse that involves *inferences of a character's attitude/motive*, although the difference between the RHD group and the LHD group was statistically significant only in their modified responses. This result differs from results obtained by Tompkins et al. (1994), where RHD individuals performed as well as LHD individuals and healthy controls on tasks requiring inference of characters' attitudes.

The individuals in the LHD group tended to wait to make their inferences until after they had read the narratives to a higher degree than the other groups. However, the subjects were told in advance that they would be given a chance to read the narratives

and modify their responses. The analysis of the number of modified responses that were correct after modification showed that at least two of the LHD subjects had problems with *revised inference* in particular, even when given the chance to read the texts and modify their responses. The RHD individuals as a group tended to be able to correct their responses to a greater degree than the LHD individuals as a group, at least when they took advantage of the opportunity to modify their responses. It is not possible to say whether more of the spontaneous responses produced by the LHD individuals as a group would have been adequate if they had not been given the possibility to modify them. Neither is it possible to conclude whether some of the RHD individuals would have been able to improve their results on tasks requiring inference if they had made more use of the opportunity to read the texts and try to modify their responses.

The statistically significant differences between the Control group and the LHD group on tasks requiring *revised inference* reflect the fact that the LHD group performed at the same level as the RHD group on those tasks. This is not surprising since these tasks may depend on access to, and flexible processing of, lexical-semantic information. Although this represented a complex task for all three groups, the brain-damaged individuals, irrespective of whether the damage was in the right or left hemisphere, might be vulnerable because they lack access to semantic information due to ineffective retrieval cues and because of constraints in the form of limited resources and inflexibility of basic cognitive functions or of compound cognitive processing.

When the test material was constructed, the possibility was considered that it would be more difficult to change a more frequent meaning to a less frequent meaning than vice versa. Even though there was a difference in the number of inadequate responses, the results of this study cannot fully confirm that possibility. The difference was not statistically significant and the material is very limited. However, it is likely that other variables in the texts and questions also influence the difficulty of the tasks. Furthermore, the frequency measures collected from the speech and text corpora might not reflect a true difference in frequency of use of a specific denotation in real life. It is

also very likely that for commonly used words and denotations, frequency of use is less important when the word is used in a certain context. Although the inconsistent narratives with ambiguous words were worded in a way that made it possible to infer both of the possible denotations from the first part of the text, the last sentence's impact on the processing of coherence inferences probably overrules the frequency of use of a specific denotation.

2.3.2 Test of visual neglect syndrome

The neglect tests were performed to control for a possible asymmetric disorder in visuospatial attention that might indicate a general attentional dysfunction and also affect performances on the other tasks.

2.3.2.1 Results on neglect tests

Participants in all three groups all participants handled *Albert's crossing out test* well. One participant in the RHD group initially omitted two lines at the left of the sheet, but noticed and corrected them after the other lines had been crossed out.

None of the participants omitted any lines in *Schenkenberg's line bisection test*. As shown in table 2:3:7, all three groups obtained more negative than positive scores, which reflects a tendency for all groups to mark the lines to the left of the true half.

TABLE 2:3:7: Group results for calculated percent deviation score, in mean and standard deviation, for Schenkenberg's line bisection test.

	Control (n=13)	RHD (n=13)	LHD (n=13)
Percent deviation score			
Mean:	-0.56	-1.74	-1.10
S. D:	3.04	5.18	3.39

The participants in the RHD group, some of them whom manifested persistent visuospatial neglect, tended to produce left-of-centre marks to an even higher degree than the participants in the other groups, although the difference was non-significant ($p = .739$).

2.3.2.2 Summary and discussion of results on neglect tests

Although only 50% of the participants in the RHD group had or had had symptoms of visual neglect, it was expected that they would produce a higher degree of right-of-centre marks than the other groups. However, the trend in the RHD group to produce left-of-centre marks instead might be explained by a normalisation in most of the RHD individuals and a tendency to overcompensate by some of them: the only subject with noticeable problems on *Albert's crossing out test*, was the subject who had the highest negative percent deviation score of all the participants. The participants who either had had fairly transient symptoms of visuospatial neglect or were still experiencing symptoms of neglect seemed to be well aware of the deficit. Most of them were several years post-stroke and they might have learned to adjust their behaviour. Nevertheless, the results on this task indicate that, as a group, the RHD individuals are not affected by an obvious neglect syndrome that could be the result of an attentional deficit.

2.3.3 Associations of VWM and sustained attention with results on Discourse Comprehension tasks

To analyse the possibility that variations in VWM or sustained attention might be associated with the significantly different results in Discourse Comprehension tasks, correlation analysis and multiple linear regression analysis were performed, the results of which will be presented here. First, between-group differences on VWM tasks and the SART will be presented.

2.3.3.1 Group comparisons on VWM tasks and SART

Two measures were obtained from the VWM task: number of word recall errors and number of true/false errors. The participants in the Control group did not make any true/false errors. The individuals in the LHD group made one error, and three RHD individuals made four errors. Altogether, true/false errors were so rare that any further statistical analyses seemed irrelevant.

The Control group performed better and recalled more correct words than the RHD group and the LHD group (table 2:3:8).

Table 2:3:8: Group results on VWM task

	Mean VWM errors	S.D.	Median	Range
Control (n=14)	8.2	4.5	7.5	0-17
RHD (n=14)	13.1	6.63	13	5-24
LHD (n=14)	14.1 ^c	5.1	12	9-23

Note: ^c = Result differs significantly from Control group result at .01 level.

Post hoc tests revealed that only the difference between the LHD group and the Control group was statistically significant ($z = -2.650$, $p = .008$). The LHD group made somewhat more errors than the RHD group although this difference was very small and not statistically significant ($p = .571$).

Although some of the subjects who performed well on the task reported that they managed to recall the words by quiet phonological rehearsal, most of the individuals with the best results used a conscious strategy to try to construct a representation, such as a verbal sentence or a visual context, that could hold the different items together. The subjects who had the most trouble either reported that they had tried to repeat the words but had not been successful, or that they had not used any conscious strategy.

Statistical analysis of the different measurements from SART revealed a significant difference in reaction times between groups, and the post hoc test indicated that only the differences between the RHD group and the Control group on *Mean reaction time in test*

was significant ($z = -3.078$, $p = .002$); see table 2:3:9. (The p -values obtained for the other SART measurements varied between .153 and .917.)

The Control group actually made slightly more *Erroneous responses* and also omitted slightly more responses than the other groups, although the difference was not statistically significant ($p = .158$).

Table 2:3:9: Group results, in means and standard deviations, for SART measures

		Control (n = 14)	RHD (n = 14)	LHD (n = 14)
Mean reaction time in test	Mean:	349.8	470.2 ^c	427.0
	S. D.:	64.6	98.8	103.0
Difference in reaction time between the first and second halves of the test				
	Mean:	-17.30	-24.35	-18.28
	S. D.:	34.33	61.83	55.10
Variation in reaction time in the test (variance)				
	Mean:	7738	10764	16078
	S. D.:	6728	6655	13631
Number of correct responses (max. = 200)				
	Mean:	182.7	183.9	187.4
	S. D.:	16.87	17.20	11.46
Number of errors (max. = 25)				
	Mean:	11.36	9.00	10.00
	S. D.:	4.09	4.98	5.44
		Control (n = 12)	RHD (n = 12)	LHD (n = 12)
Feedback time	Mean:	-8.51	-49.84	-55.4
	S. D.:	53.41	91.03	68.75

Note: ^c = Result differs significantly from Control group result at .01 level

The Control group also had a shorter *Feedback time* than the groups of brain-damaged individuals. That is, they tended to not slow down to the same extent as the other groups after making errors on the SART, although the difference in *Feedback time* was not statistically significant ($p = .427$).

As could be expected of a test of sustained attention, all three groups produced somewhat slower reaction times on the second half of the test. The RHD group had the

largest *Difference in reaction time between the first and second halves* of the test although this difference was not statistically significant within any group (p -values obtained were between .124 and .300), or between the groups ($p = .917$). The slower reaction times on the second half of the SART were not reflected in an increase in number of omitted responses or erroneous responses.

2.3.3.2 Results of correlation analysis and multiple regression

As the results on *revised inference* were statistically different for the control group and both groups of brain-damaged individuals and the results on *inference of a character's attitude/motive* were statistically different for the Control and RHD groups, the associations between these results and the results on the VWM task and the SART were analysed; see table 2:3:10.

TABLE 2:3:10: Correlation coefficients for the three groups between VWM error score and *Mean reaction time, Correct and Erroneous responses* in the SART and spontaneous responses on the different Discourse Comprehension tasks. (Statistically non-significant correlation coefficients are presented within parentheses.)

VWM error score	Control (n =14)	RHD (n = 14)	LHD (n = 14)
- Inference of attitude/motive	(-.50)	(-.23)	(-.53)
- Revised inferences	(.02)	(-.01)	-.65*
Correct responses in SART			
- Inference of attitude/motive	(-.11)	(.12)	(.26)
- Revised inferences	(-.25)	.74**	(.32)
Erroneous responses in SART			
- Inference of attitude/motive	(-.15)	(.38)	-.69**
- Revised inferences	(-.18)	-.60*	(-.26)
Mean reaction time in SART			
- Inference of attitude/motive	-.59*	(-.40)	(.13)
- Revised inferences	(-.09)	(-.06)	(.12)

Note: Negative correlations reflect the inverse association between error scores on VWM measure or erroneous responses in the SART and correct responses on Discourse Comprehension tasks.

** = Values that exceed -.66 are significantly different from 0 ($p < .01$).

* = Values that exceed -.54 but not -.66 are judged to reflect tendencies.

In the RHD group, both the results on *revised inference tasks* and *inference of a character's attitude/motive* were significantly different from the Control group's results, and therefore an analysis of correlation was performed on both kinds of tasks: there is a strong association between results on *revised inference* and *Number of correct responses* in the SART ($r_{Spearman}=.74$). Figure 2:3:2 shows that the individuals in the RHD group with a high number of *Correct responses* in the SART also have a high number of correct spontaneous responses on tasks requiring *revised inference*.

Figure 2:3:2: Associations between results on revised inference and Correct responses in the SART at an individual level in all three groups.

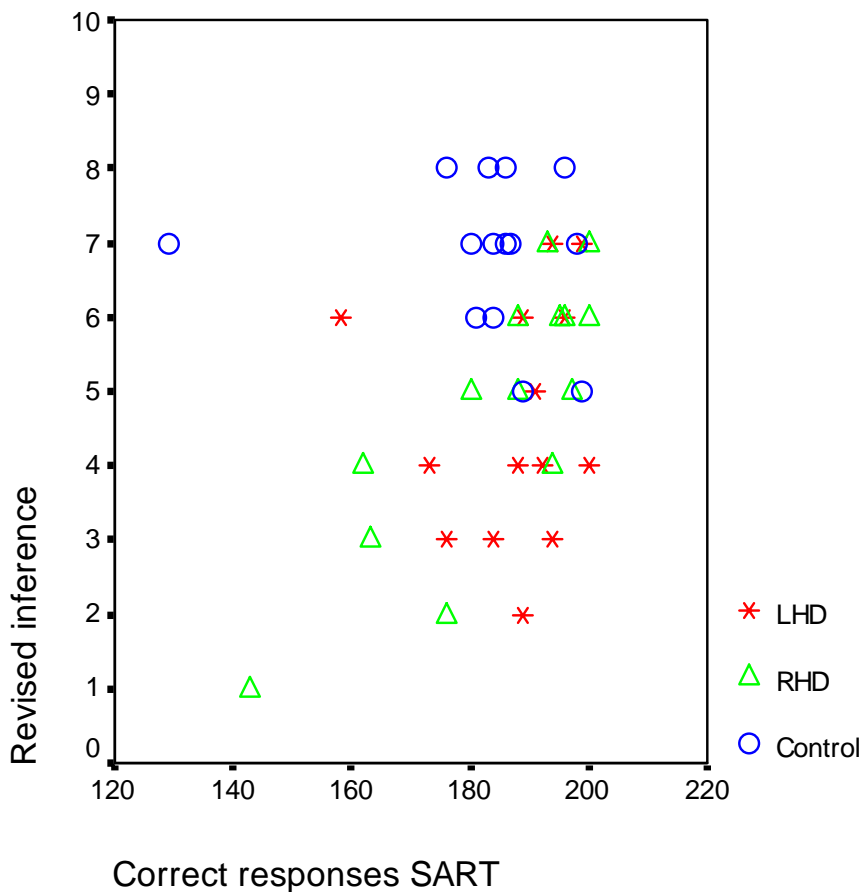
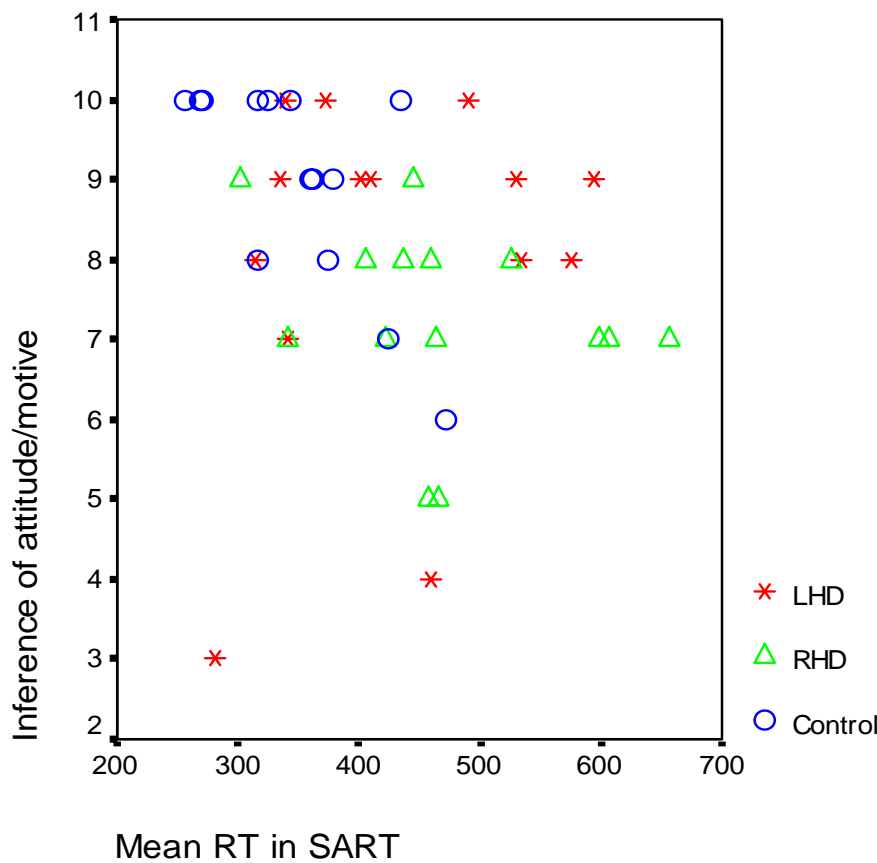


Figure 2:3:2 also shows that the individuals in the Control group generally perform better than both groups of brain-damaged individuals on *revised inference*.

In the RHD group, there is also a strong tendency toward an association between *revised inference* and *Erroneous responses* in the SART but no correlations between results on either the VWM task or measures from the SART and results on *inference of a character's attitude/motive*.

The only tendency to association seen in the Control group is between *Mean reaction time* in the SART and *inference of a character's attitude/motive*. This is displayed in figure 2:3:3.

Figure 2:3:3: Associations between results on *inference of a character's attitude/motive* and *Mean reaction time* in the SART at an individual level in all three groups.



As figure 2:3:3 shows, the results for the individuals in the LHD group are not associated at all with *Mean reaction time* in SART, while there does seem to be some tendency toward association for at least some of the individuals in the RHD group.

To investigate whether there was any interaction between the different variables that could be associated with, or predict the results on the different Discourse Comprehension tasks, multiple regression analyses were performed. Except for an interaction within the results for the Control group together with the results for the RHD group (see below), those analyses revealed the same associations as were displayed in the within group correlation analyses. That is, when results for the Controls and the RHD group were analysed, results on tasks requiring *revised inference* can be predicted by *Number of correct responses* in the SART when RHD is present ($RI = -7.456 - 1.831_{RHD} + 0.076_{\text{correct SART, adjusted}}$, $R_2 = 0.58$, $p = .000$), and by results on the VWM task when LHD is present ($RI = 7.796 - 0.131_{VWM} - 1.432_{LHD}$, $adjusted R_2 = 0.50$, $p = .000$).

In the RHD group, no significant correlations were found between results on tasks requiring *inference of a character's attitude/motive* and the measures of basic cognitive functions. However, the results of the multiple regression analysis indicated that *Mean reaction time* in the SART and *Feedback time* predicted results on those tasks ($A/M = 11.833 - 0.009_{\text{mean RT}} + 0.007_{\text{Feedback time}}$, $adjusted R_2 = 0.53$, $p = .000$). That is, if *Feedback times* for two subjects in the Control group or the RHD group are the same but *Mean reaction time in test* is one millisecond slower for one of them, that individual's results on *inference of a character's attitude/motive* will decrease by 0.01 points. The correlation analysis indicated that the only association between spontaneous responses on tasks that require *inference of a character's attitude/motive* and *Mean reaction time* in the SART is a tendency within the Control group ($r_{\text{Spearman}} = -.59$, $p = .025$). No tendencies to associations were found between *Feedback time* and Discourse Comprehension tasks in correlation analysis for any group. However, there was a tendency to correlation between *Feedback time* and *Mean reaction time* in the SART, ($r_{\text{Spearman}} = -.62$, $p = .033$) in the Control group.

2.3.3.3 Summary and discussion of results of analysis of associations

In general, the results are in accordance with the hypotheses. As hypothesised, there are associations between the measures of VWM and sustained attention and results on Discourse Comprehension tasks. There are also qualitative differences between the groups of brain-damaged individuals: in the LHD group, results on the VWM task can predict results on tasks requiring *revised inference*. Among the RHD individuals, sustained attention is strongly associated with results on tasks that require *revised inference*. On tasks requiring *inference of a character's attitude/motive*, there was no association with sustained attention in the RHD group; however, vigilance and the ability to achieve an alert state might play an important role.

The associations between results on inference tasks and results on *Correct* and *Erroneous responses* in the SART indicate that sustained attention does play for the RHD group some role in tasks that require *revised inference*. Robertson et al. (1997a) and Manly et al. (1999) only consider the number of *Erroneous responses* in the SART as a measure of sustained attention. However, Chan (2001) found that number of *Correct responses* also discriminated between groups of brain-damaged individuals and healthy controls and correlated with other established measures of sustained attention.

The fact that the Control group performs significantly better than the LHD group on the VWM task supports the hypothesis that deficits in VWM play an essential role in the LHD subject's problems in making spontaneous adequate inferences. A significantly different result on SART tasks between the Control group and the RHD group is only obtained from *Mean reaction time* in the SART. Although several individuals in the LHD group had some degree of persistent sensorimotor dysfunction in their right hand, the RHD group had the slowest *Mean reaction times* in the SART. *Mean reaction time* in the SART might be considered as a measure of vigilance, described as the ability to achieve and maintain an alert state in Fernandez-Duque and Posner's model (2000) of the human attention system. Robertson et al. (1997a) consider a faster reaction time

before *Erroneous responses* in the SART to constitute an indicator of declining attention. However, the measure *Mean reaction time* in the SART used here is a measure of mean reaction times obtained throughout the entire test and this measure corresponds more to a type of vigilance task or test of phasic arousal, as described by Rueckert and Grafman (1996), where slow reaction times are considered to be a measure of decreased vigilance or arousal. Although the degree of alertness or arousal referred to here is far beyond what is measured by gross scales for assessment of overall responsiveness, like the Glasgow Coma Scale (Jennett and Teasdale, 1977) or the Reaction Level Scale 85 (Starmark, Stålhammar and Holmgren, 1988), reduced alertness restricts the ability to quickly process any stimuli and this might be one possible explanation of the RHD individuals' performance on the inference tasks. The RHD group also had the largest *Difference in reaction time between the first and second halves* of the test, indicating a difficulty in maintaining the alert state over time.

In tasks that require *inference of a character's attitude/motive*, the importance of sufficient vigilance or level of phasic arousal is supported by the results from the multiple regression analyses, although the results for individuals in the Control group may influence and strengthen those associations beyond what is actually accounted for by the RHD individuals (see below). However, neither the Control group nor the RHD group is shown to be an important predictor variable in the results from the multiple regression analysis. This can be interpreted as indicating that, in predicting results on *inference of a character's attitude/motive*, *Mean reaction time* and *Feedback time* are more important predictor variables than whether the individual has right-hemisphere brain damage or not.

However, it is difficult to explain the significance of the variable *Feedback time* in the multiple regression analysis of results on tasks requiring *inference of a character's attitude/motive* in the Control group and the RHD group. *Feedback time* might be interpreted as a measure of a supervisory component of attention as it reflects an attempt to slow down one's speed on the test after making errors (Manly et al., 1999). This is

interesting in itself as *Feedback time* could therefore be considered as a measure of aspects of executive control. As indicated by mean *Feedback time*, the Control subjects in this study do not slow down after making an erroneous response as much as the brain-damaged individuals do, although the difference between the Control group and the groups of brain-damaged individuals was not statistically significant. The tendency toward an association between *Feedback time* and *Mean reaction time* in the correlation analysis for the Control group reflects the finding that short *Mean reaction times* are associated with a tendency to either keep up the high speed or even increase the pace instead of slowing down after mistakenly pressing the response key when the number 3 is presented in the SART.

It is possible that individuals with short reaction times also have dysfunctional executive functions, preventing them from slowing down when they are obviously going too fast and making erroneous responses. A deficit like this might also reveal itself in inadequate responses to questions that require *inference of a character's attitude or motive*. It is, however, likely that an association of this kind would be more apparent in groups of brain-damaged individuals than in a group of non-brain damaged controls and that it would become noticeable in other kinds of tasks too. As a whole, the results for estimated ability to sustain attention in this study are somewhat surprising. Although the differences were small and not significant, the Control group seemed to be going too fast, making more errors than both groups of brain-damaged individuals, and they seemed to be somewhat reluctant to slow down even after making *Erroneous responses*. The Control group also omitted more correct responses. The tendency toward an association between *Feedback time* and *Mean reaction time* in the Control group does not reveal any information about how many *Erroneous responses* or omitted responses these specific individuals produced in the SART. There are no significant associations between *Feedback time* and those measures, which makes it difficult to infer the significance at a group level, if any, of the association revealed in the correlation and regression analysis. The interpretation of short *Feedback time* as indicating a deficit in

executive function is only relevant if the same individual who has a short *Mean reaction* time and is reluctant to slow down the pace, is actually going too fast and producing many *Erroneous responses* in the SART. Furthermore, several individuals in all three groups stated that they strategically pressed the button faster after a number 3 had been presented, no matter whether they had made an erroneous response or correctly withheld a response. This was done because they did not expect the target to be presented twice in a row. Consequently, *low mean Feedback time* might reflect an ability to plan strategically – another aspect of executive function.

2. 4 General discussion: Studies 1 and 2

In this section, the results of studies 1 and 2 will first be compared and discussed in light of current theories of cognition and the causes of deficits in comprehension and other dysfunctional pragmatic abilities described in RHD individuals. After that, the results will be discussed in relation to the methods and models used in this study.

2.4.1 Results in relation to current theories

Understanding the causes of pragmatic dysfunction requires a holistic and interactionistic perspective on the mechanisms involved. Several cognitive aspects may be involved and they may interact with compensatory strategies and other factors operating within the individual and between the individual and the environment. The results of studies 1 and 2 are here discussed against the background of different theoretical frameworks in an attempt to broaden the perspective from single mechanisms to global processes involved. General alertness and the ability to sustain attention are fundamental elements of human cognition. Any dysfunction here might affect more complex cognitive processes and possibly also play a role in some of the theoretical models proposed to explain pragmatic deficits in association with RHD.

2.4.1.1 Sustained attention and theories about pragmatic deficits in RHD

In study 2, associations between the ability to make inferences and attention were investigated.

Both the RHD group and the LHD group in this study had problems with tasks requiring *revised inference*. In the RHD group, these results were associated with sustained attention. There was also an indication that problems with *inference of a character's attitude/motive* for the RHD group, and the Control group, might be associated with an attention/arousal component of the attention system. RHD might cause attentional deficits – more specifically, deficits in sustained attention and spatial orienting – although it is not possible in a test situation to completely separate even executive function from other attention systems.

There is an established view of the right hemisphere as being superior at processing the macrostructure of stimuli, leaving the processing of details to the left hemisphere. Martin and McDonald (2003) discuss whether the inference problems seen in association with RHD result from a general impairment of a right-hemisphere processing style that enables the processing of information as a coherent whole. Studies by Brownell et al. (1986) and Moya, Benowitz, Levine, and Finklestein (1986) have suggested that inference-making in general is impaired in RHD individuals. However, when Happé et al. (1999) directly compared ability to generate inferences about mental state versus general inferencing ability in RHD individuals, the problem was found to be restricted to mental inferences. However, the results of study 1 support the notion that the inferencing problem is not restricted to mental inferences.

Dysfunctional sustained attention or arousal might cause that an individual to miss important social cues or signals in discourse that are essential for an adequate comprehension of the situation. In light of the construction-integration model of comprehension, this will cause a distorted situational model because some associations will not be activated or information that might have strengthened an activation enough

to take part in the integration process is missing. Consequently, the person's comprehension of the discourse or situation will not be coherent or adequate.

The association between revised inference and sustained attention in the RHD group in study 2 might support the *Suppression deficit hypothesis*, described by Tompkins et al. (1999). A deficit in sustained attention might have impact on the ability to revise inferences, as information that would support one interpretation over the other might be missing. This would make the suppression process difficult, as several meanings might then have the same activation strength. Dysfunctional VWM capacity may also have some impact here, but this association was only seen in the LHD group. However, based on the stimuli and results of the present study, it is only possible to speculate about the RHD individuals' ability to either activate or suppress meaning.

Another way of viewing the result might start with Ramachandran's (1995) hypothesised right-hemisphere anomaly detector, combined with a left-hemisphere coherence mechanism, as described by Gazzaniga and Cooney (2003). Normally those mechanisms bridge most of the gaps that might result from a deficit in sustained attention or a normal temporary decline in attention. However, if right-hemisphere brain damage is present, problems arise when the missing information depends on right-hemisphere processing. According to the *coarse semantic coding theory* described by Beeman (1998) and Beeman et al. (2000), the right hemisphere maintains activation of many possible meanings for a longer period of time than the left hemisphere when processing a word. As a result, the right hemisphere increases the semantic overlap among multiple semantic fields. It may also function to maintain activation for peripherally related information. That kind of information may be essential for making correct coherence inferences out of subtle communication signals, such as certain associations with different nuances of the meaning of words. It might also be dependent on a functional right-hemisphere processing since the more selective left hemisphere semantic processes quickly inhibit information that is not related in an obvious way.

The *coarse semantic coding theory* in combination with Ramachandran's (1995) and Gazzaniga and Cooney's (2003) theories, might perhaps explain why there are significant associations between the measure of sustained attention and results on tasks requiring *revised inference* in the RHD group, despite the fact that there are no significant differences between the RHD and Control group's results on the SART. Sustained attention is one important factor in the processing of the tasks, but lapses in attention may become critical to processing only in combination with the RHD. In general, the RHD individuals need not have poorer sustained attention than the Control group to produce significantly less adequate responses in the tasks requiring revised inference. The RHD individuals might actually not experience more lapses in sustained attention than the individuals in the Control group. Nevertheless, *when* these, quite normal slips of the mind occur in an individual with RHD, he or she cannot compensate with an anomaly detector or coherence mechanism in the same way as a healthy individual in the Control group might. The RHD prevents the activation of relevant information, such as certain word associations, in maintaining the activation of a competing dominant meaning of an ambiguous word.

2.4.1.2 Social inference, executive function and right hemisphere hypothesis

It was hypothesised that problems making correct *inference of a character's attitude or motive* might be the result of an attentional deficit. Sustained attention is considered to be a basic attentional function motivated by stimulus anticipation; it is important for the efficacy of cognitive capacity in general. It might be essential to the ability to detect and select relevant stimuli from among social cues in discourse. Although there were indications that level of arousal, as measured by *Mean reaction time* on the test, might predict results on questions requiring *inference of a character's attitude or motive*, there was no association between the results for these questions and the results for the sustained attention task in the RHD individuals. That might be explained by this type of

task's being less cognitively demanding than the tasks that require *revised inference*; on the other hand, there was a strong association between the results on this task and ability to sustain attention, that is, *Erroneous responses* in the SART, in the LHD group, which actually had less trouble with that task than the RHD group.

Since the RHD group has problems managing the tasks that require *inference of a character's attitude/motive* almost to the same extent as they do in handling the questions requiring *revised inference*, it seems relevant to speculate that there might be another reason, more important than limited attentional resources, for their problems making correct *inferences of a character's attitudes or motives*. The reduced level of arousal, as indicated by *Mean reaction time* in the SART, could of course be expected to have some impact on performance on this task, but no such association was reflected in the correlation analysis for the RHD group.

Dysfunctional ability to make what are sometimes called *mental inferences*, as a reflection of ToM, might also be considered as a possible cause of problems with the task. According to Siegal and Varley (2002), impaired executive function could cause a deficit in ToM. Since this study does not include any specific measure of executive function capacity, it is not possible to draw any conclusions about this higher-level cognitive function in the subjects in the RHD group. Executive function is usually associated with frontal brain damage and only three individuals in the RHD group had frontal lesions. On the other hand in the model of the human attention system described by Fernandez-Duque and Posner (2001) the executive attention system is claimed to be anatomically based on distributed structures including portions of the basal ganglia and thalamus. Case reports by Summers (2002) and Rainville, Giroire, Periot, Cuny, and Mazaux (2003) concerning individuals with right thalamus damage, or damage involving other subcortical structures, have shown deficits in executive function. None of the subjects in the RHD group had damage restricted to the thalamus but at least five of them have brain damage in close connection with or involving the basal ganglia. On the other hand, the results for *Erroneous responses* in the SART speak against the notion

of a general executive dysfunction as a cause of the problems making adequate *inferences of a character's attitude or motive*. As discussed above, this might be considered as more of a measure of inhibitory control, which is also seen as a mechanism of executive function. The RHD individuals actually produce fewer *Erroneous responses* in the SART than either of the other groups and there are no associations with results on *inference of a character's attitude/motive* seen in the correlation or regression analyses.

The fact that tasks requiring *inference of a character's attitude or motive* were more difficult for the RHD group than for the other groups might fit in with the *right hemisphere hypothesis* of processing of emotional stimuli, as described by Borod et al. (2002). According to *the right hemisphere hypothesis*, the right hemisphere is considered more suitable for processing these kinds of stimuli since subtle emotional information often is dependent on non-verbal, visuospatial organisation and synthetic and holistic strategies, such as body communication or prosody. Advocates of this hypothesis put forward RHD individuals' deficits in identifying emotion in facial expressions and prosody as well as in linguistic stimuli, especially when subcortical structures are involved in the damage (Karow et al., 2001). Among the RHD subjects in this study, at least 50% have damage to subcortical structures of the right hemisphere.

Why then would identification of linguistic descriptions of attitudes and motives in discourse or an emotional semantic lexicon depend on the right hemisphere when language in so many other senses is associated with the left hemisphere? According to Adolphs (1999), a ToM approach to social cognition might be applicable when stimuli are encoded in language. Nevertheless, it is hypothesised here that when it comes to stimuli in the form of implicitly stated material in discourse, the competing view of social inference must also be considered. In this latter approach, the ability to recognise and reason about other people's state of mind is apprehended as an example of experience projection through simulation. This view also emphasises the role of the right hemisphere in the process as the importance of the right somatosensory cortex is

acknowledged together with the right and left amygdalae and ventromedial frontal cortex. Virtually every concept or word in the semantic lexicon is probably encoded and stored with certain emotional and attitudinal information. According to Van Lancker and Pachana (1998), there is evidence that the right hemisphere organises its lexicon according to contextual, affective and idiosyncratic or personalised principles. In higher perceptual functions, the processing of different aspects of, for example, visual stimuli and object recognition is dependent on distributed structures within the brain (Gazzaniga et al., 2002). In the same way, the activation of a concept, as a referent of a word used in discourse, involves not only the activation of the most common or dominant meanings of that word. It also includes the activation of various more or less idiosyncratic associations. As discussed by Damasio (1999), in recalling an object, associations like the sensory and perceptual features as well as relevant motor and emotional reactions, some based on the individual's personal experiences, are also activated in some sense, although not all of these activations reach the conscious mind. Perhaps Adolphs and Damasio's (2000) notion of right hemisphere specialisation in interpreting facial expressions applies to processing the emotional semantic lexicon as well. In their view, there is evidence that the right hemisphere is specialised for representing the body. The ability to form a mental somatosensory image can trigger other knowledge, both in image form and encoded in language, which makes it possible to understand facial expressions and verbal expressions of emotion or attitude. According to Adolphs and Damasio (2000), a subject confronted with a facial expression might ask himself or herself, 'how does it feel when my face has that expression?' In the same way, perhaps confrontation with a linguistically encoded presentation of a situation might require a response to the question 'how would I *feel* in this situation?'

This notion might be apprehended as invalidating the distinction often made between problems with the semantic processing of emotional linguistic stimuli and problems of reduced emotional experience in RHD individuals. However, the discussion here in no way implies that RHD individuals are impaired in their ability to experience

emotions per se. The notion only bears upon lexical-semantic processing, interpretation and comprehension of linguistically coded information, and as Adolphs and Damasio (2000) propose, facial expressions.

Furthermore, the comprehension of a character's attitude or motive might depend on efficient access to information encoded in episodic memory. The understanding of other people in social interaction is facilitated by personal experience with the situations at hand. Adolphs (1999) claims that the bilateral ventromedial frontal cortex may be involved in the process of associating elements of the perceived situation with previous experience. No effect of lack of specific personal experience was seen in the analysis of a possible association between personal experiences of situations depicted in the narratives and results on the Discourse Comprehension task. Instead, the reason might be that RHD may impair the capacity to retrieve encoded information as described by the Hemispheric Encoding Retrieval Asymmetry (HERA) model (Habib et al., 2003). This would, of course, affect all retrieval, not only *inference of a character's attitude/motive*, but this kind of task might be especially sensitive to impairments affecting the brains 'retrieval mode'.

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One might infer that a dysfunction in arousal and basic cognitive processes such as sustained attention or VWM might have impact on every more complex cognitive process, and also be somehow involved in a general coherence mechanism or affect a suppression process. However, the methods and stimuli used in these studies do not produce results that are sufficient to support the *suppression deficit hypothesis*. Instead, *the coarse semantic coding theory*, perhaps in combination with Ramachandran's (1995) theory of a right hemisphere anomaly detector, seems to be the most suitable theoretical framework to explain the impact of sustained attention on tasks that require *revised inferences* in studies 1 and 2.

The RHD individual's results on tasks requiring *inference of a character's attitude/motive* are not associated with the measures of sustained attention or VWM used, although general alertness may play some role here. Instead, the notion of social inference as a process that depends on the ability to *simulate* other people's mental states, as described by Adolphs (1999) and Adolphs and Damasio (2000), perhaps in combination with the HERA model (Habib et al., 2003), might contribute to the understanding of RHD individuals' problems with social inference in written discourse and conversation. This, however, remains to be investigated more thoroughly in another study.

2.4.2 Theoretical considerations and methodological issues: What is really being measured?

Language, communication and cognition in humans are complex matters. In the search for knowledge, research in this field is often obliged to construct new models on relatively well-established theoretical grounds. New knowledge questions old theories and requires new definitions. There *are* well-established theories and definitions of what psychological concepts such as VWM and sustained attention are and how they can best be measured. But there are a range of different theories with different views and all of them can be questioned in one way or another. The method used in this study might also need to be altered and developed in several ways. In this section, the results will be discussed in relation to the models and methods used to obtain them.

2.4.2.1 VWM capacity

Given that VWM, at least in the sense of verbal short-term memory, is most commonly associated with functions in the left hemisphere, it is not surprising that there is a significant difference in performance on the VWM task between the LHD group and the Control group. Furthermore, the only strong tendency toward association between the

results on Discourse Comprehension tasks and the VWM was found for the LHD group on tasks requiring revised inference. Stimuli in the form of verbal semantic items might be especially taxing for the LHD group. Even subtle language disturbances have an impact on semantic activation and on the pragmatic aspects of language.

The association between VWM and results on the Discourse Comprehension task in the LHD group was also to be expected, given the number of inadequate spontaneous responses due to *no inference expressed*. Especially on questions about explicitly stated matters, the LHD group made more inadequate responses than the other groups. Several individuals in this group took advantage of the possibility of reading the texts and modifying their responses. This might be a symptom of poor VWM capacity; it is also a conscious strategy for these LHD individuals. Anyhow, it is clear that a cognitive function like VWM can influence the comprehension of more complex communicative contexts, at least in individuals with LHD.

So what does the VWM task used really measure? Engel et al. (1999) argue that simple digits and word span tasks cannot reliably and consistently predict mainstays of more compound cognitive processes such as reading or listening comprehension. In everyday skilled performance, such as discourse comprehension, LT-WM might play a potentially important role as part of a working memory mechanism. However, in tasks where prior knowledge or skills are excluded, sometimes deliberately, as in laboratory and experimental memorising tasks, more general strategies might, according to Ericsson and Delaney (1999), come into play, such as the use of a phonological short-term buffer for rehearsal. Nevertheless, Ericsson and Delaney (1999) do consider that Daneman and Carpenter's (1980) reading span task, being a dual task, is able to measure an ability that is fundamentally important to more complex cognition. Significant relationships have been demonstrated between this measure and a variety of real-world cognitive tasks, e.g. reading comprehension, language comprehension and complex learning.

No test can measure a function like VWM in isolation. The VWM task used in this study depends on access to the verbal semantic system to interpret and respond accurately to the stimuli. The task also requires sustained attention as well as orienting to the verbal stimuli. Listening to the phrases and selecting the appropriate response at the same time as the growing list of words is kept in STM requires an executive function such as divided attention. The new information interferes in the memorising process. Another element of executive function might be the suppression of irrelevant items in the form of words memorised in the previous sets or other unrelated associations. However, although sustained attention might be considered an essential mechanism in working memory, the VWM task in this study is not thought to measure the same mechanisms as the task used to measure sustained attention. This is confirmed by the fact that the correlation analysis does not reveal any significant associations between the two measures.

2.4.2.2 Sustained Attention to Response Test

The only difference in the results between groups on the SART was on *Mean reaction time*, where the RHD individuals responded significantly more slowly than the Control group. This difference may be interpreted as reflecting a general decrease in arousal or, as in the model presented by Fernandez-Duque and Posner (2001), ability to achieve an alert state, in the RHD group. A deficit affecting the ability to achieve an alert state may in itself decrease a person's ability to grasp and integrate subtle items in discourse in order to infer the meaning.

As argued by, for example, Rueckert and Grafman (1996), reaction time may be a critical measure in sustained attention tasks. Increased reaction times usually correlate with decreased detection rates, supporting the hypothesis that reaction time also indicates a decline in vigilance. Although there is no real difference between groups for *Number of correct responses* in these studies, and the Control group even makes slightly

more *Erroneous responses* than the other groups, the RHD group does show a somewhat higher increase in *Mean reaction time on the second half of the test* than the other two groups; still, this difference is not statistically significant.

One reason for the lack of difference between the RHD group and the Control group in terms of number of *Correct* and *Erroneous responses* in the SART might be that the groups of brain-damaged individuals in these studies present no obvious deficits in sustained attention. Symptoms of neglect have been associated with deficits in attention systems of orienting as well as sustained attention (Robertson et al. 1997b). None of the subjects showed obvious symptoms of neglect in the neglect tasks in study 1. Another reason might be that many of the brain-damaged individuals in these studies reported that they had performed similar tasks in neuropsychological evaluations during their rehabilitation, which may give them an advantage over to the control subjects. The brain-damaged individuals may also, because of their disability, be more used to consciously monitoring and adjusting their behaviour when exterior requirements tax a reduced cognitive capacity. Conversely, brain injury might actually prevent that sort of adjustment.

A couple of the younger participants in the Control group said that they were used to computer games that offered them ‘more than one life’, that is, more than one chance, when they went too fast or failed in the game. This, they said, made them more inclined to take the risk of keeping up their high speed even though it resulted in erroneous responses. Perhaps that explains at least a small amount of the group’s performance in this context.

Except for increased reaction times, both groups of brain-damaged individuals in these studies performed at the same level as the Control group. This differs from the results obtained by Manly et al. (1999) and Chan (2001). One possible reason for the lack of differences between groups on the SART might be that the task focuses on the inhibitory aspects of sustained attention. Although the creators of the SART consider the *Number of erroneous responses* to be a measure of the ability to sustain attention or

vigilance, it might actually reflect a capacity to inhibit erroneous activities in action or cognition. In that way it may be considered a measure of *sustained inhibition*. The participants in the SART studies cited here had traumatic brain injuries. Traumatic brain injuries often involve the frontal lobes and can cause deficits in inhibitory mechanisms, which might explain the between-group differences in those studies. However, the SART might still measure other aspects of sustained attention. There is a significant association in the RHD group between results on *revised inference* and the *Correct responses* measure in the SART.

This raises the question of how to apprehend the human attention system and, for example, separate a sustained attention system from the system for orienting to stimuli. Not only do separate attention systems interact, but it is also impossible to measure one attentional function separately from any other in practice. Performance on the SART requires basic arousal functions, sustained attention and selective orienting to stimuli. It is also dependent on executive functions such as inhibitory control. Compared to the study by Chan (2001), the brain-damaged individuals in the present study perform at the same level as or somewhat better than the non-brain-damaged subjects. The individuals in the Control group in the present study perform as well as or somewhat worse than the controls in Chan's (2001) study. The conclusion would have to be that, as a group, the brain-damaged subjects in this study do not really have a deficit in sustained attention, as measured by the SART. Although inhibitory control might be considered an important symptom of deficits in sustained attention, the SART might be more sensitive to symptoms of traumatic brain injury than to symptoms of the type of brain damage seen in association with stroke. Only three individuals in the RHD group and three individuals in the LHD group had brain damage involving the frontal lobe. The size and extent of the brain damage and time post-incident may also be important. Most of the subjects in the RHD group were several years post-stroke and they had all been able to go back to living by themselves or with their families after rehabilitation.

Furthermore, in the SART every stimulus requires some kind of response, as the inhibition of an action in the form of a response key press must also be considered a cognitive action or response. Perhaps a sustained attention task involving more of a selective element in the processing, such as the auditory Elevator counting task in the Test of Everyday Attention (Robertson et al., 1994), would better discriminate the RHD group from the Control group.

There was no correlation between results on the SART and spontaneous responses in tasks requiring *revised inference* in the LHD group. One possibility might be that this group's poor VWM overrides any effect of sustained attention on the task results. The inadequate spontaneous responses might be associated with the subjects' being aware of their poor VWM capacity. Although a couple of individuals in the LHD group had difficulties responding to the inference questions even after reading the texts, the possibility of reading the texts and modifying their responses might make the subjects in general more inclined to withhold a spontaneous response or to put less effort into it.

2.4.2.3 Discourse Comprehension task

The narratives used in the Discourse Comprehension task were developed as an adaptation of a method used by Tompkins et al. (1994). That study found no significant differences in the results of a group of RHD individuals, LHD individuals and healthy controls on the inference tasks. To increase the demands on cognitive processing, the narratives were lengthened and open questions were used. This procedure was successful as it made it possible to differentiate the RHD individuals from the non-brain-damaged controls. In the present study, there were also meaningful associations between the results on discourse comprehension tasks and the results of either the VWM measure or the measures of sustained attention in the groups of brain-damaged individuals. On the other hand, the more complex a task, the more difficult it is to determine what makes it difficult to solve. As described in terms of the construction-integration model, there

are several different mechanisms that might cause an inadequate response on the questions.

Although they did not refer to Kintsch's construction-integration model in that particular study, Tompkins et al. (1999) would probably be more prone to relate the RHD individuals' problems revising inferences to the *integration process* of comprehension. Ambiguous words are assumed to have both their, possibly conflicting, meanings active during the construction process. During the integration process of comprehension the more context relevant interpretation is supposed to be strengthened, as more nodes will have connections with this interpretation. According to the *suppression deficit hypothesis*, the irrelevant representations activated during the construction process are not repressed during the integration process and thus they interfere with the appropriate interpretation.

However, integration is not, according to Kintsch (1998), a sentence wrap-up phenomenon. Sometimes the listener or reader uses delaying strategies, or continues reading or listening, hoping that the succeeding discourse will clarify any uncertainties. In general, though, information is processed as soon as possible. It is likely that the correct meaning of the ambiguous word has already been suppressed during the completed integration process in the first part of the narrative. This is probable because that particular meaning will only become the most context-relevant when the last sentence of the text is processed. That is, the context-relevant interpretation might have to be reactivated in a reconstruction of the text base and situation model, and this causes the stimuli used in this study and any conclusions that can be inferred from the results to differ from the results and conclusions of Tompkins et al. (1994). It is possible, that even though RHD individuals activate several meanings of an ambiguous word in the context of two sentences, they might not do so under more cognitively taxing conditions, such as a more comprehensive discourse.

In the *revised inference* tasks used in studies 1 and 2, there was no significant difference in errors depending on whether a more common meaning had to be changed

into a less common meaning. Kintsch's (1998) construction-integration model may also explain why the frequency of meaning of an ambiguous word is less important when the word is presented in context. Although a frequent denotation might be more easily accessed in isolation, the presentation in a context overrules any frequency effects that might be observed in, for example, a priming task. In the process of integration, the nodes that satisfy the multiple constraints of the network become stronger and nodes that do not satisfy those constraints become weaker. Nodes that have few connections in the network of propositions, or are negatively connected, will be suppressed in the process of constraint satisfaction. Hence, any meaning preference is dependent on the specific context, not on general frequency of use. It ought not to be possible to relate reluctance to revise an initial interpretation to frequency of use of the denotation in isolation.

Some theories hypothesise that RHD might prevent the activation of relevant elements, such as emotional or attitudinal aspects, in discourse (see the discussion above). This would be considered a deficit originating in the construction phase according to the construction-integration model. In the narratives used in study 1, the context favours a given interpretation of a specific character's attitude and/or motive to act. This is constructed through the situation described and the words used. The words signal what the character's attitude towards someone or something is, or the motive for an action. As the relevant attitude or motive is not explicitly expressed, comprehension depends on the words and sentences forming compound cues to retrieve information from LTM and to structure LT-WM. According to Kintsch (1998), any inconsistency in the text base formed also hinders the building of effective retrieval structures. Even though in most cases a word might be linked to its lexical node, LT-WM will be fragmented and any item retrieved from that kind of structure will be deactivated as there are not enough links to sufficiently strengthen the activation.

Another limitation on the stimuli used in studies 1 and 2 is that, although efforts were made to make the narratives similar in terms of frequency of words used and they

are all about equal in length and syntactic complexity, there might still be other aspects that are difficult to control for but that might influence the ease of comprehension.

The construction of the Discourse Comprehension task can be justified and the measures of VWM and sustained attention, as interacting cognitive functions, are relevant. Nevertheless, in terms of cognitive resources and mechanisms involved, VWM and sustained attention are not the only requirements for the tasks. In addition to the ability to stay alert and focused on the task, the ability to detect and orient to relevant stimuli and suppress irrelevant stimuli is needed. Performance on the task also depends on executive function. Measures of the ability to activate, process and suppress certain semantic information would also have contributed important information to the interpretation of results obtained. It may be inferred from the construction-integration model that the processes of construction and integration are dependent on some kind of executive functions or supervisory attention in the process of activating and deactivating items. On the other hand this supervisory attention or executive function should not be visualised as a homunculus or little mind within the mind sorting out which associations are most relevant in the context. As has been shown in computerised experiments, according to Kimberg and Farah (1993), there is actually no need for a separate central executive to account for several typical frontal lobe damage deficits, commonly explained as deficits in executive function. The idea of some form of distinct central executive, as proposed by, for example, Shallice and Burgess's (1991) 'Supervisory Attentional System' has thus been called into question. According to Kimberg and Farah (1993), work in several different disciplines, including computation and animal behaviour, shows that there is no need to posit a central executive to account for complex organised behaviour. In their computer model, the weakening of associations among elements in working memory results in impairments on a variety of tasks traditionally accounted for by a central executive. Although Kimberg and Farah (1993) do not define working memory, their alternative hypothesis postulates that the frontal lobes are important in maintaining associations among elements in working memory.

Dysfunction then is a consequence of damage to the available knowledge representation. The weakening of associations results in a reduced sensitivity to the mutual relevance of information and the relations between facts and their contexts.

2.4.2.4 Heterogeneity of groups and multifaceted functions

Research designed to understand the right hemisphere's role in language and communication often involves groups of RHD individuals. These group studies, using different methods, sometimes obtain contradictory results. One limitation on these studies is that RHD is often the only criterion of inclusion, which might result in groups containing both individuals with pragmatic deficits and individuals with no symptoms.

In this study, only subjects who had, according to themselves or to others, experienced communication problems that could be associated with pragmatic or subtle language deficits were included. But then there is the problem of defining and diagnosing pragmatic deficits. There is no common standard for sufficient pragmatic ability. What would be described as dysfunctional pragmatic behaviour in one context might be experienced as a personality trait in slightly different circumstances. Pragmatic abilities may vary among perfectly healthy and, in other areas, well-functioning individuals. In clinical work, in the case of suspected pragmatic deficits in association with brain damage, speech-language pathologists are referred to the patient's subjective experience and sometimes to the relatives' experience of changed communicative behaviour on part of the patient.

Another criticism that often comes up in relation to research on groups of brain-damaged individuals is the mix of different lesion localisations in the same small groups. Working with mixed groups is often a necessity because of the difficulty finding suitable subjects for group studies in the research of speech and language deficits. Still, sometimes the different effects of diverse lesion localisations within one hemisphere are greater than those of localisations in different hemispheres. The groups in this study *are*

heterogeneous, with lesions in different parts of the cortex and also subcortical lesions within each hemisphere. Because of the limited size of the groups, further subdividing and comparison of, for example, subjects with brain-damage restricted to cortex and subjects with brain-damage involving subcortical structures, or frontal brain-damage and posterior lesions, was not meaningful. On the other hand, mixed groups can be considered as a demand for obtaining results generalisable to populations with RHD or LHD.

Apart from the fact that a few more of the individuals in the RHD group than in the LHD group have sub cortical involvement in their brain damage, both groups are heterogeneous to approximately the same extent. Unfortunately, the available data in medical charts ruled out making more exact estimations of lesion size for comparison between the groups. Still, when one works with individuals with acquired brain damage who, before their disease, had developed well-established complex cognitive functions, like language, completely homogeneous groups are impossible to obtain. When it comes to complex human cognition, acquired brain damage in one individual cannot always be expected to have exactly the same consequences for cognition as it does in another individual, even if the localisation and size of the lesion are the same.

Research on language in RHD individuals has still not been able to attribute specific pragmatic deficits to lesions in certain areas or structures within the right hemisphere. This is probably not just because of the heterogeneous groups in the studies performed. One reason is of course the lack of established definitions of right hemisphere pragmatic deficits. But another important element is the type of symptoms. The pragmatic deficits affecting language and communication of RHD individuals must be assumed to depend on several different cortical and subcortical structures. Although essential structures for executive function in the frontal lobes might be important, there are no specific areas associated with pragmatics, corresponding to the frontal and temporal areas in the left hemisphere associated with articulation and phonology. Another reason for the difficulty relating specific pragmatic symptoms to well-defined

structures within the right hemisphere might also be the neuroanatomic organisation. The right hemisphere is assumed to be more diffusely organised with more white matter, more connections between different regions and greater multimodality than the left hemisphere (Gur et al., 1980). This is believed to be one reason why the right hemisphere is superior at processing complex emotional stimuli and multifaceted interactions in communication (Tompkins, 1995). One can assume that a well-defined lesion in one structure within the right hemisphere may result in similar pragmatic symptoms to a well-defined lesion in a different region within the hemisphere. Furthermore, an utterly important reason for the conflicting results in the research on pragmatic aspects of language associated with brain damage is probably the phenomenon of pragmatics itself. As Perkins (2005b) describes it, pragmatics is the emergent outcome of interactions between several elements within and between individuals. The behaviours we identify as pragmatic impairments may be the result of deficits in any of the involved elements, in combination with compensatory adaptive processes. This means that the same symptom in two individuals might have totally different causes while two identical lesions might result in totally different symptoms in testing and in conversational interaction.

3. PART II: CONVERSATIONAL INTERACTION

This part of the thesis examines study 3 and study 4. In these studies pragmatic aspects of language are investigated in the production of speech and comprehension in conversational interaction post-stroke. Human behaviour in natural conversational interaction can be looked upon as the outcome of pragmatic ability. This is where the communicative competence is actualised and applied in everyday life.

The method used in study 3 involves a questionnaire for the investigation of post-stroke changes in perceived pragmatic ability and its consequences for communication. The presentation of the results from study 3 is followed by the presentation of study 4. In this study, four individual brain-damaged subjects are presented as cases. Their individual results from studies 1-3 will be presented along with an analysis of their video-recorded conversational interaction in a dyad. Part II concludes with a general discussion of results from studies 3 and 4. The thesis then concludes with a brief summary of results and conclusions, including implications for further research and clinical management of pragmatic language disturbances in relation to RHD.

3.1 Introduction and outline to study 3: The questionnaire

In this study the brain-damaged subjects' own experience and perception of their communicative ability post-stroke is investigated on a group level. This is done by means of a number of pragmatic parameters presented in a questionnaire. Since communication is a matter involving at least two persons, the questionnaire was also distributed to the conversational partners of the brain-damaged individuals. After the presentation of research questions and method, results of perceived change will be presented and concluded with a summary. This is followed by the presentation of results and a summary of reported negative impact from these changes.

3.1.1 Research questions in study 3

The aim of study 3 is to map how pragmatic aspects of language might change post-stroke and the effect of that change on conversational interaction. The research questions are:

1. In what pragmatic areas among those presented in a questionnaire about conversational interaction do *a majority* of the subjects and their conversational partners perceive change post-stroke? Are they the same between groups and between the brain-damaged individuals and their conversational partners?
2. Are there any differences between groups, or between the brain-damaged individuals and their conversational partners regarding the reported *degree of change* in the different areas?
3. Are all changed behaviours perceived as having a negative impact on conversational interaction?
4. Are there any differences between groups or between the brain-damaged individuals and their conversational partners in the ratings of *degree* of negative impact, measured as frequency of occurrence of a negative impact?

3.2 Method: Study 3

In this section, the participants in study 3 are discussed, followed by a presentation of the questionnaire used and the analysis performed.

3.2.1 Participants in study 3

Completed questionnaires were collected from all subjects in both groups of brain-damaged individuals and from conversational partners of 13 of the 14 subjects in each group of brain-damaged individuals. The remaining two brain-damaged participants (one LHD and one RHD) were not able to provide any conversational partner who was able to participate in the study. The conversational partners responded to how *they* perceived the subjects' conversational abilities. The conversational partners who participated were all well acquainted with the conversational style of the subject both before and after the stroke. Most of the participating conversational partners were spouses or children of the subjects, while some were close friends. The brain-damaged subjects were told that they should have a certain conversational partner in mind – if possible, the participating partner – when they responded to the questions.

The main aim of this study was to investigate which pragmatic areas *among those presented in the questionnaire* are most often reported as changed post-stroke and as having a negative impact on conversational interaction. Therefore, individuals who consistently reported no perceived change on the parameters presented in the questionnaire were excluded from further analysis. One criterion for being included in these studies was the experience of post-stroke problems affecting communication, reported by the subjects themselves or any conversational partner. Still, these reports were sometimes given by clinicians or other persons who did not participate as conversational partners in the study. Furthermore, even if a change in communication was reported, that change was not always covered by the issues in the questionnaire. Table 3:2:1 displays data on the included participants on a group level.

Some of the individuals who did not report any changes on the parameters included in the questionnaire instead reported change in the form of more frequent and more explicit verbal expressions of, for example, anger or intolerance in social interactions. Changes in general attitude, as expressed in readiness to communicate and use of conversational tone, were also reported, along with more frequent experiences of difficulties with motor planning of speech.

Table 3:2:1: Group means for personal data of brain-damaged subjects included in study 3

	LHD subjects' conversational partners	RHD subjects' conversational partners
Number	13	9
	LHD subjects	RHD subjects
Number	13	11
Sex (male/female)	7/6	5/6
Age	60.7 (S.D: 12.11)	64.8 (S.D: 10.91)
Educational level	2.2 (S.D: 0.69)	2.2 (S.D: 0.75)
Reading habits	2.7 (S.D: 1.60)	2.9 (S.D: 1.38)
Month post-onset	26 (S.D: 21.27)	53 (S.D: 42.12)

The mean time post-stroke for the RHD group is almost 4.5 years, compared to about 2 years in the LHD group. However, the variation within the RHD group is large and no differences between the groups were statistically significant.

3.2.2 Material and method of analysis

The questionnaire was an adaptation of an interview procedure developed by Perkins, Whitworth, and Lesser (1997) and introduced in *Conversation Analysis Profile for*

People with Cognitive Impairments (CAPPCI). The CAPPCI was developed for research projects that address cognitive impairments in dementia of Alzheimer's type (DAT) and dementia in people with Parkinson's disease.

There are several assessment tools for functional communication for the aphasic population, e.g. *Communicative Abilities in Daily Living* (Holland, 1980), the *Revised Edinburgh Functional Communication Profile* (Wirz, Skinner, and Dean, 1990), and The Communicative Effectiveness Index (Lomas et al., 1989). There are also tools for assessing pragmatic skills in LHD or RHD subjects, e.g. *Pragmatic protocol* (Prutting and Kirchner, 1987), *The Right Hemisphere Language Battery* (Bryan, 1993) and *The RIC Evaluation of Communication Problems in Right Hemisphere Dysfunction* (Burns, Halper, and Mogil, 1985). The choice of an adaptation of the interview questions in the CAPPCI was based on the fact that the CAPPCI emphasises both the collaborative features of conversation and the impact of non-linguistic cognitive aspects on communication.

As the participating subjects in study 3 were also performing the tasks included in studies 1 and 2, a lot of their time and energy was already used up. The 35 interview questions in the CAPPCI were therefore transformed into a 25-question questionnaire for this study, to make it possible for the participants to complete the form at their convenience. Eleven questions in the CAPPCI were excluded as they are intended for people with dementia or motor speech problems as in Parkinson's disease. One question was added (question 24) as it is reported that some RHD individuals tend to make inappropriate jokes (Tompkins, 1995).

The questions in the CAPPCI are meant to be asked in an interview with a key conversational partner of the individual with a cognitive impairment. The questions therefore had to be adapted to make them more suitable for a questionnaire. A version with the same questions intended for the brain-damaged individuals themselves was also created. The adapted questions for the brain-damaged individuals are presented in Appendix 3. The questions in the questionnaire distributed to the conversational partners

are worded the exact same way, apart from the replacement of second person (you) to third person (for example he/she), see figure 3:2:1.

The questionnaire inquires about communicative behaviour in areas such as:

- Initiation and Turn-taking (questions 1 to 6),
- Topic management (questions 7 to 10),
- Repair (questions 11 to 14) and
- Prosody (question 25).

The questionnaire also examines linguistic abilities such as semantic production, e.g. Word retrieval (questions 16 to 17), use of pronouns in Reference (question 19) and Comprehension (question 18) as well as more complex linguistic abilities such as ability to interpret metaphoric meaning, generate inferences and understand and use humour (questions 20 to 24). Memory and attention are also addressed (question 15).

The questions are worded like the following examples: ‘*When you speak to your friend/relative, are your responses very long and detailed?*’ (question 5), or ‘*Do you ever stop speaking in the middle of a sentence and leave it unfinished as if you had lost the thread or been distracted?*’ (question 15). The subjects rated the frequency of occurrence of a certain kind of communicative behaviour on a five-point scale. For each question, the subjects rated the frequency of occurrence in conversations both as they remembered it from the period before they had their stroke and as how they perceived it now, after the stroke. Figure 3:2:1 shows an example from the questionnaire intended for conversational partners of brain-damaged subjects. The scale runs from *Very seldom/Never* through *Rarely*, *Occasionally* to *Often* and *Very often*. As the communicative behaviours included in the questionnaire are fairly common in natural conversations between healthy individuals, the subjects also responded to how often they feel that the behaviour in question had a negative impact on their communicative ability. It was also possible to add personal comments to the questionnaire.

The questionnaire forms were either sent to the subjects by mail in advance and then collected at the test session, or distributed at the test session and then returned by mail. In this way most of the respondents were given the opportunity to ask about the questions at a personal meeting as well as over the telephone.

Figure 3:2:1: Example of question in questionnaire intended for conversational partner of brain-damaged subject

3. Are there occasions when there is a long pause before he/she answers when you address him/her?					
Before illness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Very often	Often	Occasionally	Rarely	Very seldom/Never
After illness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Very often	Often	Occasionally	Rarely	Very seldom/Never
Do you find that this has a negative impact on his/her conversational ability since he/she was taken ill?					
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Very often	Often	Occasionally	Rarely	Very seldom/Never

Most of the behaviours inquired about in the questionnaire, such as for example: *interruption of conversational partner's turn, misperception of intended meaning and failure to orient conversational partner to new topics*, are quite common in all natural conversations. Frequency of occurrence might be an indicator of personality and conversational style rather than a measure of deficits in pragmatic ability specifically associated with brain damage. Furthermore, both too high and too low frequency of occurrence of certain behaviours could have a negative impact on conversational ability. In the analysis of the responses to the questionnaires, two measures were used:

1. *The occurrence of reported changes in the different areas:* To establish which of the areas presented in the questionnaire were perceived as most commonly affected by the stroke, an analysis was performed of which questions each individual and his/her conversational partner had marked as changed. The definition of change is that the respondent rates the occurrence of the behaviour as being either more or less frequent than before. A change by a single step, for example, from *Rarely* to *Occasionally* (see figure 3:2:1), or by several steps, is considered to be a change. Behaviours that more than 50% of the participating individuals in each group reported as changed are regarded as being frequently affected.

2. *The degree of change in each area:* To investigate whether there were any differences between groups in reporting the *degree of change*, the difference in changed frequency was compared. For each individual the difference between the reported frequency pre-stroke and post-stroke was calculated for each issue in each area. For example, if a behaviour is reported to have increased in frequency from *Occasionally* to *Very often*, it is marked as changed by two degrees; see figure 3:2:1 above.

3. *The degree of negative impact of changed behaviours on the ability to interact in conversation:* To investigate which changed issues were perceived as having a negative impact on the conversational interaction, further analysis was done on the issues that were reported to have changed. In the questionnaire, the respondents reported how often, that is, with what frequency, they perceived that the behaviour in question had a negative impact on their conversational interactions. In analysing the degree of negative impact, only ratings from individuals who had reported some degree of change on the issue in question were allowed to contribute to the group rating for that particular behaviour. This was

done in an effort to exclude the negative impact of behaviours that were due to personality traits rather than brain damage. To analyse the results on the group level, the ratings of frequency of negative impact in the questionnaire were transformed to numerical values:

Very seldom/Never = 0

Rarely = 1

Occasionally = 2

Often = 3

Very often = 4

Statistical analysis was performed on *degree of reported change* using the Kruskal-Wallis test. The Mann-Whitney-U test was used to compare groups of reports of *degree of negative impact*. To avoid type I errors due to multiple comparisons, the alpha level was set at 0.01.

3.3 Results of the questionnaires

In these sections, the results of the analysis of the data collected with the questionnaires will be presented. First, in section 3.3.1, the areas that were most often reported as changed, that is, reported as changed by a majority of the brain-damaged individuals and their conversational partners will be accounted for. Section 3.3.2 presents the degree to which the different areas were changed. Finally, in section 3.3.3, the results of the analysis of reports of occurrences and the degree of negative impact of changed behaviours are presented. The results of these analyses will be summarised here but discussed in more detail in a general discussion, along with the results obtained in study 4.

A table displaying the number of reports on each issue for each group as well as the group median and range of reported degree of negative impact is given in Appendix 4.

There was great variation in both degrees and types of reported change on the parameters presented between subjects in both groups. Eleven of the 14 participating RHD individuals and 13 of the 14 participating LHD individuals reported changes in one or more of the behaviours inquired about; see table 3:2:1 above. Among the individuals who did not report any change, one of the RHD subjects was backed up by the conversational partner, while another of the RHD subjects who reported no change had no participating conversational partner. The remaining two subjects were not supported by their conversational partners; that is, one LHD subject and one RHD subject who did not report any change had conversational partners who actually reported a perceived change in one or more of the behaviours investigated.

All of the 13 participating conversational partners in the LHD group reported change in one or more areas. Only 9 of the 13 participating conversational partners of the RHD subjects reported change on the issues presented in the questionnaire.

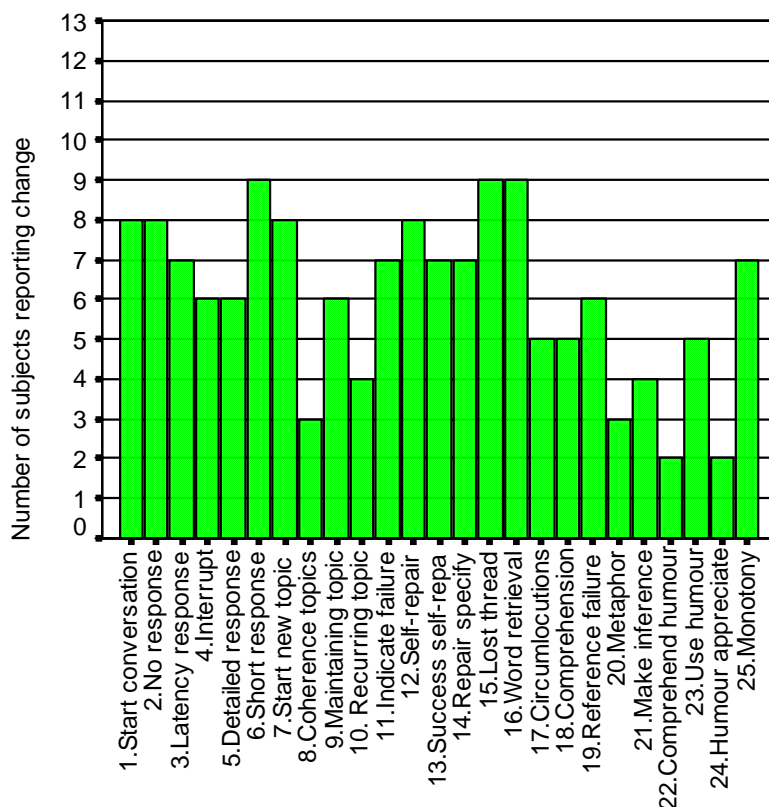
3.3.1. Areas of conversational interaction most often changed

In this section, the areas the brain-damaged individuals and their conversational partners *most often* reported as changed are presented.

3.3.1.1 Areas reported as changed by the brain-damaged individuals

The 13 individuals in the LHD group who had reported change reported that their communication was changed in several areas after the stroke. See figure 3:3:1, where frequencies of reported change are displayed.

Figure 3:3:1: Frequency of reported change in the different behaviours inquired about in the questionnaire, as perceived by the LHD individuals. N = 13.

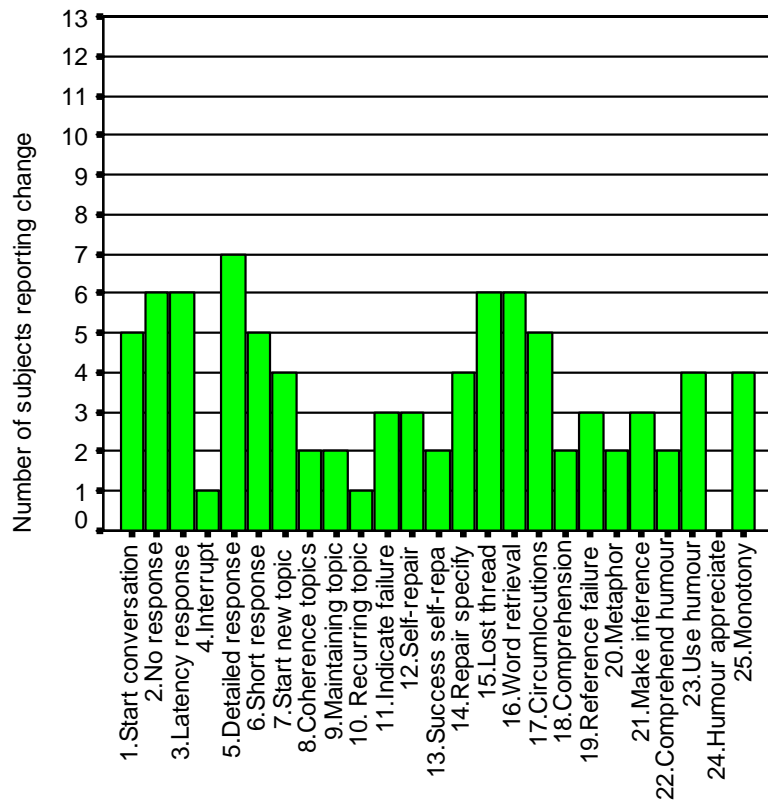


Nine of the 13 LHD individuals perceived that that they had an increased tendency to produce very short responses (question 6), and lose the thread while speaking (question 15); they also had more word retrieval problems (question 16) than before the stroke.

The other behaviours most often reported to be affected in the LHD group were in the Initiation area (questions 1, 2 and 3) and the Repair area (questions 11, 12, 13 and 14), together with changed behaviour when it comes to starting new topics in conversation (question 7). Most of the LHD subjects felt that they introduced new topics less frequently than before, but two of them felt that they did so more often. Changing the topic might, of course, be a strategy to avoid word retrieval problems. A majority of the LHD subjects also reported having a more monotonous intonation (question 25). Table 3:3:1 displays the areas reported by a majority of the participants in each group.

Six of the eleven participants in the RHD group who had reported any changes said that Initiation and Turn-taking were affected (questions 2 and 3). Figure 3:3:2 shows the number of reports for each issue in the RHD group. The issue of detailed responses (question 5) was reported as changed by 7 of the 11 RHD subjects.

Figure 3:3:2: Frequency of reported change in the different behaviours inquired about in the questionnaire, as perceived by the RHD individuals. N = 11.



Six of the eleven RHD subjects reported an increased tendency to lose the thread and more word retrieval problems post-stroke.

Table 3:3:1: Areas where issues were reported as *changed* in the conversational interaction by > 50% of the participating brain-damaged individuals and their conversational partners.

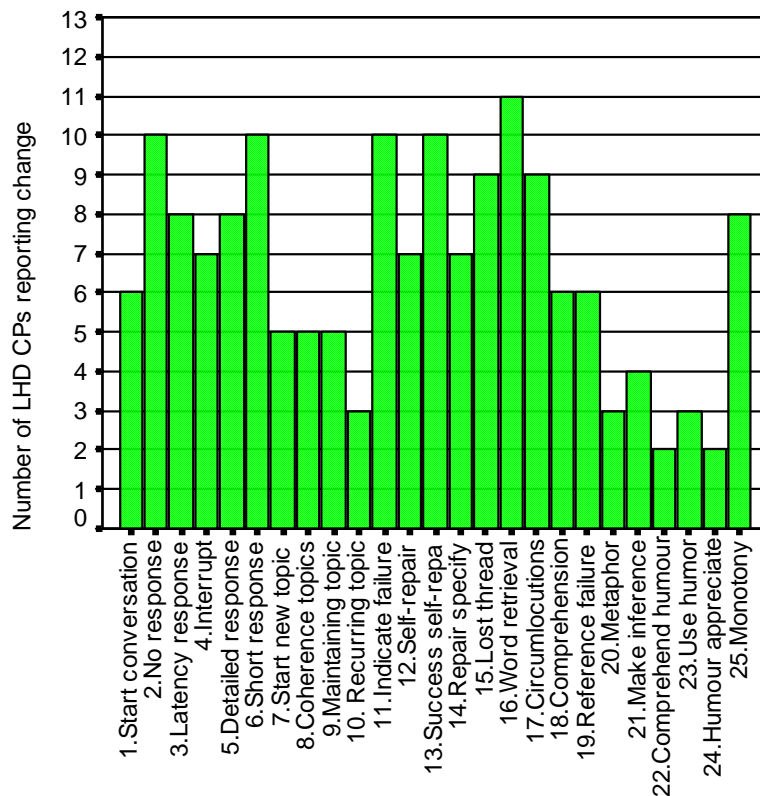
LHD subjects (n = 13)	RHD subjects (n = 11)	LHD conversational partners (n = 13)	RHD conversational partners (n = 9)
Attention	Attention	Attention	
Word retrieval	Word retrieval	Word retrieval	Word retrieval
Initiation	Initiation	Initiation	
Turn-taking	Turn-taking	Turn-taking	Turn-taking
Topic management			
Repair		Repair	
Prosody		Prosody	
			Reference
			Comprehension, general
			Complex language comprehension

To summarise: most of the participating subjects in both the LHD and RHD groups reported change in the areas of Attention, Word retrieval and Initiation and Turn-taking; see table 3:3:1 and Appendix 4. The majority of subjects in the RHD group did not report any change in the areas of Repair, Topic management and Prosody, as the individuals in the LHD group did.

3.3.1.2 Areas reported as changed by the conversational partners

Most of the 13 conversational partners of the LHD group agreed with the subjects' own perception, except that they did not recognise Topic management (questions 7 and 9) as an affected area to the same extent; see figure 3:3:3 and table 3:3:1.

Figure 3:3:3: Frequency of reported change in the different behaviours inquired about in the questionnaire, as perceived by the conversational partners of the LHD individuals. N = 13.

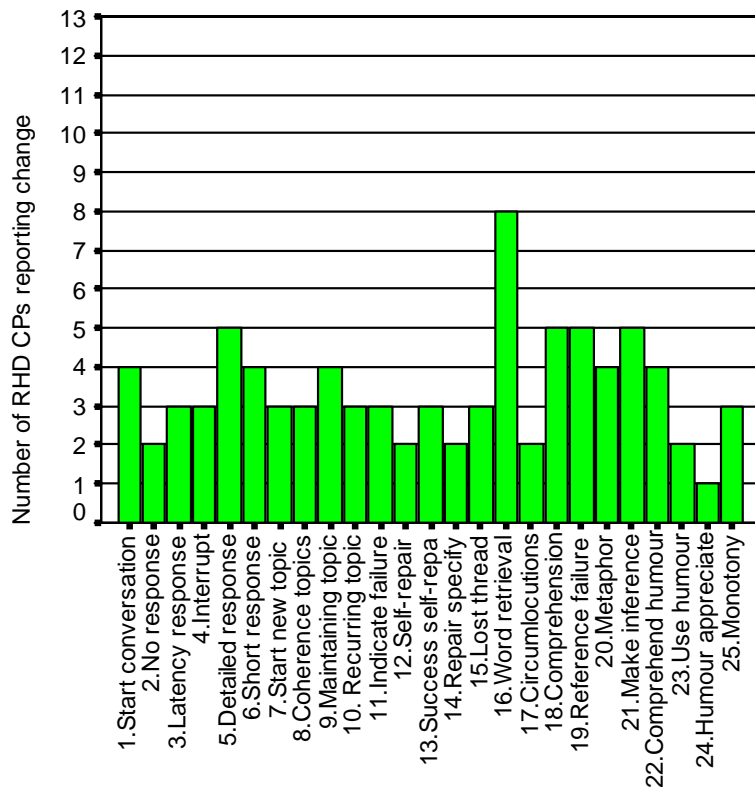


Instead they more often report an increased tendency to use circumlocutions associated with word retrieval problems (question 17). As many as 10 of the 13 participating conversational partners, report changed behaviours in the Initiation and Turn-taking areas (questions 2 and 6) and in the Repair area (questions 11 and 13). Six of the conversational partners of the LHD subjects also report that the LHD subjects have more comprehension failures (question 18) post-stroke.

A majority of the 9 participating conversational partners of the RHD group agree with the RHD subjects in reporting changes in frequency of word retrieval problems (question 16) and in behaviours in the Turn-taking area (question 5); see figure 3:3:4 below. As many as 8 of the 9 conversational partners perceived an increase in word retrieval problems in the conversational interaction of the RHD subjects. The issues in

the Repair area are, in agreement with the subjects themselves, among those reported by less than 50% of the conversational partners of the RHD group.

Figure 3:3:4: Frequency of reported change in the different behaviours inquired about in the questionnaire, as perceived by the conversational partners of the RHD individuals. N = 9.



The conversational partners of the RHD subjects do not recognise changes in Attention (question 15), in the production of circumlocutions (question 17) or in the Initiation area (questions 2 and 3) to the same extent as the RHD subjects themselves; see table 3:3:1. Instead, a majority of the conversational partners of the RHD subjects report changes in Comprehension, especially comprehension in general (question 18), and in the making of inferences (question 21). A majority of the conversational partners also report an increase in the tendency to use pronouns unclearly (question 19).

3.3.2 Degree of change in the different areas

In this section, the *degree of change* reported by the groups of brain-damaged individuals and their conversational partners is presented. The reported change might be an increase or a decrease in the frequency of a behaviour. This analysis does not reflect whether the change was perceived as having a negative impact on the conversational interaction. The results of the analysis of perceived negative impact will be presented in section 3.3.3 below.

As can be seen in table 3:3:2, where the group median and range of reported degree of change in each area is presented, several subjects do not report any change. The changes are often subtle and the median degree of change at a group level is often 0 (zero).

Table 3:3:2: Group median and range for reported degree of change in each area.

Area	Subjects		Conversational partners	
	LHD (n = 13)	RHD (n = 11)	LHD (n = 13)	RHD (n = 9)
Initiation	2 (0–6)	2 (0–9)	3 (0–5)	1 (0–6)
Turn-taking	3 (0–6)	1 (0–4)	3 (0–5)	1 (0–6)
Topic management	1 (0–6)	0 (0–8)	0 (0–8)	1 (0–12)
Repair	3 (0–8)	1 (0–9)	4 (0–9)	0 (0–6)
Attention	1 (0–3)	0 (0–4)	1 (0–2)	0 (0–4)
Word retrieval	1 (0–6)	1 (0–6)	3 (0–6)	1 (0–4)
Reference	0 (0–2)	0 (0–3)	0 (0–3)	1 (0–4)
Prosody	1 (0–4)	0 (0–3)	1 (0–2)	0 (0–2)
General comprehension	0 (0–2)	0 (0–3)	0 (0–2)	1 (0–3)
Complex language comprehension	1 (0–6)	1 (0–9)	1 (0–5)	2 (0–11)
Total degree of change	20 (1–35)	10 (1–55)	18 (1–37)	7 (2–52)

At a group level, the LHD subjects and their conversational partners tend to report higher degrees of change in the different areas than the RHD subjects and their conversational partners. Still, in the areas of general and complex Comprehension as well as Reference, the conversational partners of the RHD group tend to report higher

degrees of change. However, the variations within the groups are large. None of the differences were statistically significant: the p -values obtained varied between .156 and .695.

3.3.3 Degree of negative impact of changed behaviours

In this section, the occurrence and degree of negative impact of the changed behaviours reported by the subjects and their conversational partners will be presented. *Degree of negative impact* corresponds to the question about the frequency of negative impact for each issue in the questionnaire and is presented here as the median of reported frequencies at a group level. In these analyses, only reports from individuals who had reported change in each specific area are included.

3.3.3.1 Brain-damaged subjects' perception of negative impact

In both the RHD group and the LHD group, most of the individuals who had reported a change in one or several behaviours inquired about in the questionnaire also reported that they perceived a negative impact on their conversational interaction caused by these behaviours. The data on reported change and *degree of negative impact* for each issue in questionnaire are presented in Appendix 4.

A majority of the 13 LHD subjects reported negative impacts on the same behaviours they reported to have changed. That means that, among the LHD individuals, a majority report that issues in Initiation and Turn-taking (1, 2, 3, 6), Attention (15), Word retrieval (16), Repair (12, 13, 14) and Prosody (25) have a negative impact on their ability to interact in conversation.

Table 3:3:3 shows the reported degree of negative impact as well as the number of reports of change and negative impact. Only issues reported as changed by a majority of the individuals in the LHD group and/or the RHD group are displayed. Issues in the

Comprehension areas were not reported as changed by a majority in either group of brain-damaged individuals. Appendix 4 provides data on all issues in the questionnaire.

There are small differences in reports of change and reports of negative impact. Not all the individuals who reported an issue as changed reported any negative impact of this change. For example, in issue number 7 (initiating new topics) and number 11 (indicating comprehension problems), two individuals who reported the issue as changed did not report it as having a negative impact (see Appendix 4).

The issue with the highest degree of negative impact was latency for response (issue 3), which was reported as *often* having a negative impact on conversational interaction.

In the LHD group, most of the issues are reported as having a negative impact *occasionally* (corresponding to a group median of 2); see table 3:3:3.

Table 3:3:3: Number of subjects reporting *change* (within brackets) and negative impact, as well as group median and range (within parentheses) of rated *degree of negative impact*.

Area	Issue	Subjects	
		LHD (n = 13)	RHD (n = 11)
Initiation	1. Start conversation	[9] 8 <i>md: 2 (1-3)</i>	[5] 4 <i>md: 2 (0-3)</i>
	2. No response	[8] 7 <i>md: 2 (0-3)</i>	[6] 5 <i>md: 2.5 (0-4)</i>
	3. Latency response	[7] 7 <i>md: 3 (1-3)</i>	[6] 6 <i>md: 2 (1-4)</i>
Turn-taking	5. Detailed responses	[6] 6 <i>md: 2.5 (1-3)</i>	[7] 6 <i>md: 2 (0-3)</i>
	6. Short responses	[9] 7 <i>md: 2 (0-3)</i>	[5] 4 <i>md: 2 (0-3)</i>
Topic management	7. Start new topics	[8] 6 <i>md: 1 (0-3)</i>	[4] 4 <i>md: 2 (1-4)</i>
Repair	11. Indicate comprehension problems	[7] 5 <i>md: 2 (0-3)</i>	[3] 3 <i>md: 3 (2-4)</i>
	12. Initiate self-repair	[8] 8 <i>md: 1 (1-3)</i>	[3] 3 <i>md: 2 (2-3)</i>
	13. Successful self-repair	[7] 7 <i>md: 2 (2-2)</i>	[2] 1 <i>md: 0.5 (0-1)</i>
	14. Repair through specifying	[7] 7 <i>md: 2 (1-3)</i>	[4] 3 <i>md: 3 (0-4)</i>
Attention	15. Lost thread when speaking	[9] 8 <i>md: 2 (0-3)</i>	[6] 6 <i>md: 2 (1-4)</i>
Word retrieval	16. Word retrieval difficulties	[9] 8 <i>md: 1 (0-3)</i>	[6] 6 <i>md: 1.5 (1-4)</i>
Prosody	25. Monotonous intonation	[7] 7 <i>md: 2 (1-4)</i>	[4] 4 <i>md: 3 (2-4)</i>

Note: Figures in bold type denote that a majority of individuals in that group reported the issue.

As can be seen in Appendix 4 there are also issues that, although not reported as changed by a majority of the subjects, still were reported as having a high degree of negative impact by most of them who reported the issue as changed. For example, issue number 5, production of detailed responses, has a median of 2.5, indicating that the subjects who report it find that it has a very negative impact.

Issue number 12, about the initiation of self-repair, and issue number 16, about word retrieval, are both reported by a majority of individuals in the LHD group although the group median indicates that they *rarely* find that these issues have a negative impact on their conversational interactions (corresponding to a median of 1).

As table 3:3:3 shows, a majority of the RHD subjects agree with the LHD subjects that change in Attention and Word retrieval difficulties, as well as some issues in the Initiation and Turn-taking areas, have a negative impact on their conversational ability.

Most of the issues reported by a majority of RHD subjects are said to *occasionally* have a negative impact (corresponding to a group median of 2); see table 3.3.3 above. However, issue 16, about word retrieval difficulties, is only reported as rarely or occasionally having negative impact (corresponding to a group median of 1.5). Just as in the LHD group, some issues are not reported as having a negative impact by all the individuals who reported that they had changed.

There are also several issues that are only reported by a few of the subjects but that nevertheless have a high *degree of negative impact*. Issues that are reported as *often or very often* having a negative impact on conversational interaction include indication of comprehension problems (11), repair through specifying (14) and monotonous intonation (25), along with comprehension of metaphorical meaning (20) and general comprehension (18); see Appendix 4. This means that generally the RHD individuals who actually did perceive such changes also found that they had a high degree of negative impact on their conversational interaction. The production of circumlocutions (17) was reported as changed by five individuals in both the LHD and RHD groups. However, while only two individuals in the LHD group reported a negative impact of this change, with a median of 0, all five RHD individuals reported a negative impact of this change, with a median of 2.

The only statistically significant difference between groups on reports of *degree of negative impact* is from the change in successful self-repair, question 13 ($z = -2.806, p =$

.005), where the LHD group reported a higher *degree of negative impact*. Other *p*-values obtained varied between .061 and 1.000.

3.3.3.2 Conversational partners' perception of negative impact

In the RHD group all conversational partners who had reported changes in behaviours also reported that they perceived a negative impact of one or more of these changed behaviours on conversational interaction. In the LHD group, 12 of the 13 conversational partners who had reported changes claimed to perceive a negative impact by one or several of the changed behaviours.

A majority of the conversational partners of the LHD individuals reported that the behaviours they had reported as changed had a negative impact on conversational interactions. Table 3:3:4 displays the number of reports of change and negative impact as well as the reported degree of negative impact on issues reported by a majority of the conversational partners of the LHD and RHD groups.

Table 3:3:4: Number of partners reporting *change* (within brackets) and negative impact, as well as group median and range (within parentheses) of rated *degree of negative impact*.

Area	Issue	Conversational partners	
		LHD (n = 13)	RHD (n = 9)
Initiation	2. No response	[10] 10 <i>md: 2 (1–4)</i>	[2] 1 <i>0.5 (0–2)</i>
	3. Latency response	[8] 7 <i>md: 2 (0–4)</i>	[3] 3 <i>md: 1 (1–4)</i>
Turn-taking	4. Interrupt others' turn	[7] 5 <i>md: 1 (0–3)</i>	[3] 2 <i>md: 1 (0–3)</i>
	5. Detailed responses	[8] 8 <i>md: 2 (1–3)</i>	[5] 4 <i>md: 2 (0–2)</i>
	6. Short responses	[10] 10 <i>md: 2 (1–3)</i>	[4] 3 <i>md: 1 (0–2)</i>
Repair	11. Indicate comprehension problems – failure	[10] 10 <i>md: 2 (1–4)</i>	[3] 3 <i>md: 2 (1–2)</i>
	12. Initiate self-repair	[7] 7 <i>md: 2 (1–3)</i>	[2] 1 <i>md: 1 (0–2)</i>
	13. Successful self-repair	[10] 10 <i>md: 2 (2–3)</i>	[3] 3 <i>md: 1.5 (1–2)</i>
	14. Repair through specifying	[7] 7 <i>md: 2 (2–3)</i>	[2] 1 <i>md: 1.5 (0–3)</i>
Attention	15. Lost thread when speaking	[9] 8 <i>md: 2 (0–3)</i>	[3] 3 <i>md: 1 (1–4)</i>
Word retrieval	16. Word retrieval difficulties	[1] 11 <i>md: 2 (1–4)</i>	[8] 6 <i>md: 1 (0–2)</i>
	17. Production of circumlocutions	[9] 9 <i>md: 2 (1–3)</i>	[2] 1 <i>md: 1.5 (0–3)</i>
Reference	19. Reference failure	[6] 6 <i>md: 1.5 (1–3)</i>	[5] 4 <i>md: 2 (0–3)</i>
Prosody	25. Monotonous intonation	[8] 7 <i>md: 1 (0–2)</i>	[3] 3 <i>md: 1 (1–3)</i>
Comprehension, general	18. Comprehension in general	[6] 6 <i>md: 2 (1–4)</i>	[5] 4 <i>md: 2 (0–3)</i>
Complex language comprehension	21. Make inferences	[4] 4 <i>md: 1.5 (1–3)</i>	[5] 5 <i>md: 2 (1–4)</i>

Note: Figures in bold type denote that a majority of individuals in that group reported the issue as changed or as having a negative impact.

Most of the issues the conversational partners of the LHD group had reported as changed are also said to have a negative impact *occasionally* (corresponding to a median

of 2 on a group level). The area of prosody is perceived as rarely having a negative impact on conversational interaction (corresponding to a median of 1 at a group level).

The majority of conversational partners report a negative impact of change in Word retrieval (16 and 17), Initiation and Turn-taking (2, 3, 5 and 6), and Repair (11, 12, 13 and 14), as well as Attention (15) and Prosody (25).

The ratings of degree of negative impact for the different issues made by the LHD subjects and their conversational partners are similar. However, the conversational partners tend to be more concerned about the change in the production of circumlocutions associated with word retrieval difficulties than the LHD subjects themselves are. The only difference that is close to statistical significance is the lower ratings of the conversational partners on the degree of negative impact of the change in Prosody ($p = .015$). Other p -values obtained varied between .139 and 1.000.

A majority of the conversational partners of the RHD subjects report that the changes in making inferences (question 21) and word retrieval (question 16) have a negative impact on the RHD individual's interaction in conversation.

Some issues that were reported as changed by a majority of partners were only perceived as having a negative impact by four of the nine conversational partners of the RHD subjects (issues 5, 18 and 19). As can be seen in table 3:3:4 above, there were several other cases where one or another of the conversational partners did not report any negative impact from issues reported to have changed.

According to the reports of the RHD conversational partners as a group, word retrieval problems (issue 16) *rarely* (md: 1) had a negative impact while the problems making inferences (issue 21) *occasionally* (md: 2) had a negative impact on conversational interaction. As can be seen in Appendix 4, detailed responses (issue 5), reference failures (issue 19) and general comprehension (issue 18), as well as comprehension of humour (issue 22), were also rated as *occasionally* having a negative

impact; nevertheless, more respondents reported changes in these areas than negative impacts of those changes.

The differences in the ratings of *degree of negative impact* between the RHD individuals and their conversational partners were small and not statistically significant. The *p*-values obtained varied between .076 and 1.000.

When comparing the ratings of conversational partners of the RHD group to the ratings of the conversational partners of the LHD group, the latter tend to report a higher degree of negative impact on the subject's conversational ability. The difference was close to statistically significant for word retrieval (16) ($p = .011$). The other *p*-values obtained varied between .056 and .906.

3.3.4 Summary: Change and negative impact on interaction

The results of the questionnaire indicate that regardless of the lateralisation of brain damage, there are changes in pragmatic ability manifested in conversational interaction. The LHD group and their conversational partners tend to report more marked changes more often than the RHD group and their conversational partners. At a group level, the changes are often subtle but at an individual level they may have a significant negative impact on the ability to interact in conversation.

A response to the first research question for study 3 can be summarised as follows: several areas are reported by a majority of the participants in both the LHD group and the RHD group. Both groups report changes in Attention, Word retrieval, Initiation and Turn-taking. The changes in Word retrieval and Turn-taking are agreed on by the conversational partners of both groups of brain-damaged individuals. In addition, the LHD subjects and their conversational partners tend to report more change within the Repair and Prosody areas than the RHD subjects and their conversational partners.

There are also tendencies to differences in the reports of perceived change between the brain-damaged individuals and their conversational partners, especially between the

RHD subjects and their conversational partners. The most obvious differences were that the RHD individuals themselves more often report changes in several issues in the Initiation area, and a majority of them also report an increased tendency to lose the thread while speaking. The conversational partners of the RHD subjects, on the other hand, tend to report changes in general comprehension, and more specifically in more complex language comprehension, as well as increased reference failures.

The answer to the second research question is that although the differences are not statistically significant and the variations within the groups are large, the LHD subjects and their conversational partners tend to report changes in conversational interaction *more often*, and to a *higher degree* and they also tend to report *more issues* as having a negative impact than the RHD subjects and their conversational partners do. However, the RHD conversational partners tend to report a higher degree of change in the Comprehension areas.

The answers to the third and fourth research questions are that the areas reported as changed often also have a negative impact on conversational interaction. The only statistically significant difference in rating of degree of negative impact between the brain-damaged subjects related to one issue: the LHD subjects rated the degree of negative impact from the change in their ability to perform successful self-repairs higher than the RHD subjects. The RHD subjects did not even report much change in their ability to perform self-repairs successfully. On the other hand, a subgroup of RHD subjects did report a negative impact of change in the production of circumlocutions and the ability to repair by specifying. They reported that those changes *occasionally* or *often* had a negative impact on conversational interaction.

Even though most subjects who reported an issue as changed also reported that change as having a negative impact, there were exceptions. Some issues reported as *changed* by a majority of the participants were not perceived as having a *negative impact* by all of them. There are also issues not reported as having a negative impact by a majority of the participants that were still rated as having a *high degree* of negative

impact by those who experienced them. The subjects in the RHD group who did report a negative impact often tended to report *a higher degree* of negative impact than their own conversational partners and than the LHD subjects and their conversational partners. For example, although only reported by a few of the RHD subjects, the degree of negative impact of monotonous intonation in the Prosody area and of several issues in the Comprehension areas are rated high. That is, subjects who actually perceived an issue as changed often tended to perceive it as having a major negative impact on the conversational interaction.

3.4 Introduction and outline to study 4: Case studies

The results of group studies may give a picture of the effect of brain damage on different aspects of pragmatic ability. However, although group results may be more suitable for generalisation to a larger population, they can obscure individual results. Therefore, in this final study, the group results will be supplemented by four case studies that can demonstrate the consequences of pragmatic language impairment at the individual level. The cases involve two RHD individuals and two LHD individuals.

First, the research questions and methodology of study 4 will be presented. After that, the individual cases are introduced, and the quantitative and qualitative results of their participation in studies 1 to 3 are presented. This is followed by the results of the analysis of the video-recorded conversational interaction. These data will then be summarised and briefly discussed as examples related to the research hypotheses. Study 4 concludes with a summary and discussion of the individual features of each of the four cases.

3.4.1 Research questions in study 4

The research question in this study is: How does pragmatic language impairment manifest itself at an individual level in cognitive tasks and in informal conversational interaction?

From an ethnomethodological perspective, all perception of reality is the result of assumptions that are sometimes implicit and often culturally and personally rooted. The aim of these studies has been to use an empirical, data-driven point of departure for the analysis, at least in part. Nevertheless, it was considered important to make any manifestations of implicit assumptions explicit. Based on the bottom-up analyses of the video-recordings, but also on the literature on pragmatic language impairment in association with RHD and LHD (see section 1.2.6, in part I of the thesis), as well as the

results of the cognitive tasks and personal reports in the questionnaire, the following three hypotheses were formulated:

1. Although all participants had personally experienced a change in word retrieval issues, it was hypothesised that these problems would manifest themselves in different ways, in terms of OCM phenomena (see section 3.5.2.2 for a definition). *It was hypothesised that the two LHD subjects would express their word-finding difficulties in a more salient way than the two RHD subjects.*
2. Due to the different expressions of for example word retrieval issues, *the pattern of turn-taking was expected to be qualitatively different for the two RHD subjects vs. the two LHD subjects.*
3. Finally it was hypothesised that: *a) the conversational interaction with the two RHD subjects would be characterised by a need for other-initiated repair, and b) the interaction with the two LHD individuals would be characterised more by trouble performing self-repair.* This hypothesis is also based on the group results from the questionnaire, where subjects in the RHD group and their conversational partners said they experienced less change and less negative impact from patterns related to self-repair.

3.5 Method: Study 4

Each of the four individuals will be presented and the quantitative and qualitative results from the Discourse Comprehension task will be analysed in association with their performance on the VWM task and the SART. Some of the personal data have been slightly modified; for example, code names have been used to assure the participants of anonymity. The subjects' results on the questionnaire will also be described,

supplemented by an analysis of their video-recorded conversational interaction. The video-recorded samples are included in study 4 to allow a more data-driven approach, and to illustrate the results of the questionnaire used in study 3.

3.5.1 Selection of participants in the case studies

Four cases will be presented here; see table 3:5:1 for personal data. Two of the participants have RHD and two have LHD. The participants were selected from among the 28 RHD and LHD individuals participating in studies 1 to 3.

Two of the cases, one RHD and one LHD individual, were selected from among the three individuals in each group who had the lowest scores on the inference tasks in study 1. Thus, they are representative of individuals in their groups who had problems making inferences. Of the three RHD individuals who had the lowest scores on inference tasks in study 1, Nils was the only one who had the lowest scores both on tasks that required *inference of a character's attitude or motive* and on tasks requiring *revised inference*. All of the three LHD individuals with the lowest scores on inference tasks, had low scores for both types of tasks. Johan was selected because his recorded conversation included the topic of rehabilitation post-stroke, which was the dominant topic in the recorded conversation with Nils (RHD), and an effort was made to have any background factors in the conversational interaction as similar as possible for these two cases. Johan does, however, have more obvious phonological and semantic problems in conversation than most of the other participants in the LHD group.

The other two cases, Carl (RHD) and Thomas (LHD), were selected as they, and their conversational partners, were as representative as possible of typical responses to the questionnaire on the group level. That is, these two subjects had reported change in areas where a majority of participants in the groups had reported change.

Table 3:5:1: Personal data of cases.

	<i>Mean (S.D.)*</i>	<i>Range *</i>	Nils (RHD)	Johan (LHD)	Carl (RHD)	Thomas (LHD)
Sex			Male	Male	Male	Male
Age	62.6 (11.4)	39–80	67	54	74	67
Educational level	2.1 (.72)	1–3	2	2	1	1
Reading habits	2.8 (1.4)	0–4	3	1	0	4
Month post-onset	40.9 (37.6)	6–120	52	62	6	7
Site and type of lesion according to CT or MRI.			CT: In RH ^a infarction in Sylvian fissure towards basal ganglia and caudate nucleus.	MR: In LH ^b infarction temporal and frontal (centra semiovale down to corona radiata).	CT: In RH ^a infarction involving temporal, insula as well as frontal and central parts.	CT: In LH ^b infarction in putamen, reaching towards cortical parts of the frontal lobe

Note: * = The presented mean, standard deviation and range are for all 24 subjects from both RHD and LHD groups. RH^a = right hemisphere, LH^b = left hemisphere.

All four cases are men. Two of them are at least four years post-stroke. The remaining two cases had had their stroke fairly recently. Three of the cases have brain damage with frontal involvement and one of the cases from each group also has brain damage involving the basal ganglia (table 3:5:1). The results on the cognitive tests from studies 1 and 2 are presented in table 3:6:1.

3.5.2 Methodology in case studies

In this section, the analysis performed in study 4 will be described.

3.5.2.1 Individual cases

For the presentation of the individual cases, personal data and their results on the cognitive tasks in studies 1 and 2, and the responses of the brain-damaged individuals and their spouses on the questionnaire are compiled. Quantitative and qualitative results on the following cognitive tasks will be presented:

1. Spontaneous responses on the Discourse Comprehension task
2. The VWM task
3. The Sustained Attention to Response Test (SART)

3.5.2.2 Analysis of conversational interaction

At least 10-minute-long samples of conversational interaction between the brain-damaged individuals and the test leader were video-recorded. To make the conversations as natural as possible, the recordings were made in the homes of the brain-damaged individuals during a coffee break while the cognitive tests were being administered. It was considered important to let each conversation proceed as naturally as possible. No attempt was made to influence the choice of topics. However, it was also considered important to achieve a conversational interaction with mutual and equal participation. That is, the type of activity that was aimed for was more in the form of a first encounter between acquaintances than an interview. The participants were informed that the videos would be compared to the results from the questionnaires. The only instruction given

was that they were expected to act as they normally did in conversation with a new acquaintance.

The research leader's participation in the conversational interaction and in the analysis of the video-recorded samples calls for conscious control over personal preconceived notions in both the interaction and the analysis of the material. To control for a possible bias, an analysis of the reliability of the transcriptions and assessments of the content of the conversational interaction were performed. Ten percent of the samples of the video-recorded interaction from each dyad, randomly picked out, were also transcribed by an experienced transcriber. This independent observer was otherwise not involved in the project and was naive to the background of the subjects in the interaction. The comparison of the transcriptions showed only minor differences, primarily in the notation of the start and the end of overlapping speech and gestures. Differences in the interpretation of utterances were predominantly seen in the sample from one of the participants who tended to articulate unclearly in his rapid speech. The same independent observer also analysed the entire samples of analysed video-recorded conversational interactions to assess the occurrences of other-initiated repair concerning reference to a locative adverb. There was 100% agreement between observers that examples of other-initiated repair associated with the use of a place adverb were seen only in the discourse samples with the RHD subjects.

However, the disadvantage of the research leader participating in the conversational interaction as well as in the analysis might be considered to be counterbalanced by the advantages (Ottesjö, 2005). One of these advantages is the natural background to the encounter. The recording of the conversational interaction was not the primary reason for the meeting between the brain-damaged individual and the test leader. The background activity, the coffee break between tasks, actually provided a natural setting for an encounter between the brain-damaged person and a casual acquaintance. Another advantage in having the same person who took part in the conversation perform the analysis is the inherent knowledge and memory of the situation and the motivations of at

least one of the participants, which reduces the amount of interpretation and guessing needed in the analysis. Finally, although it might have been preferable to record natural conversations between each of the participating brain-damaged individuals and their spouses, another advantage of using the same person in all interactions is that at least the personality and interaction style of the conversational partner is kept as constant as possible. This facilitates the comparison of different samples of conversational interaction.

From the video-recorded conversational interaction, samples about ten minutes long were transcribed in standard orthography and analysed. The analysed sample with Thomas (LHD) and the test leader was 7.27 minutes long, as Thomas's wife took part in most of the interaction.

The preferred sizes of samples used conversational discourse analyses varies depending on the variable studied. In a study of variations in repair, speaking rate and utterance length by Boles and Bombard (1998), 5- to 10-minute samples have been found to be sufficient. According to Perkins et al. (1997), a sample about 10 minutes long should normally be adequate to look for evidence of behaviour reported in the CAPPIC interview, which is the model for the questionnaire used in study 3.

As the conversational interactions between the four dyads were also to be compared to each other, analyses were done to make sure that the context of the interaction was as similar as possible and that any background factors that might have an influence were considered. To map background factors that might influence the conversational interaction, *Activity Based Communication Analysis* (ACA) (Allwood, 1995; Ahlsén 1995) was used. In ACA, the goals, roles and other specific features of the individuals are compared with the conventional and possible modified goals and features of the activity they are involved in. This can highlight and explain both problems and possibilities in the communicative context. In this framework, background factors that influence or determine the conditions of the communication can be either *collective activity background factors* or *individual background factors*. The collective activity

background factors are composed of features of the interaction type and the actual physical context of the interaction. Individual background factors are the social, biological, physical and psychological features brought into the interaction by each participant. These background factors are believed to influence and determine *the interaction pattern* and the *individual means of expression* in the interaction, which are both considered as behavioural factors.

The analysed samples were transcribed according to the transcription standards for spoken language, *Modified Standard Orthography (MSO6) for Swedish language*, presented in the *Gothenburg Transcription Standard (GTS)*, developed by Nivre, Allwood, Grönqvist, Gunnarsson, Ahlsén, Vappula, Hagman, Larsson, Sofkova, and Ottersjö (2004) at the Department of Linguistics, Gothenburg University. In accordance with GTS, both vocal and communicative non-vocal contributions were transcribed. A contribution is defined as ‘a continuous stretch of communicative activity from one participant, bounded either by inactivity, or by communicative activity from another participant (Nivre et al., 2004, p. 4). This means that in the transcriptions contributions from two different participants may either overlap each other or succeed each other. In addition to speech, transcribed in modified standard orthography, contributions such as laughter, sighing and audible inhalations were transcribed, as were pauses and body communication such as gestures.

From the recordings of Nils (RHD) and Johan (LHD), ten minutes of conversation on the topic of their personal experience of rehabilitation was chosen for the analysis. Since this topic was dealt with in the first ten minutes of interaction in the recorded conversation, the first ten minutes of interaction were also chosen for analysis in the two remaining cases, Carl (RHD) and Thomas (LHD).

In an effort to analyse the samples in a way that would not jeopardise the possibility of discovering any interesting patterns in the interaction, the analysis at first proceeded in a bottom-up, data-driven manner. That is, the video-recordings were viewed several times and transcribed before any decisions were made as to which specific areas were to

be analysed in depth. In this way, any salient individual traits could be captured. The impressions from these analyses are presented for each case below. The results of the bottom-up analysis of the video-recordings indicated that it would be interesting to look at strategies used in association with word retrieval problems and repair, and more specifically, occurrences of other-initiated repair.

The research question for study 4 – ‘*how does pragmatic language impairment manifest itself at an individual level in cognitive tasks and in informal conversational interaction*’ – includes intent to describe the actual effect of pragmatic language impairment on conversational interaction. Hence, it was considered important to look into areas that commonly change in association with brain damage. The bottom-up procedure was therefore followed by a top-down procedure, where the group results on the questionnaire were used as a guiding principle for further analysis of specific areas; see table 3:5:2.

Table 3:5:2: Areas reported as *changed* in the conversational interaction by > 50% of the participating individuals within each group.

LHD subjects (n = 13)	RHD subjects (n = 11)	LHD conversational partners (n = 13)	RHD conversational partners (n = 9)
Attention	Attention	Attention	
Word retrieval	Word retrieval	Word retrieval	Word retrieval
Initiation	Initiation	Initiation	
Turn-taking	Turn-taking	Turn-taking	Turn-taking
Topic management			
Repair		Repair	
Prosody		Prosody	
			Reference
			Comprehension, general
			Complex language comprehension

The areas of *Word retrieval* and *Turn-taking* were reported to be changed by over 50% of the participants in each of the four groups of brain-damaged individuals and their

conversational partners. Therefore these areas were selected for analysis in the recorded samples.

Areas reported to be changed by the four subjects and their spouses are presented in table 3:5:3.

Table 3:5:3: Areas reported to be changed by the four subjects and their conversational partners.

Thomas LHD	CP – Thomas	Johan LHD	CP – Johan	Carl RHD	CP – Carl*	Nils RHD	CP –Nils
Attention	Attention	Attention				Attention	Attention
Word retrieval	Word retrieval	Word retrieval	Word retrieval	Word retrieval		Word retrieval	Word retrieval
Initiation	Initiation	Initiation	Initiation			Initiation	Initiation
Turn-taking	Turn-taking	Turn-taking	Turn-taking	Turn-taking		Turn-taking	Turn-taking
		Topic management	Topic management	Topic management		Topic management	Topic management
Repair	Repair	Repair	Repair (11 [†])			Repair	Repair
	General comprehension					General comprehension	General comprehension
Reference	Reference		Reference			Reference	Reference
Comprehension, complex language ^a		Comprehension, complex language ^a				Comprehension, complex language	Comprehension, complex language
Prosody			Prosody				

Note: ^a = Issue 21 (Inference failure) is the only issue reported in the more complex language area in the questionnaire.

[†] = Issue 11 (Indicating comprehension failure) is the only issue reported in the Repair area in the questionnaire.

* = Conversational partner not included in the presentation of group results on questionnaire in study 3 since she did not report any change in any of the behaviours inquired about in the questionnaire.

Among typical areas changed post-stroke in both groups of brain-damaged individuals, as indicated by the group results on the questionnaire and the impressions from the video-recordings of the four cases, the following areas of conversational interaction were analysed:

1. Word retrieval,
2. Turn-taking and
3. Repair.

In the analysis of these issues, the concept of *Own Communication Management* (OCM), developed by Allwood, Nivre, and Ahlsén (1990), and Allwood, Ahlsén, Nivre, and Larsson (2001), was used as a tool to conceptualise and describe the findings. Any speaker, whether brain-damaged or not, supervises the planning and implementation of his or her speech. The process from thought to speech is managed by different means; such features as pausing, hesitation sounds and repetition are symptoms of the planning, and sometimes the revision, of a speech plan.

Speech plan is defined as the planned explicit linguistic manifestation of any intended meaning; that is, the plan of how to convey the intended notion or implication to the conversational partner by verbal and non-verbal means. An inability to successfully implement or revise a speech plan may result in failure to produce the message and force the individual to abandon his or her aim of conveying an intended meaning.

Allwood et al. (1990, 2001) supplemented the theories of, for example Levelt (1983) and Schegloff (1979) regarding repair issues in oral discourse. Allwood et al. (1990) describe communication management phenomena as a set of highly regular operations for efficient and flexible speech management. They also find that there is a close structural and functional interaction between speech management and certain aspects of the management of conversational interaction. This is especially true for turn-

taking and feedback functions in interaction. Furthermore, these authors claim that, although it is sometimes appropriate to tie speech or communication management to repair and correction, as being related to *change* in the performance of speech, such a narrow characterisation cannot constitute the complex concept of communication management as a whole. Change-related phenomena help the speaker to change content that has already been produced. The process of change might be elicited by an internal feedback process, or by external sources, for example, in the form of other-initiated repair. However, aspects of communication management related to the planning, or *choice*, of expressions in speech are also relevant. Such *choice-related* functions occur before the start of the expression of the main message and are therefore not related to *change*. The function of choice-related phenomena might be to gain time for processing in the form of word retrieval, episodic memory search and other speech planning.

Allwood et al. (1990, 2001) account for an OCM system in units, divided into *Basic single features* and *Complex feature combinations*. The latter are combinations of basic features in the same occurrence. For the purpose of this study, only *Basic single features* will be classified and described, even though the combinations of several features commonly occur in natural discourse. Table 3:5:4 displays the Basic single features used.

Table 3:5:4: Basic single features of Own Communication Management (OCM) units in discourse

Basic single features						
Basic OCM expressions				Basic OCM operations		
Pause	Simple expressions e. g.: ‘eh’, ‘äh’, ‘m’, ‘like’, ‘or’	Explicit phrases e.g.: ‘What’s it called?’	Sounds e. g.: sigh, hiss, click, (Swedish: <i>smacka</i>)	Prolonged vowel	Self-interruption	Self-repetition

The single features are described as either *Basic OCM expressions* or *Basic OCM operations*. Basic OCM expressions are pauses; expressions such as ‘eh’, ‘m’, etc.; explicit phrases such as ‘What’s it called?’ and sounds such as sighs, hisses and clicking

sounds. Basic OCM operations are the lengthening of a vowel, self-interruption and self-repetition.

In this study the OCM findings are used as way of describing symptoms of disfluency and repair due to processing problems in discourse. However, those features in discourse may very well be considered as the *solutions* to problems in speaking. Clark (2002) discusses different forms of disfluencies as signals used by the speaker for coordinating with their addressees on certain of their speech actions. In this way a simple basic OCM expression like ‘uh’ might signal that the speaker wishes to keep the floor while searching for the correct verbal expression to be used.

3.6 Presentation of individuals in cases

In this section, the cases will first be presented in comparison with each other. The personal data and individual results on the cognitive tasks in studies 1 and 2 and a description of the responses to the questionnaire in study 3 will follow for each case individually.

As can be seen in table 3:6:1, Nils (RHD) and Johan (LHD) present several similarities with respect to their test results. They both make more errors than the average brain-damaged individual on the VWM task and also on the SART. Their low scores on the Discourse Comprehension tasks are in fact the very reason they were selected as representatives for their groups. Their *Mean reaction time in the sustained attention task* is about the same, although they diverge from each other on *Number of correct responses* in this task.

Table 3:6:1: Individual performance and mean, standard deviation and range of group results on cognitive tasks.

	VWM errors (max. 42)	Sustained attention: Correct responses (max. 200)	Sustained attention: Errors (max. 25)	Mean reaction time in SART	Revised inference (max. 8)	Inference of attitude/ motive (max. 10)	Explicit inform. (max. 11)	Number of responses modified (max. 33)
<i>Mean (S.D.) and range of Control group</i>	<i>m: 8.2 (4.5) Range: 0–17</i>	<i>m: 182.7 (16.9) Range: 129–199</i>	<i>m: 11.4 (4.1) Range: 6–18</i>	<i>m: 350 (64.6) Range: 256–473</i>	<i>m: 6.9 (1.0) Range: 5–8</i>	<i>m: 9.0 (1.3) Range: 6–10</i>	<i>10.2 (1.0) Range: 8–11</i>	<i>m: 2.1 (2.4) Range: 0–6</i>
<i>Mean (S.D.) and range of RHD and LHD groups*</i>	<i>m: 13.6 (5.8) Range: 5–24</i>	<i>m: 185.6 (14.5) Range: 143–200</i>	<i>m: 9.5 (5.1) Range: 0–20</i>	<i>m: 449 (101.5) Range: 282–657</i>	<i>m: 4.7 (1.7) Range: 1–7</i>	<i>m: 7.7 (1.7) Range: 3–10</i>	<i>9.2 (2.3) Range: 2–11</i>	<i>m: 4.3 (5.5) Range: 0–23</i>
Nils (RHD)	21	163	12	466	3	5	11	4
Johan (LHD)	22	189	11	459	2 (4) ^a	4 (8) ^a	2 (11) ^a	23
Carl (RHD)	16	143	6	598	1	7	9	2
Thomas (LHD)	16	158	6	490	6	10	10	0

Note: * = The presented mean, standard deviation and range on tasks are for all 24 subjects from both groups of brain-damaged individuals.

^a = Results on modified responses on Discourse Comprehension included within parentheses for Johan as he almost always suspended his inferences until after reading the narratives.

Carl (RHD) and Thomas (LHD) make the same number of errors on the VWM; this result is slightly higher than the mean result for the brain-damaged individuals. They also produced the same number of errors on the SART. In this case, their performance was slightly better than the mean performance of the brain-damaged individuals. Their results for explicit tasks and tasks requiring *inference of a character's attitude or motive* are at about the same level; however, they do deviate from each other when it comes to results on tasks requiring *revised inference*. The score for Carl (RHD) is the lowest score of all the participants in the study. The score for Thomas (LHD) on these tasks is above the mean score for the brain-damaged individuals and actually level with the mean score for the Control group. Both Thomas (LHD) and Carl (RHD) have slower reaction times and produce fewer correct responses in the SART than the average brain-damaged individual in the study, but Thomas (LHD) performs somewhat better than Carl (RHD) on these measures.

3.6.1 Nils (RHD): Personal data and results

Nils is a 67-year-old man. His personal data are displayed in table 3:5:1 above.

Nils has completed his compulsory school education followed by two years of theoretical studies in secondary grammar school. In his professional life, he mostly worked as a foreman and in administration in big industrial companies. Next to playing musical instruments, sometimes in public, and listening to music, reading is one of his greatest interests and he still reads about 13 books a year, including both fiction and non-fiction. Nils has been an active member of various social associations and takes great interest in politics.

About four and a half years pre-test he had a stroke with an infarction in the right hemisphere and left hemiplegia including facial paresis. He may have had neglect or hemianopia in the initial phase. The CT scan indicated brain damage involving the Sylvian fissure and reaching towards the basal ganglia and caudate nuclei. After

several weeks in post-stroke rehabilitation, he was able to return to his apartment where he lived with his wife.

At the time of his participation in the study Nils was still weak in his left hand and he used a walker to walk. His speech was still influenced by a mild dysarthria with somewhat imprecise articulation of consonant clusters; his voice quality was also affected. There were also noticeable remains of dysphagia. Apart from the problems in conversational interaction reported below, he himself reported post-injury memory failures, resulting in problems remembering people's names. He also experienced difficulty in recognising and naming previously well-known musical pieces.

Nils' wife perceived that Nils, who always had been, as she described him, 'a hot-tempered and argumentative man', had become more 'nice and calm' after the stroke. Nils agreed with this. He felt that since the stroke he did not have the strength to live the active life he was used to. Nils also found his impaired mobility and dependence on his family disturbing, and worried about the impact on the health of his significant others.

3.6.1.1 Qualitative data from inference tasks – Nils

Although Nils handled all questions that depended on explicit information in the narratives without any hesitation, his scores for both kinds of questions about implicit information were among the three lowest results in the RHD group; see table 3:6:1. He scored 3 out of 8 on tasks requiring *revised inference*. The mean score for all brain-damaged subjects in both groups was 4.7 (S.D.: 1.7). On tasks requiring *inference of a character's attitude or motive*, he scored 5/10 (mean for all brain-damaged subjects: 7.7, S.D.: 1.7). On the few occasions when he took the opportunity to read the narratives and modify his responses, he managed to improve his results to a mediocre level but only on questions depending on *revised inference*. His score is still among the three lowest in the RHD group for tasks depending on *inference of a character's attitude or motive*. All the inadequate responses produced by Nils are

inadequate due to erroneous inference. That is, instead of postponing responses until after reading the text, he produced incorrect responses.

During the test session, Nils seemed to be focusing on the task and listening to the narratives. Still, his low scores, in association with his way of responding, indicate that he might not be fully aware of his own difficulties in performing in the task. He gave 22 out of the possible 33 responses without any hesitation, that is, he initiated a response within approximately one second of the end of the question. Furthermore, he only took the opportunity to reread a narrative five times and he modified his responses to just four questions in all.

Nils commented during the task that during the period immediately following the stroke he often had to reread sections of books or newspapers as he found that he lost track of what he was reading. He now felt that he no longer had to do that.

The inadequate responses he produced to questions depending on *inference of a character's attitude and motive* might indicate that he does not consider the emotional or attitudinal aspects of the narratives. The response '*She was in a hurry*' to question (1b) about why Asta had run off in narrative 1 is quite possible if one passes over the emotionally charged content of the situation described:

1.

The broken vase

With shaky hands Johan picked up the pieces of the vase she had thrown. There was broken glass all over the hall. He listened for any sound from the stairwell. Half an hour had passed since Asta had run off. He hadn't had any chance to explain. 'If she doesn't come back tonight... or maybe tomorrow, if she doesn't come back tomorrow, I'll phone mother-in-law', Johan thought to himself.

The thrown vase might indicate anger. The narrative also implies that something had happened that needed an explanation. Johan's thoughts of calling his mother-in-law may activate knowledge of common, or cliché, scenarios of couples who have had an argument. None of this is reflected in Nils' response.

The response '*She had overslept*' to question (3a) about why the character in narrative 3 still had not got up also indicates that any emotional aspects implied by the content of the narrative are overlooked. This response might also be a hangover

from narrative 2, where it is the correct response to question 2a, (all the narratives and questions are presented in Appendix 1).

3.

A sunny day

The sun stood already high above the rooftops when the cat, with its enthusiastic purring, once again tried to make her get up and refill its bowl. The blanket she had nailed up in front of the window three days ago didn't succeed in shutting out the stinging rays of sunshine. 'Lovely, a new wonderful day', she said with a sigh and pulled the cover over her head. The letter she had received was still lying torn up on the kitchen table.

This narrative involves irony in the character's comment on the weather: '*Lovely, a wonderful new day*'. This comment conflicts with the description of her behaviour in the narrative: "*“Lovely, a new wonderful day,” she said with a sigh and pulled the cover over her head*". Her words also have to be interpreted in the context of her trying to block out the sunlight with a blanket, indicating that she does not appreciate the sunny weather. The torn-up letter in the kitchen also implies a negative attitude. Nils does not grasp the irony, since he incorrectly responds 'Yes' to the question about whether the character in the narrative appreciates the beautiful weather (question 3b). His responses to these questions indicate that he has not managed to integrate the information in the narrative into a coherent whole, and this results in an inadequate inference about the character's state of mind. Still, it is not possible, in light of Kintsch's (1998) construction-integration model, to come to any conclusions about whether he fails to apprehend relevant information about the character's state of mind in the construction phase of the comprehension or if the activation is not strong enough to trigger a successful integration process that would guide him to the relevant inference.

It is always *possible* that the character in this story really is feeling fine and enjoying the weather and that she has simply overslept. But in light of Grice's maxims (1975, 1978) and Relevance theory (Sperber and Wilson, 1995), the mention of the rather drastic measure of nailing up a blanket in front of the window and the letter being torn up means something important and relevant for the situation described.

The next inadequate response to a question that depends on *inference of a character's attitude or motive* might also be the result of a misinterpretation of a lie or ironic comment by the main character, in narrative number 9.

9.

The cat

The cat stood up on its hind legs and pawed his newly ironed trousers. In the kitchen the cat's owner was clattering about with china and water for the coffee. 'There, there', Anders muttered and tried to free himself. Now the cat was persistently rubbing hundreds of soft hairs against his legs. Anders clenched his jaw as he pushed the cat's wriggling body away from the expensive trousers. 'That's a really nice cat you have!' he called out to the kitchen.

In this narrative, as in narrative number 3, the main character's comment about his attitude is in conflict with the content of the rest of the story. Nevertheless, Nils responded to question number 9a that he believed that Anders appreciated the cat. In this case, Nils grasped the irony when he took the opportunity to read the narrative and then corrected his response. The second inadequate response Nils gave to narrative number 9 is difficult to understand. On the question of what the character named Anders wanted the owner of the cat to believe (question 9c), Nils responds, *'that he was going to fetch the cat'*. In the narrative, the main character, Anders, wants the female owner of the cat to believe that he is content with the behaviour of her cat. He wants to make a certain impression, perhaps hoping for a favourable development in their relationship. To make the correct inference, you need not only to have a theory about one character's mental state. The comment by the character is motivated by a wish for, or an idea about, the mental state of another character. This is a tricky question, demanding a complex kind of inference, that requires the recursive attribution of mental states. Nevertheless, it was mostly RHD individuals who gave inadequate responses to that particular question. Only one individual from the Control group and one from the LHD group produced inadequate responses to this question.

This is one of the few narratives that Nils decided to read and also one of the four questions that he responded to with latency. Latency in this context means that it takes more than approximately two seconds from the end of the question until a

response is initiated. After reading the text, Nils correctly interpreted the situation described and inferred that Anders did not appreciate the cat: *'He didn't like it to cling tightly to him. He got hair on his trousers.'* Nevertheless, he did not seem to be able to use the inference of the main character's attitude towards the cat to make an adequate inference of the character's motive in *lying* about his attitude. Actually, Nils' response doesn't involve any inference of a motive or an attitude. It involves an action, *'to fetch the cat'*, which of course might have some relevance in the situation, except that Nils does not account for it in his response.

The remaining five inadequate responses are on tasks requiring revised inference. In one case, Nils omits any response. In the remaining four cases, he makes the wrong assumption about the meaning of the ambiguous words, for example, in narrative number 12:

12. The book/beechn (Swedish: *Boken*)
He had given her a book/beechn (Swedish: bok) on their first wedding anniversary. She had been so pleased and had kissed him. After that, she often sat in the garden, looking at it. It had turned into a symbol of their marriage, he thought. That was many years ago. She was dead now but the book/beechn (Swedish: boken) was still there. He reached out and touched it. It was so large now that it shadowed the entire lawn.

Nils makes the wrong interpretation of the Swedish word *bok* ('book'/'beechn') as meaning that the man had given his wife a book which she had kept all these years. In this case, Nils persisted in his initial interpretation even though he took the opportunity to read the text. On the question of whether it was a large *book/beechn* that she had been given long ago, he comments: *'Yes, it has to have been a large book as it shadowed the entire lawn.'*

Thus, Nils is using the information given in the text in his response but he sometimes seems to exclude emotional and attitudinal aspects of the semantics of the narratives or fails to integrate information in the narratives with knowledge of the world and objects in it.

3.6.1.2 Results on VWM task – Nils

In the task for estimated VWM, Nils produces 21 word recall errors; he also produces one of the four true/false errors produced by the RHD group. His results are among the three lowest in the RHD group (mean word recall error: 13.1, standard deviation: 6.6); see table 3:6:2.

Table 3:6:2: Group results on VWM task

	Mean VWM errors	S.D.	Median	Range
Control (n = 14)	8.2	4.5	7.5	0–17
RHD (n = 14)	13.1	6.63	13	5–24
LHD (n = 14)	14.1 ^c	5.1	12	9–23

Note: ^c = Result differs significantly from Control group result at .01 level.

Nils commented about this task that he used to have a good memory before he had his stroke. He gave no report on the strategy he used to remember the words. During the task, he sometimes commented on the content before starting to recall the words, but when this happened it did not interfere with his ability to recall the words. Three of the word recall errors are in the form of semantically related paraphasias such as ‘tigers’ instead of ‘lions’ or ‘talk’ instead of ‘speak’. Three others are in the form of perseveration of words from an earlier set in the task. In the remaining 15 errors, no word was recalled. In conclusion, Nils does not have a high-capacity VWM, as assessed by this adapted version of Daneman and Carpenter’s (1980) reading span test.

3.6.1.3 Results on the SART – Nils

Of all the RHD individuals, Nils has the third lowest *Number of correct responses*, the fifth highest *Number of erroneous responses*, the third slowest *Mean reaction*

time in test, the second highest *Variations of reaction times* (variance) and the highest *Feedback time* on the SART; see table 3:6:3.

Table 3:6:3: Individual results on the different SART measures. Mean scores and standard deviations for results on the measures in the Control group are presented within parentheses.

	Number of correct responses Max. 200	Number of erroneous responses Max. 25	Mean reaction time in test in ms	Variance in reaction times in test	Feedback time in test*
Nils	163	12	466.3	18748	-223.5
Johan	189	11	459.3	41449	-154.2
Carl	143	6	598	16785	-6.1
Thomas	158	6	490	32549	-
Control group mean (range)	182.7 (129–199)	11.4 (6–18)	349.8 (255.5–472.6)	7738 (1048–24668)	-8.5 (-157.26–62.05)
RHD group mean (range)	183.9 (143–200)	9 (2–18)	470.2 (302.4–657.4)	10764 (2011–18449)	-49.84 (-49.8–29.5)
LHD group mean (range)	187.4 (158–200)	10 (0–20)	426.95 (281.8–593.2)	16078 (1551–41449)	-55.39 (-157–35)

Note: * It was only possible to obtain *Feedback time* from 12 individuals in each group.

According to the measure used in this study, Nils' ability to sustain attention is low. He might also have reduced general arousal, as indicated by the slow reaction time and the wide variability in reaction times during the task. However, the high *Feedback time* indicates that he is able to monitor his behaviour in the task and slows down the pace when he goes too fast and makes erroneous responses in the SART.

3.6.1.4 Responses to questionnaire – Nils

According to Nils' own responses to the questionnaire and those of his spouse, it is clear that both of them are aware of a persistent change in his communicative behaviour more than four years after the stroke.

The total degree of change in the ability to interact in conversation after the stroke, as reported by Nils, is 55. This should be compared to the RHD group's mean

for total degree of change, which is 13.4 (S.D.: 14.8); see table 3:6:4. (The total is the sum of the degrees of change reported by each group on the 25 issues in the questionnaire.)

The total degree of negative impact of this change, as assessed by Nils is also 55, indicating that he perceives most of the changes as having very negative impact on his ability to interact in conversation. The RHD group's mean total degree of negative impact is 16.9 (S.D.: 15.8).

Table 3:6:4: Group data for total degree of change and negative impact on conversational ability as reported by the individuals themselves and by their conversational partners.

	LHD (n = 13)	RHD (n = 11)
Total degree of change		
Mean	17.8	13.4
S.D.	10.6	14.8
Median	20	10
Range	1–35	1–55
Total degree of negative impact		
Mean	21.2	16.9
S.D.	15.9	15.8
Median	26	13
Range	1–55	2–57
	CP LHD (n = 13)	CP RHD (n = 9)
Total degree of change		
Mean	17.6	17.0
S.D.	10.8	18.1
Median	18	7
Range	1–37	2–52
Total degree of negative impact		
Mean	25.9	14.8
S.D.	18.2	17.0
Median	22	10
Range	1–71	1–54

Nils' spouse reports a total degree of change of 52. The total degree of negative impact on Nils' ability to interact in conversation as perceived by his wife is 54. Both production and comprehension in conversations seem to be affected.

As can be seen in table 3:6:5, Nils and his wife report change and negative impact on conversational interaction related to several of the issues in the questionnaire. (The wording of the questions can be found in Appendix 3.) More

frequent occurrences post-stroke of the behaviour mentioned in the question are denoted with a plus sign (+). Less frequent occurrences post-stroke are denoted with a minus sign (-).

Even though the exact ratings may vary, the couple often, but not always, agree on which issues have changed and have a negative impact on conversational interaction post-stroke.

Table 3:6:5 Degree of change and negative impact of change for issues in questionnaire, as reported by Nils and his spouse (CP).

Issue in questionnaire	Change/ Nils	Change/ CP	Neg. impact/ Nils	Neg. impact/CP	Issue in questionnaire	Change/ Nils	Change/ CP	Neg. impact/ Nils	Neg. impact/ CP
1. Start conversation	-1	0	0	-	15. Lost thread when speaking	+4	+4	4	4
2. No response	+4	+2	4	2	16. Word retrieval difficulties	+4	+3	4	2
3. Latency response	+4	+4	4	4	17. Production of circumlocutions	-2	+1	3	3
4. Interrupt others' turn	0	0	-	-	19. Reference failure	+3	+2	3	3
5. Detailed responses	+4	-2	0	2	25. Monotonous intonation	0	0	-	-
6. Short responses	0	+2	-	2	18. Comprehension in general - failure	+3	+3	4	3
7. Start new topics	+4	+4	4	4	20. Metaphorical meaning - failure	+4	+4	4	4
8. Coherence of new topics - failure	+4	+4	4	4	21. Make inferences	-3	-4	4	4
9. Maintain topics	0	+4	-	4	22. Comprehension of humour	-2	-3	4	3
10. Recurring topics	0	0	-	-	23. Use humour	0	0	-	-
11. Indicate comprehension problems	+4	-2	4	2	24. Humour appreciated by others	0	0	-	-
12. Initiate self-repair	+1	0	3	-	TOTAL:	55	52	57	54
13. Successful self-repair	0	-2	-	1					
14. Repair through specifying	-4	-3	4	3					

Issues with high ratings from both Nils and his spouse include tendency to lose the thread while speaking (15), word retrieval problems (16), problems initiating a response (2 and 3), tendency to initiate new topics (7), ability to introduce new topics that are coherent with previous topics (8), ability to repair through specifying (other-initiated repair, 14), reference failure (19) and both general (18) and more complex comprehension (20 to 22).

Issues they disagree on are the increased tendency to produce short responses (5) and to maintain the same topics (9) as well as the decrease in the ability to perform self-repair successfully (13), reported by Nils' spouse. Nils himself instead reports an increase in the production of self-initiated self-repair (12). Nils feels that this change, or perhaps rather the need for that change, has a real negative impact on his conversational interaction.

3.6.1.5 Impressions from video-recorded conversation

The most salient impression from the video-recorded conversational interaction with Nils is, in addition to occasional word retrieval difficulties and some slips of attention, the high frequency of other-initiated other-repair. Nils often seems to make his contributions somehow unspecific. This results in a need for repair through requests for clarification from the conversational partner. Word retrieval difficulties are sometimes handled by circumlocutions but these are often not successful. There are also several occasions of interruptions and overlap on the conversational partner's turn, but, according to Nils and his wife, this was just as frequent before the stroke.

3.6.2 Johan (LHD): Personal data and results

Johan is a 54-year-old man. He had completed his compulsory education and three years of further medical education. (Table 3:5:1 above compiles personal data on the cases.) At the time of his stroke, he was working as a care and social service professional. He is interested in the theatre, had acted himself and had been on tour with an independent theatre group for a few years.

He used to read 1 to 3 books a year before his stroke. Since then, he reads about one book a year, but he still reads the newspaper every day.

He had a left-sided infarction involving frontal and temporal as well as subcortical structures about five years before participating in the study. At the acute stage of his disability, he was diagnosed with global aphasia and oral apraxia. He recovered after several months in rehabilitation and returned to living with his family. At the time of his participation in the study, he was taking part in an outpatient rehabilitation program. His right hand was still weak and he said that he still sometimes had subtle word retrieval difficulties and he felt that his speech was inhibited.

3.6.2.1 Qualitative data from inference tasks – Johan

Johan had problems giving adequate spontaneous responses in the inference task. This is true for questions about explicitly stated information in the narratives as well as on tasks requiring *revised inference* and *inference of a character's attitude or motive*. His scores on all three types of tasks are the lowest for all participating subjects in studies 1 and 2. On tasks that depend on explicitly stated information, he produced 2 adequate responses out of a possible 11. The mean score for all the brain-damaged individuals is 9.2 (S.D.: 2.3), while it is 10.2 (S.D.: 1.0) for the control subjects; see table 3:6:1 above. Johan improved his scores markedly when he had read the texts. In his modified responses related to explicitly stated information, he

scored 11/11. In tasks requiring *revised inference*, he scored 2 out of 8 in his spontaneous responses and on tasks requiring *inference of a character's attitude or motive*, 4 of 10, which also are among the lowest scores for these tasks. When given the opportunity to modify his responses after reading the narratives, he improved his score on tasks requiring *inference of a character's attitude or motive* to 8 of 10, but on tasks requiring *revised inference*, his score on modified responses was still quite low (4/8).

Johan actually takes the opportunity to simply listen to the questions before he reads the narratives as a strategy. His inadequate responses were a result of his suspending his responses until after he had read the narratives; consequently, his spontaneous responses were often limited to 'I don't remember'. He chose to read 9 of the 11 narratives and modified 23 out of 33 responses, which is the highest frequency of modified responses for all the participating subjects. He produced 9 out of 33 spontaneous responses (often in form of 'I don't remember') with latency. Two responses were produced without hesitation, both of them adequate and in answer to questions about narrative number 12, which is the last one. Johan reports that he feels that his performance improves with time. This is also reflected in his results, at least on the score for modified responses as he almost always prefers to read the narratives before trying to answer the questions.

3.6.2.2 Results on VWM task – Johan

Johan's tendency to suspend his responses until he had read the narratives might be a strategy associated with memory failure. It is not possible to infer whether this is due to a failure of encoding or retrieval. According to his medical chart, a neuropsychological assessment performed shortly before Johan's participation in the study concluded that he was weak in verbal encoding. His result on the VWM test, 22 errors on 42 tasks, is also among the lowest scores for all the participants; see table 3:6:2 above. The mean error score among the brain-damaged subjects is 13.6 (S.D.: 5.8). Among the LHD subjects, one other subject used the same strategy, that is, suspending responses until after reading the narratives in the inference. She also has

almost the same high error score as Johan on the VWM. A low VWM capacity might, of course, interfere with both comprehension and encoding of more complex stimuli.

Most of Johan's errors on the VWM task were due to no word being recalled. One was an antonym (i.e. the opposite of the correct word, for example 'hot' instead of 'cold') and one was a word from another statement, but not the word that was meant to be memorised.

Johan is well aware of his memory failures and even before starting he stated that he did not have high hopes of being able to perform well on this particular task. Afterwards, he reported sometimes using a visualisation strategy and sometimes trying to memorise the word through silent rehearsal. The latter strategy, he reported, did not help him very much as he felt that the questions interfered with this strategy. He himself does not feel that he has any trouble responding to the interfering true/false questions, although in fact he actually was one of only four subjects who made any true/false errors on the task.

3.6.2.3 Results on the SART – Johan

Johan produced 189 *Correct responses* and 11 *Erroneous responses* in the SART. This is equivalent to the results for the Control group, see table 3:6:3, above. He had a *Feedback time* of -154, the third lowest, meaning that after making erroneous responses in the SART, he was able to slow down in order to avoid further mistakes. The variance of reaction times in test is 41449, which is well above the results for the other participating subjects. This can be interpreted as indicating a fluctuating level of arousal. Johan's *Mean reaction time in test* is 459 ms, which is quite slow but not among the 5 slowest brain-damaged participants in the study. One reason for the slow *Mean reaction time in test* might be that Johan used his left hand to press the response button in the task. However, it was five years since Johan had had his stroke, and he had become quite skilled in the use of his left hand to compensate for his spastic right hand.

3.6.2.4 Responses to questionnaire – Johan

According to the questionnaires responded to by Johan and his spouse, they had both experienced change and negative impact, especially in the production of language; see table 3:6:6 below.

Table 3:6:6: Degree of change and negative impact of change for issues in questionnaire as reported by Johan and his spouse (CP).

Issue in questionnaire	Change/ Johan	Change /CP	Neg. impact/ Johan	Neg. impact/CP	Issue in questionnaire	Change/ Johan	Change/ CP	Neg. impact/ Johan	Neg. impact/CP
1. Start conversation	-1	-1	1	2	15. Lost thread when speaking	+2	0	1	-
2. No response	+1	0	0	-	16. Word retrieval difficulties	+2	+2	1	2
3. Latency response	0	0	-	-	17. Production of circumlocutions	+2	0	0	-
4. Interrupt others' turn	0	0	-	-	19. Reference failure	0	+1	-	1
5. Detailed responses	0	-2	-	2	25. Monotonous intonation	0	+1	-	1
6. Short responses	+2	+2	0	2	18. Comprehension in general – failure	0	0	-	-
7. Start new topics	-2	-2	1	2	20. Metaphorical meaning – failure	0	0	-	-
8. Coherence of new topics – failure	0	+2	-	2	21. Make inferences	-1	0	0	-
9. Maintain topics	-1	-2	0	2	22. Comprehension of humour	0	0	-	-
10. Recurring topics	-1	-2	0	2	23. Use humour	0	0	-	-
11. Indicate comprehension problems	+1	+1	0	1	24. Humour appreciated by others	0	0	-	-
12. Initiate self-repair	-1	0	1	-	TOTAL:	17	18	5	19
13. Successful self-repair	0	0	-	-					
14. Repair through specifying	0	0	-	-					

Note: More frequent occurrences of the behaviour mentioned in the question are denoted with a plus sign (+). Less frequent occurrences are denoted with a minus sign (-).

However, Johan does not seem to feel that these changes have had a negative impact on his conversational ability. The total degree of change reported by Johan is 17 (LHD group mean: 17.8, S.D.: 10.6). The total degree of negative impact he reported is only 5 (LHD group mean: 21.2, S.D.: 15.9). Johan has a more positive view of the impact of the post-stroke change than his spouse. She reports a total degree of change of 18 and a total degree of negative impact of 19, which is more in line with the mean result for the LHD group; see table 3:6:4 above, where group data from the questionnaire are presented.

In fact, Johan and his wife disagree about several issues in the questionnaire. For example, Johan reports a change in attention (15) and ability to produce circumlocutions (17). His wife, on the other hand, reports a change in the production of detailed responses (5) and reduced ability to make new topics coherent (8), which are issues Johan did not report. Johan's wife's report of increased problems in making a new topic coherent might be associated with her experience of Johan as having a slight increase in reference failures (19).

However, they do agree on the increased word retrieval difficulties (15), and production of short responses (5) and the decreased tendency to initiate new topics (7), although Johan's spouse consistently rates the negative impact from these changes higher.

3.6.2.5 Impressions from video-recorded conversation – Johan

In the first part of the video-recorded conversation with Johan, there are several instances of word retrieval difficulties. There are also occurrences of phonological and semantic paraphasias. There are several instances of a change of speech plan, which affects the syntax. This might be a result of word-finding difficulties. At the beginning of the conversation, Johan seemed reluctant to keep his turn, producing short responses, and he seldom embellished a topic, although he did sometimes introduce a new one. The topic of his disability and speaking about his rehabilitation seemed to be more motivating, resulting in longer contributions, although they were

still affected by paraphasias and self-initiated repair. Towards the end of the analysed sample, the speech becomes more fluent and the rate of speech also seems to increase.

3.6.3 Carl (RHD): Personal data and results

Carl is a 74-year-old man. At the time of his stroke, he was still active as a professional driver. He had completed compulsory school and had also attended some courses in, for example, sales. (Table 3:5:1 above displays personal data on the cases.) He is interested in bee-keeping and gardening, and he used to take a great interest in motor sports. He reads newspapers every day and specialist magazines, but almost no fiction at all.

Carl described himself as always being a hard worker and he has several children and grandchildren.

Six months before participating in the study, he had a large right-sided infarction in the medial cerebral artery. The CT showed that the infarction involved the insula temporally and also reached into the frontal and central parts of the brain. His motor abilities were never affected but the medical charts describe reduced sensitivity in his left hand and anosognosia in the acute stages of his disease.

After a short period (10 days) of rehabilitation at the hospital, he returned home to live with his wife. At the time of his participation in the study, he stated that he felt almost fully recovered and was only aware of small changes in his language ability. His rate of speech was fast and occasionally characterised by imprecise articulation although mostly comprehensible.

3.6.3.1 Qualitative data from inference tasks – Carl

In the comprehension task, Carl produced 7 adequate responses out of 10 on tasks requiring *inference of a character's attitude or motive*. On tasks requiring *revised inference*, he only produced 1 adequate response out of the possible 8. The mean score for this type of task among the brain-damaged individuals is 4.7 (S.D.: 1.7); see

table 3:6:1 above. He actually chose to read 10 of the 11 narratives but only modified 2 of his responses. Most of the time, he stated that he thought that his spontaneous response was the right one.

He often reasoned aloud about the narratives when producing his responses, for example, narrative number 8:

8. The crack in the forehead/furnace (Swedish: *panna*)
The artist had worked on the face of the sculpture half the night. He slept until late in the morning, when his wife came in and woke him up.' I'm sorry, but you have to wake up now. They say there is a crack in the forehead/ furnace (Swedish: *panna*)', she said and pointed towards the hall. He went out to the studio and loosened the cloth around the sculpture. Not until then did he notice that the house had already got cold.

In response to question 8b, about what had happened during the night, Carl said, '*the sculpture had been cracked... it was in an apartment or a studio connected to it, and it ought not to have been pushed in there.*' Nevertheless, he stuck to his first spontaneous response, that 'the sculpture had been cracked', after reading the narrative.

Question number 12a is another example of Carl sticking to his first interpretation of an ambiguous word (see Appendix 1 where the narratives are presented). On the question of whether she had been given a large book/beechnut (Swedish: *bok*) long ago, Carl responded: '*Yes, as he describes it... but how could it throw a shadow over the entire lawn...? It perhaps depends on which angle you hold it at...*'. Even though Carl seemed to realise the incoherence of the narrative when the ambiguous word is interpreted in that way, he still did not revise his interpretation. Instead, he came up with a marginally plausible explanation of the stated facts in the narrative.

Carl also produced a few inadequate responses on tasks requiring *inference of a character's attitude or motive*. On narrative 9, he reasoned about what motive the main character might have for his actions (question 9b, see Appendix 1). Carl reasoned as follows: '*... perhaps the cat was lying around somewhere... it doesn't seem as if he removes the cat... perhaps he was waiting for food or something like*

that.' Although starting up his reasoning with the whereabouts of the cat, Carl gives a response that might be coherent with the activity of the cat's owner, '*clattering about with china and water*' in the kitchen. However, he does not manage to incorporate the attitudinal information about the main character and his relationship to the cat.

3.6.3.2 Results on VWM task – Carl

Carl produced 16 errors in the VWM task, rather more than the mean scores for the brain-damaged individuals and the control subjects. His was the fifth highest error score for the RHD subjects. One of his errors was due to recalling another word than the target in the stimulus sentence, three were words from previous sets and two were seemingly unrelated. The remaining 10 errors were due to no word's being recalled. Carl did not report any conscious strategy to remember the words. He sometimes reproduced the whole statement in his responses in a corrected form. This directly caused at least one of the errors: in the stimulus sentence '*water is dry*', the target word is '*dry*'. Carl reproduced it as '*water is wet*' (the antonym to '*dry*') when asked to recall the last words of the sentences in that set. He handled the true/false questions well. He often made associations with the content of the stimulus sentences but tried hard to recall the words before sharing his thoughts. He commented about the task that the content was not very interesting and therefore it was difficult to keep in mind.

3.6.3.3 Results on the SART – Carl

Carl produced the fewest correct responses in the SART of any of the RHD individuals, only 143. In fact, he had the second lowest score among all participants in the study. On the other hand, he only produced 6 *Erroneous responses*; see table 3:6:3. These results might be due to Carl's slow *Mean reaction time in test*: his Mean reaction time, 598 ms, is the highest for all subjects in the study. *Mean reaction time in test* may be interpreted as a measure of level of arousal. The slow reaction time caused him to miss several of the targets as well as preventing him from making too many *Erroneous responses*. Carl had the fifth highest *Feedback time* among the RHD

subjects, -6.1 , and this might indicate a reduced ability to monitor and flexibly adapt the pace of his responses in the SART. That is, he did not seem to slow down after making erroneous responses. Carl also had the fourth highest variance in vigilance among the RHD subjects, 16785 , which might be interpreted as showing that there are some fluctuations in his level of arousal.

3.6.3.4 Responses to questionnaire – Carl

In responding to the questionnaire about issues in conversational interaction, Carl's spouse reported no change. In fact, she more or less consistently reported that the issues inquired about occurred very rarely or never, both before and after the stroke; see table 3:6:7. According to Carl's medical charts, during Carl's hospitalisation another member of his family stated that after the stroke he had an apparent increase in speech production. The total degree of change and of negative impact, as reported by Carl himself, is 4 – below the RHD group's mean for change (13.4 , S.D.: 14.8) and for degree of negative impact (16.9 , S.D.: 15.8).

Table 3:6:7: Degree of change and negative impact of change for issues in questionnaire as reported by Carl and his spouse (CP).

Issue in questionnaire	Change/ Carl	Change /CP	Neg. impact/Carl	Neg. impact/CP	Issue in questionnaire	Change/ Carl	Change / CP	Neg. impact/ Carl	Neg. impact /CP
1. Start conversation	0	0	–	–	15. Lost thread when speaking	0	0	–	–
2. No response	0	0	–	–	16. Word retrieval difficulties	–1	0	1	–
3. Latency response	0	0	–	–	17. Production of circumlocutions	0	0	–	–
4. Interrupt others' turn	0	0	–	–	19. Reference failure	0	0	–	–
5. Detailed responses	+1	0	1	–	25. Monotonous intonation	0	0	–	–
6. Short responses	0	0	–	–	18. Comprehension in general – failure	0	0	–	–
7. Start new topics	+1	0	2	–	20. Metaphorical meaning – failure	0	0	–	–
8. Coherence of new topics – failure	0	0	–	–	21. Make inferences	0	0	–	–
9. Maintain topics	0	0	–	–	22. Comprehension of humour	0	0	–	–
10. Recurring topics	+1	0	0	–	23. Use humour	0	0	–	–
11. Indicate comprehens. Problems	0	0	–	–	24. Humour appreciated by others	0	0	–	–
12. Initiate self-repair	0	0	–	–	TOTAL:	4	0	3	–
13. Successful self-repair	0	0	–	–					
14. Repair through specifying	0	0	–	–					

Note: More frequent occurrences of the behaviour mentioned in the question are denoted with a plus sign (+). Less frequent occurrences are denoted with a minus sign (–).

Carl feels that he has a slight increase (+1) in the frequency with which he produces long and very detailed responses. According to his report, he used to do this sometimes before the stroke, but since the stroke the behaviour has become more frequent. He reports that this change does have a negative impact on his ability to interact in conversation, but only rarely. Carl also reports that before the stroke he sometimes started up new topics in conversation, but that now he often does this (+1). This, he feels, sometimes has a negative impact. Furthermore, he reports that he tends to bring up favourite topics recurrently in conversation slightly more often than before (+1), but he does not feel that this tendency has any negative impact on his ability to interact in conversation. He used to do this occasionally but he feels that he often does so since the stroke.

Finally, he does notice a change in word mobilisation. Interestingly enough, he reports that before the stroke he sometimes experienced word retrieval difficulties, but since the stroke he rarely feels that he has problems finding the right word (-1). He reports that this change does have negative impact on his conversational ability, but only rarely.

3.6.3.5 Impressions from video-recorded conversation – Carl

The most prominent impression of the recorded conversation with Carl is his continuing development of new topics and his reluctance to hand over the turn to his conversational partner. Although there is an evident thread in his topic development, there are occasional reference failures and several instances of other-initiated repair in the form of requests for clarification by the conversational partner. At some points, he also seems to lose the thread. Carl's articulation is sometimes slurred, especially when the speech is rapid, and small portions of it are occasionally difficult to understand on the video. It is possible that there are occurrences of phonological and semantic paraphasias, although the small portions of incomprehensible speech might also be the result of sporadic motor planning problems.

3.6.4 Thomas (LHD): Personal data and results

Thomas is a 67-year-old man. He completed his compulsory schooling and used to work as a salesman. He is interested in literature, the arts and architecture. Before the stroke, he used to read 30 to 40 books a year. He states that he may read about that many books now, but that he has trouble concentrating on his reading and often has to reread passages to understand them. (Table 3:5:1 compiles personal data on the cases.)

He had an infarction in the left hemisphere six months before participating in the study. An MRI scan showed damage within the central parts of the left putamen reaching into the corona radiata and also extending from the left lateral ventricle into subcortical and cortical portions of the frontal lobe. At first, he experienced right-sided weakness and aphasia. These problems were quickly resolved and he was left with more subtle language impairment. Thomas states that during his rehabilitation he felt that he had more word-finding difficulties than the standard aphasia test batteries were able to detect.

After several weeks of rehabilitation he returned to living with his wife in the house he built himself. When he participated in the study, he was still experiencing some language impairment. He felt that he was still recovering but that the process was now much slower.

3.6.4.1 Qualitative data from inference tasks – Thomas

Thomas performed fairly well on the inference tasks. On questions related to explicitly expressed information, he scored 10 out of 11 for his spontaneous responses.

He scored 6 out of 8 on tasks requiring *revised inference*. The mean score for all brain-damaged subjects in both groups was 4.7 (S.D.: 1.7); see table 3:6:1. He chose to read all the narratives and checked all of his answers but did not modify any of his responses. On tasks requiring *inference of a character's attitude or motive*, he scored

10 out of 10 (mean: 7.7, S.D.: 1.7). His result on these tasks is among the best three results for the LHD individuals.

The two inadequate responses he produced on tasks requiring *revised inference* were both for task 8. In answering the question about what had happened during the night, Thomas responded based on an interpretation of the Swedish word *panna* ('forehead'/'furnace') as 'forehead'. He responded that '*the head had cracked*'. On the question of how the sculptor's wife could know there was a crack in the forehead/furnace, he responded: '*She must have been curious and lifted the veil*'.

He produced 8 of the 33 responses with latency and 5 without any hesitation.

3.6.4.2 Results on VWM task – Thomas

On the VWM task, Thomas produced 16 errors. This is slightly worse than the mean results for the LHD group (group mean: 14.1, S.D.: 5.1); see table 3:6:2 above. He made one error producing a word from an earlier set. The remaining errors involved words that were not recalled. He reported using a strategy of silently repeating the words to remember them.

3.6.4.3 Results on the SART – Thomas

On the SART, Thomas produced 158 *Correct responses* and made 6 *Erroneous responses*, that is, pressing the response button for number 3, when he was not supposed to give a response. This meant that he produced fewer correct responses but also made fewer mistakes than the mean score for both groups of brain-damaged individuals and for the control subjects (table 3:6:3). Actually, his error score on the SART is the fourth lowest for the subjects in the LHD group. He had a *Mean reaction time in test* of 490 ms, which is slower than the mean *Mean reaction time in test* for both groups. The slow pace might be a strategy that allowed him to avoid false alarms but it also made him miss several responses. It was not possible to obtain a measure of *Feedback time* due to Thomas's numerous misses. He had a mean variance of vigilance of 32549, which is high compared to the mean variance for all

three groups (table 3:6:3). It is the third highest variance in the LHD group, and might indicate that his level of arousal was fluctuating.

3.6.4.4 Responses on questionnaire – Thomas

Both Thomas and his spouse reported changes and a negative impact of several issues inquired about in the questionnaire. Thomas himself reported a total degree of change of 29. His wife reported a total degree of change of 21. Their change ratings are slightly higher than the mean ratings within the LHD group; see table 3:6:4 above. When it comes to degree of negative impact, Thomas reported a total of 31, while his spouse reports a total of 25; see table 3:6:8.

Table 3:6:8: Degree of change and negative impact of change for issues in questionnaire as reported by Thomas and his spouse (CP).

Issue in questionnaire	Change / Thomas	Change /CP	Neg. impact/ Thomas	Neg. impact/ CP	Issue in questionnaire	Change / Thomas	Change /CP	Neg. impact/ Thomas	Neg. impact /CP
1. Start conversation	0	0	–	–	15. Lost thread when speaking	+2	+2	2	2
2. No response	+3	+2	3	2	16. Word retrieval difficulties	+3	+1	3	2
3. Latency response	+3	+2	3	2	17. Production of circumlocutions	+3	+2	3	3
4. Interrupt others' turn	0	–1	–	0	19. Reference failure	+2	+1	2	2
5. Detailed responses	–2	–3	3	2	25. Monotonous intonation	+2	0	2	–
6. Short responses	+2	+1	2	2	18. Comprehension in general – failure	0	+2	–	3
7. Start new topics	0	0	–	–	20. Metaphorical meaning – failure	0	0	–	–
8. Coherence of new topics – failure	0	0	–	–	21. Make inferences	–1	0	2	–
9. Maintain topics	0	0	–	–	22. Comprehension of humour	0	0	–	–
10. Recurring topics	0	0	–	–	23. Use humour	0	0	–	–
11. Indicate comprehension problems	0	+1	–	1	24. Humour appreciated by others	0	0	–	–
12. Initiate self-repair	+2	0	2	–	TOTAL:	29	21	31	25
13. Successful self-repair	+2	–2	2	2					
14. Repair through specifying	–2	–1	2	2					

Note: More frequent occurrences of the behaviour mentioned in the question are denoted with a plus sign (+). Less frequent occurrences are denoted with a minus sign (–).

The most important issues reported to have changed are in the areas of Attention and Word retrieval (15 to 17), Initiation (2 and 3) and Turn-taking (5 and 6). Both Thomas and his spouse agree on these changes although Thomas tends to rate both the change and its negative impact slightly higher than his wife.

Issues they disagree on include an increase in general comprehension failures (18) reported by Thomas's spouse. Thomas instead reports an increase in inference failures (21) and also more monotonous speech (25). In natural conversation, it may be difficult to decide whether comprehension failures or misunderstandings are due to 'general' comprehension or ability to make adequate inferences.

3.6.4.5 Impressions from video-recorded conversation – Thomas

In the video-recorded conversation with Thomas, there are several cases of difficulties initiating a response when he accepts his turn. However, even though he evidently has word retrieval difficulties and produces slow speech with several pauses and hesitation sounds, he does extend his turns sometimes using detailed responses and he also introduces several new topics. There are also noticeable occurrences of phonological paraphasias resulting in self-initiated self-repair.

3.6.5 Results of activity based communication analysis

Considering the *collective activity background factors*, the goal of communicative activity can be described as social interaction for all four dyads. The conventional goal in that kind of activity is to get to know each other on a 'first encounter' basis, e.g. to share thoughts and experiences with a new person. However, the context of the activity also involves a modified goal: to record the activity in order to analyse conversational interaction in association with brain damage and subtle language disorders. This modified goal might put some psychological constraints on the interaction patterns. However, none of the participants expressed any discomfort about this. All four of them had experienced being assessed in different contexts during their rehabilitation.

Sub-activities involved in the main activity were (1) having coffee, with the conventional goal of constructing a culturally favourable context for social interaction; (2) informing; (3) narrating; (4) listening; (5) giving feedback; (6) repairing. Those sub-activities were the same for all participants in the dyads.

The analysis of *roles in activity* shows that they are modified in this particular context compared to the conventional roles where two persons who are unfamiliar with each other have a shared responsibility, participating and alternating as sender and receiver in the interaction.

In the modified roles in this particular context, the research leader, as the initiator of the meeting and the interaction, and also as someone who has no communication disorder, has a greater responsibility for the interaction than the brain-damaged individuals. Although the activity is not an interview, the interaction patterns might be influenced by the modified goal and roles. In all four dyads, the research leader tends to do more of the listening and feedback activities, while the brain-damaged individuals hold the floor. In all four dyads, the brain-damaged individuals tend to provide more information and talk about personal experiences. The research leader occasionally embellishes a topic or introduces new topics.

The *physical circumstances* were similar for all four dyads. The brain-damaged individual and the research leader were sitting alone, at the kitchen table in the subject's home. The video camera was set up and running.

In all four dyads, the first part of the testing session had been performed when the conversational interaction took place; the testing was to be completed after the coffee break. In all four cases, the video-recorded conversation followed a recording of social interaction between the research leader, the brain-damaged individual and his spouse.

Individual background factors for the brain-damaged individuals were introduced in sections 3.6.1 to 3.6.4, above. They all have communication deficits that influence their interaction patterns and individual means of communication. In this particular context, all four brain-damaged individuals have the goal of social interaction and sharing personal experiences and facts about the world in common.

These goals include several sub-goals that are also shared by the brain-damaged individuals, for example, making the interaction proceed smoothly, encouraging sharing and giving social affirmation, and helping the communication to run smoothly by making their contributions comprehensible and unambiguous. However, due to the subjects' communication deficits, the research leader had to take more responsibility for these processes in the communication situation, which influenced the interaction pattern. All four brain-damaged individuals also shared the modified goal of contributing to the making of a video of conversational interaction. The goal of learning about facts in the world and getting to know a person might be somewhat less prominent for the brain-damaged individuals since this context involves an activity with modified goals. The roles of the brain-damaged individuals were similar. They were all conversational partners and persons with information to share in this specific context. The goal of the research leader was to initiate and maintain natural social conversational interaction for research purposes as well as social purposes. In this particular context, the impact of status based on cultural patterns – an older man in social interaction with a younger woman – might conflict with the fact that the younger woman is the research leader, has more education and also functions as a representative of the post-stroke rehabilitation facilities, being a speech-language therapist. There is also a possible conflict, for both the research leader and the brain-damaged individuals, between the role of the research leader as a conversational partner and as a researcher studying conversational interaction post-stroke.

To sum up, the results of the activity based communication analysis indicate that the modified goal of the *collective activity background factors* and the modified roles due to the *individual background factors* might influence the interaction patterns as mentioned above. However, the context for the conversational interaction is similar in all four dyads.

3.7 Analysis of conversational interaction

In this section the results of the analysis of video-recorded samples of conversational interaction will be explored. Results concerning word retrieval will be presented first. This is followed by the presentation of the results of the analyses of turn-taking patterns and repair issues.

3.7.1 Word retrieval

The results of the analysis of word retrieval difficulties and attentional slips will be presented in this section. Only when the speaker uses explicit OCM phrases such as '*what is it called?*' is it possible to be certain that any OCM phenomenon is due to word retrieval difficulties rather than some other form of processing difficulty affecting the production of speech. As it is also presumed that attention in one form or another may often be involved in word retrieval or other processing difficulties, no attempt is made to separate attentional lapses from word retrieval or other processing difficulties here. Still, even though OCM phenomena can often be related to word retrieval difficulties in healthy individuals, as well as in brain-damaged individuals, it is not possible to infer that the OCM phenomena in the analysed samples are always due to word retrieval difficulties alone. Although all of the four individuals reported a change in the area of word retrieval, occurrences of OCM phenomena may instead be due to such things as a search for a specific episodic memory or the planning of discourse structure. Therefore, it often seems more appropriate to talk about OCM phenomena as symptoms of general production difficulties rather than strictly word retrieval difficulties. Hence, any references to word retrieval difficulties in the presentation below are made with this reservation.

According to the hypothesis presented above, it was expected that the LHD subjects' word retrieval difficulties would be more obvious than the corresponding production difficulties experienced by the RHD subjects. In the first section below,

explicit symptoms of word-processing problems are presented and this is followed by a presentation of more subtle symptoms of such production difficulties.

A key to the symbols used in the transcriptions is provided in Appendix 5. The English translation (E) is given in italics below each contribution in Swedish (S). The specific features referred to in the comments immediately connected with the transcriptions are, when possible, marked in bold. However, the transcriptions are sometimes also referred to and used as examples of features mentioned in another section in the presentation.

3.7.1.1 Explicit symptoms of word processing

In the conversational interaction with Thomas, one of the LHD individuals, there are several examples of explicit symptoms of word retrieval difficulties.

The example in contribution (C) 51 below shows OCM phenomena in the form of both choice-related and change-related features

Extract 1: Thomas (LHD)

S: 51 \$T: själv **eh** när gäller utseendemässigt med <¹ >¹ **e:h** // **mas+ man ser eh** <² **jo aj+ öh** <³ / >³ **s+** färdiga element som kom **eh** garderober skåp å sånt >² <⁴ / >⁴ nog fan var jag å hacka på dom här å <⁵ ändra modell på det också >⁵

*E: 51 \$T: myself **uh** when it comes to appearance with <¹ >¹ **u:h** // **yoc+ you can see uh** <² **well ah I+ uh** <³ / >³ readymade elements that was delivered **uh** closets cupboards and such >² <⁴ / >⁴ I bloody well was there and picked on those and <⁵ change the style on that too >⁵*

@ <¹ inhalation sound: T >¹

@ <² hand gesture: T showing rectangular form with both hands >²

@ <³ inhalation sound: T >³

@ <⁴ inhalation sound: T >⁴

@ <⁵ laughter: T >⁵

There is obvious evidence of word-processing difficulties in the video of the interaction with Thomas, but he never uses an explicit OCM phrase. There are basic OCM expressions such as pauses and simple OCM expressions allowing for further processing for word retrieval and planning. There are also basic OCM operations like self-interruption and self-repetition. Often, several OCM features are combined.

The word retrieval difficulties of the other LHD individual, Johan, sometimes force him to demonstrate what he means instead of expressing it verbally:

Extract 2: Johan (LHD)

S: 158 \$J: men **sen ä det sen ä det // eh** ä det väldigt okej överhuvudtaget med den armen å så /
men / om jag lägger mej ner å gör armhävningar å så ä det **ing+** ä det inga **so+ som** helst problem
det enda det ä att < **den dom den handen** // så ä sån väldig styrka i dom så att dom // jag ställer
mej så först va>

E: 158 \$J: *but then it is then it is // uh it is rather okej on the whole with that arm and that / but / if
I lay down and do press-ups and so there is no+ there is no problems what s+ so ever the only thing
is that < that those that hand // so is such tremendous strength in them so they // I place myself like
this first see >*

@ <hand gesture starts: J putting his right hand on the table to show the status of his hand >

S: 159 \$P: ja

E: 159 \$P: yes

S: 160 \$J: ungefär så

E: 160 \$J: *something like this*

@ <hand gesture continued: J putting his right hand on the sofa, showing the spasticity of his hand
>

S: 161 \$P: ja

E: 161 \$P: yes

@ <hand gesture: J showing the spasticity of his hand >

S: 162 \$J: å så gör jag så här

E: 162 \$J: *and then I do like this*

@ <hand gesture continued: J showing the spasticity of his hand >

Johan is demonstrating several OCM phenomena, both basic OCM expressions and operations such as pauses, hesitation sounds, self-interruption and self-repetition. He also often uses circumlocutions and hand gestures to get his message across.

In the next extract from the video-recorded samples, Carl, one of the RHD individuals, shows OCM phenomena that most likely are evidence of word retrieval difficulties. Carl is recalling a café that had a doorman whom he knew:

Extract 3: Carl (RHD)

S: 125 \$C: utkastare som det heter

E: 125 \$C: *chucker-out as it is called*

S: 126 \$P: < ja ja > ja just det ja

E: 126 \$P: < I see > yes right

@ < head movement: P nods

S: 127 \$C: **ja / < det // > så det var** [¹⁵ //]¹⁵ **jodå**

E: 127 \$C: *yes / < it // > so it was* [¹⁵ //]¹⁵ *oh yes*

@ < head movement: C and P turning head towards other room where spouse goes by>

S: 128 \$P: [¹⁵ m]¹⁵

E: 128 \$P: [¹⁵ m]¹⁵

S: 129 \$P: men [¹⁶ hur]¹⁶

E: 129 \$P: *but* [¹⁶ how]¹⁶

S: 130 \$C: [¹⁶ det]¹⁶ det hände på det caféet eller det kunde bli lite väsen

E: 130 \$C: [¹⁶ it]¹⁶ *it happened at that café or there could be a bit of a row*

S: 131 \$P: < ja > just det
 E: 131 \$P: < yes > right
 @ < head movement: P nods
 S: 132 \$C: men då var det ju rä+ roligt na+ [¹⁷ namn]¹⁷ namnsson hette han ja [¹⁸ (...)]¹⁸ det hette han som jobbade vid järnvägen också
 E: 132 \$C: but then it was qui+ fun na+ [¹⁷ name]¹⁷ nameson was his name yes [¹⁸ (...)]¹⁸ the name of him who worked at the railroad too
 S: 133 \$P: [¹⁷ m]¹⁷
 E: 133 \$P: [¹⁷ m]¹⁷
 S: 134 \$P: [¹⁸ m]¹⁸
 E: 134 \$P: [¹⁸ m]¹⁸

In C127, Carl, who usually has very fluent speech, slows down and actually pauses for a moment. Still, he is not willing to hand over the turn. Rather, he seems to be engaged in word processing, successful as it appears in C132, where he recalls the name of his friend. There are also other occasions in the analysed sample where Carl is searching for a name of a person:

Extract 4: Carl (RHD)

S: 95 \$C: det (var) man köpte en **ba:kelse** // eller vad det nu kostade två å0 f+ femti
 E: 95 \$C: it (was) you bought a pa:stry // or what ever cost two and f+ fifty
 S: 96 \$P: hm
 E: 96 \$P: hm
 S: 97 \$C: det var rätt mycket då för en kopp kaffe å en bak+
 E: 97 \$C: that was quite expensive then for a cup of coffee and a (pas+)
 S: 98 \$P: det var (mycket ja)
 E: 98 \$P: that was (expensive yes)
 S: 99 \$C: men det var roligt det var musik å sång
 E: 99 \$C: but it was fun it was music and singing
 S: 100 \$P: ja
 E: 100 \$P: yes
 S: 101 \$C: å jag tror att han var där **eh // en (...) det måste vara harry brandelius**
 E: 101 \$C: and I think he was there **uh // a // (...) it must have been harry brandelius**
 S: 102 \$P: jaha
 E: 102 \$P: I see
 S: 103 \$C: han var (...) på den tiden / femtitalet
 E: 103 \$C: he was (...) at that time / the fifties
 S: 104 \$P: ja
 E: 104 \$P: yes
 S: 105 \$C: å det var det sa dom också lite skumt det var lite (många) sjömän där / (...)
 E: 105 \$C: and that was they said also a little fishy it was rather (many) sailors there / (...)

In C95 above, Carl first demonstrates choice-related OCM phenomena in the form of a prolonged vowel and pausing, probably related to the processing of episodic memory. This is followed the processing of a person's name in C101.

There are several occasions with basic OCM expressions in the form of pauses, especially preceding names of persons and places, but also on other occasions. See, for example, C18 in extract 30, section 3.7.3.2 below, where Carl seems to lose the thread of what he was talking about.

Even though there are choice-related OCM phenomena, predominantly short pauses, in Carl's speech, they are not as prominent as they are in the speech of the two LHD subjects, Johan and Thomas.

In the analysed sample from the conversational interaction with Carl, there is only one occurrence of an OCM phrase, '*What's it called?*', in association with the processing of a place name. Instead, there are several instances of change of speech plan and topic; see section 3.7.1.2 below.

Circumlocution is also a fairly explicit symptom of word processing. In addition to demonstrating several obvious OCM phenomena, Johan, one of the LHD individuals, also produces obvious circumlocutions:

Extract 5: Johan (LHD)

S: 1 \$P: <men vad sa du du hade börjat med / med da+ å jobba med / eller / > med en sån datorkurs eller

E: 1 \$P: < but what did you say you had started with / with co+ to work with / or / > with such a computer course or

@ < body movement P sits down at the table >

S: 2 \$J: < nä det > det den **eh** (vi) går på **ett data en data slags eh en slags data**

E: 2 \$J: < no it > *it that uh (we) are attending **an computer a computer kind of uh a kind of computer***

@ < head movement: J shakes >

S: 3 \$P: < ja >

E: 3 \$P: < yes >

@ < head movement: P nods >

S: 4 \$J: å jag det jag gör mest det ä **jag sitter å skriver**

E: 4 \$J: *and I what I do mostly that is **I sit and write***

S: 5 \$P: < jaha / [¹ så det]¹ >

E: 5 \$P: < I see / [¹ so it]¹ >

@ < head movement: P nods >

S: 6 \$J: [¹ på den här]¹ < den handen >

E: 6 \$J: [¹ on this]¹ < that hand >

@ < hand gesture start: J shows right hand >

S: 7 \$P: <¹ <² ja ja [² genom å]² >² >¹
 E: 7 \$P: <¹ <² I see [² buy]² >¹
 @ <¹ hand gesture continued: J shows right hand >¹
 @ <² head movement: P nods >²
 S: 8 \$J: < [² så de+]² så att jag jag får med den handen så >
 E: 8 \$J: < [² so i+]² so that I I bring along that hand like that >
 @ < hand gesture continued: J shows right hand >

In extract 5 above, Johan wants to specify that the goal of the computer activity is to use his right hand but his word retrieval difficulties force him to convey the main message in a fragmented way. That is, he specifies that it is a ‘kind of computer (course)’, that writing is the main activity and that the purpose of the writing is to use his right hand in a motor activity. Several times, he manages to use circumlocutions in a way that, for example by contextual references, enables him to get his main message across in spite of his word retrieval difficulties:

Extract 6: Johan (LHD)

S: 76 \$J: ja det var en grej som / (han) vet inte vad (han) heter / **eh** / **vad det kallas** / som dom tar pekar på nånting alltså / < pekar på nåt / >
 E: 76 \$J: yes it was a thing as / (he) don't know (his) name / **uh** / **what is it called** / as they take point to something see / < point to something / >
 @ < hand gesture starts: J points with left hand >
 S: 77 \$P: [¹¹ m]¹¹
 E: 77 \$P: [¹¹ m]¹¹
 S: 78 \$J: <¹ [¹¹ så]¹¹ <² **så ä det en dator** >² som / <³ som **dom binder också** e+ >³ >¹
 E: 78 \$J: < I [¹¹ then]¹¹ <² **then there is a computer** >² as / <³ as they also **tie up** o+ >³ >¹
 @ <¹ hand gesture: continued: J points with left hand >¹
 @ <² hand gesture: J moving right hand from left to right in the air >²
 @ <³ hand gesture: J placing right hand behind his back >³
 S: 79 \$P: ja <¹ nä <² vänta du prata vi >² prata om det här med virtuell [¹² eh]¹² / >¹
 E: 79 \$P: yes <¹ no <² wait you talked we >² talked about this with virtual [¹² uh]¹² /
 @ <¹ hand gesture: P touching mouth then points to J >¹
 @ <² hand gesture stops: J points with left hand >²
 S: 80 \$J: [¹² just det]¹²
 E: 80 \$J: [¹² right]¹²

In the sequences in extract 6 above, Johan demonstrates choice-related and change-related OCM phenomena such as basic expressions and operations. There are several hesitations sounds and pauses as well as hand gestures and a repetition and also an explicit verbal phrase expressing the word retrieval difficulties, ‘*what is it called?*’ in contribution C76.

There are no examples of circumlocution in the analysed sample from the conversational interaction with Thomas, the other LHD individual. Because of the extra time he gains by using several OCM phenomena, Thomas seems to be able to handle word processing quite well.

Carl, one of the RHD individuals, does not use any obvious circumlocutions in the analysed sample either. The other RHD individual, Nils, on the other hand, demonstrates a need for circumlocutions. In extract 7, below, Nils is trying to describe an activity involving gymnastics. The symptoms of word processing in the conversational interaction with Nils are more obvious than the possible word retrieval difficulties Carl manifests. Nils often shows OCM phenomena related to choice, indicating the need for word processing:

Extract 7: Nils (RHD)

S: 60 \$P: ja det kan ju inte vara roligt [²² för ledaren heller < >]²²

E: 60 \$P: well that can't be fun [²² for the leader either < >]²²

@ < laughter: P >

S: 61 \$N: [²² nä nä nä nä nä]²² det var inget skoj för mej heller men [²³ jag]²³ fick ju <¹ tag i ett annat va sånt där eh andra eh det var ju eh en sån där gympa eh // <² >² så jag gjorde andra rörelser du å cykla å [²⁴ så där va / ja]²⁴ >¹

E: \$N: [²² oh no oh no no]²² it was no fun for me either but [²³ I]²³ got <¹ hold of an other you know such a uh other uh one of those gym uh // <² >² so I made other movements you and cycled [²⁴ and things like that see yes]²⁴ >¹

@ <¹ hand gesture: N demonstrating with both hands movements involved in the activities described >¹

@ <² click: N >²

S: 62 \$P: [²³ nä]²³

E: 62 \$P: [²³ no]²³

63 \$P: [²⁴ ja ja dom har såna / e1]²⁴

E: 63 \$P: [²⁴ I see they have those]²⁴

S: 64 \$N: men då jag jag tänkte det **eh** ///

E: 64 \$N: but then I I thought it **uh** ///

S: 65 \$P: ja / men annars brukar ni göra så att hon < gör före å ni gör / likadana > rörelser eller [²⁵ hur]²⁵

E: 65 \$P: yes / but otherwise is the usual procedure that she < demonstrates and you do / movements of the same kind > or [²⁵ how]²⁵

@ < hand movements: P both hands up and then moving from side to side >

S: 66 \$N: [²⁵ ja hon]²⁵ (...) **nä** < dom ä med hela tiden å [²⁶ gör]²⁶ **eh visar eller gör** [²⁷ öh]²⁷ **så tar vi den** > **å**

E: 66 \$N: [²⁵ yes she]²⁵ (...) no < they take part all the time and [²⁶ do]²⁶ **uh show or do** [²⁷ uh]²⁷ **then let's take that one > and**

@ < head movement: N nods >

S: 67 \$P: [²⁶ < ja >]²⁶

E: 67 \$P: [²⁶ yes]²⁶

@ < head movement: P nods >
 S: 68 \$P: [²⁷ < ja >] ²⁷
 E: 68 \$P: [²⁷ yes] ²⁷

@ < head movement: P nods >
 S: 69 \$P: ja just det just det
 E: 69 \$P: [³ yes right right] ³

@ < head movement: P nods >
 S: 70 \$N: å öh[²⁸ gör vi det] ²⁸ å gör vi det å
 E: 70 \$N: *and uh* [²⁸ let's do that] ²⁸ *and let's do that and*

S: 71 \$P: [²⁸ ja] ²⁸ <¹ ja >¹ <² men nu fick du mer gå från olika såna tränings eh [²⁹ <³ instrument då >³ liksom >² (...)] ²⁹
 E: 71 \$P: [²⁸ yes] ²⁸ <¹ yes >¹ <² but now you had to move between different such training uh [²⁹ <³ instruments then >³ sort of >²] ²⁹

@ <¹ ingressive >¹
 @ <² hand movement: P pointing circular movements with right hand >²
 @ <³ head movement: P nods >³
 S: 72 \$N: [²⁹ < ja ja > men jag var ensam] ²⁹ då den gången
 E: 72 \$N: [yes right but I was alone] then that time

@ < head movement: N nods >

In extract 7 above, Nils demonstrates several choice-related basic OCM expressions and pauses. He also uses hand gestures to describe his activity. OCM phenomena such as hesitation sounds and repetition in the sequence might indicate that Nils is having word retrieval difficulties. There are examples of Nils finding it difficult to produce effective circumlocutions. He seems to be forced to use a kind of circumlocution where he lists parts of the concept he wants to describe. In extract 7, he does this in the form of recalling phrases used by the trainer when she is demonstrating the activities the participants in the group are to perform (C66 and C70).

3.7.1.2 Subtle symptoms of word processing

Own communication management phenomena such as hesitation expressions, pauses and operations like self-interruption and repetition as well as occurrences of circumlocutions are common and can be considered as obvious symptoms of word retrieval difficulties in both brain-damaged and healthy individuals. However, there are other symptoms, more subtle, that may also indicate word-processing difficulties. OCM sounds like sighs and clicking sounds may also indicate word retrieval difficulties. Audible inhalation is also considered as a more subtle manifestation of

OCM. One of the LHD individuals, Thomas, and one of the RHD individuals, Nils, both show examples of inhalation sounds as OCM phenomena in their videos.

The pauses with noticeable inhalation occur several times in the video-recording with Thomas and always in association with other OCM phenomena:

Extract 8: Thomas (LHD)

S: 120 \$P: hur < lång slinga blir det då eller hur långt > blir det om du går en sån

E: 120 \$P: *how < long will that track be then or how far > is it if you walk such a*

@ < hand gesture: P pointing movements with right hand >

S: 121 \$T: nä det bli+ brukar bli en halvmil

E: 121 \$T: *no it i+ usually is about five kilometres*

S: 122 \$P: < ja [⁹ (...)]⁹ >

E: 122 \$P: < yes [⁹ (...)]⁹ >

@ < head movement: P nods >

S: 123 \$T: [⁹ (...)]⁹ **men men eh** / när jag kom < tillbaka eh > / **i / återvände till livet** i höstas så eh

E: 123 \$T: [⁹ (...)]⁹ **but but uh** / when I got < back uh > / **last / returned to life** last autumn then

uh

@ < hand movement: T puts left hand on table >

S: 124 \$P: m

E: 124 \$P: *m*

S: 125 \$T: fick jag <¹ >¹ / minska ner <² till **en eh** >² / <³ >³ / till drygt hälften

E: 125 \$T: *I had to <¹ >¹ / reduce <² to **a uh** >² / <³ >³ / to slightly more than half*

@ <¹ inhalation sound: T >¹

@ <² head movement: P nods >²

@ <³ inhalation sound: T >³

Thomas is demonstrating several other OCM phenomena in C123 and C125 in extract 8; he also inhales audibly on two occasions.

Nils also demonstrates audible inhalation sounds that might be associated with word retrieval difficulties on several occasions:

Extract 9: Nils (RHD)

S: 42 \$N: < >

E: 42 \$N: < >

@ < inhalation sound: N >

S: 43 \$P: < ja >

E: 43 \$P: < yes >

@ < ingressive >

S: 44 \$N: <¹ nä nä men det ä ju så man får ju om man ä med så här så får man ju **eh** man **eh** vill ja **u+ eh** inte >¹ helst inte vara borta men **det blir** [¹⁸ <² **det** >²]¹⁸ blir man sjuk så kan man ju inget göra åt det /

E: 44 \$N: <¹ oh no but the thing is you have to if you are in on it like this then you have to uh you d+ uh don't want to >¹ rather not be absent but it is [¹⁸ <² it >²]¹⁸ if you get sick then there is nothing to do about it /

@ <¹ hand movement: N right hand tapping on table >¹

@ <² hand movement: N left hand points towards P >²

In C42 in extract 9, Nils inhales before he is able to initiate an utterance in C44. Basic simple OCM expressions in the form of hesitation sounds and change-related OCM operations in the form of self-interruption and repetition as well as the tapping on the table indicate that he has trouble expressing himself. In C85 in extract 18, presented in section 3.7.2.1, common OCM phenomena and audible inhalations again occur in the same contribution.

In next example from the recorded conversation with Nils, he also shows basic OCM phenomena in the form of pauses and OCM sounds such as inhaling and a sigh in C53.

Extract 10: Nils (RHD)

S: 53 \$N: jag vet en gång jag var (...) på gymnastiken å hon <¹ >¹ /// <² >² å det kom ju å jag var ensam //

E: 53 \$N: there was at one occasion I was (...) at the gym class and she <¹ >¹ /// <² >² and you see it was and I was alone //

@ <¹ inhalation sound: N >¹

@ ²< sigh: N >²

S: 54 \$P: var var alla de andra borta

E: 54 \$P: were were all the others absent

S: 55 \$N: ja

E: 55 \$N: yes

Furthermore, he does not finish his contribution and the conversational partner initiates other-repair in C54 in the form of a request for confirmation of the inference made from the utterance in C53.

There are also other tokens in conversational interaction that may be manifestations of word retrieval difficulties. Although Carl's speech is more fluent and he demonstrates less frequent obvious OCM phenomena than the other three individuals, there are sequences with phenomena that may be associated with either attentional lapses or word retrieval difficulties or both:

Extract 11: Carl (RHD)

S: 6 \$C: [¹ men det]¹ (...) jag hade nu / < > **nä** det var på **sah+ nä** på östra var jag

E: 6 \$C: [¹ but that]¹ (...) I had now / < > **no** it was at **sah+ no** at Östra I was

@ < Click: C >

S: 7 \$P: m

E: 7 \$P: m

S: 8 \$C: så kom det en tjej som med en vagn (med) (...) ska du in <¹ här >¹ ja (...) labbet där [² /]²
(...) <² >² det ä ju <³ // (...) /// >³ <⁴ >⁴ å jag stod å tittade på / en pojke där på ett postkontor på
danska vägen

E: 8 \$C: then a girl came who with a pram (with) (...) are you going in <¹ here >¹ yes (...) the
laboratory there [² /]² (...) <² >² why it is <³ // (...) /// >³ <⁴ >⁴ and I stood looking at / a boy
there in a post office on svenska vägen

@ <¹ head movement: C nods >¹

@ <² head movement: P nods >²

@ <³ Comment: C drinks from coffee cup >³

@ <⁴ head movement: P turning head to look into other room where spouse goes by >⁴

S: 9 \$P: [² m]²

E: 9 \$P: [² m]²

S: 10 \$P: < m >

E: 10 \$P: < m >

@ < head movement: P nods >

In C6 in extract 11, Carl pauses briefly, probably engaged in episodic memory search or word retrieval, he then produces change-related basic OCM expressions and operations in correcting the name of the hospital he had in mind. In C8, several speech segments were impossible to interpret. The unclear articulation might also be associated with word retrieval difficulties, since it often occurs in association with other symptoms of word-processing difficulties in the video-recorded sample of interaction with Carl. After he has emptied his coffee cup, Carl seems to lose track of what he was talking about and abruptly changes the subject and instead starts to recall another, albeit related, incident. Further examples of the two RHD individuals tendency to abandon an initial speech plan as well as the intended message will be presented below and in section 3.7.3.1.

In extract 12, Carl shows common OCM phenomena such as pausing in C169 and on into C172:

Extract 12: Carl (RHD)

S: 167 \$C: jag gick en gång jag jobbade som fastighetsskötare här uppe i </> våran fastighet som vi ägde

E: 167 \$C: *I once went I worked as a caretaker up here in </> our building which we owned*

@ < hand gesture: C pointing towards window >

S: 168 \$P: m

E: 168 \$P: *m*

S: 169 \$C: (...) det var en bost+ / en bostadsrätt [¹⁹ å]¹⁹ så var det den mitt emot / å jag hade la bra / jag hade (som extraknäck där jag jobbade mycket) å då hade / < bytte soptunnor >

E: 169 \$C: (...) *it was a tenant+ / a tenant-owned apartment [¹⁹ and]¹⁹ then it was the one just opposite / and why I had good / I was (moonlighting there I worked a lot) and then had / < was exchanging the dustbins >*

@ < hand gesture: C sweeping movement with right hand >

S: 170 \$P: [¹⁹ < m >]¹⁹

E: 170 \$P: [¹⁹ < m >]¹⁹

@ < head movement: P nods

S: 171 \$P: < m >

E: 171 \$P: < m >

@ < head movement: P nods

S: 172 \$C: // det var ett <¹ **sopnedkast där som det** <² (...) >² **drog ut tunnan å så la på locket** >¹ å jag vet inte jag fick nån utslag på /

E: 172 \$C: // *it was a <¹ refuse chute there which it* <² (...) >² *pulled out the bin and then put on the lid* >¹ *and I don't know I got some rash on /*

@ <¹ hand gestures: C demonstrating with both hands movements involved in the activity >¹

@ <² Comment: C mumbling >²

S: 173 \$P: usch då

E: 173 \$P: *ugh*

S: 173 \$C: på handen lite men jag vet inte vad det var för något om jag hade skrapat // så gick jag till sociala huset

E: 173 \$C: *on my hand a little but I don't know what it was if I had scratched // so I went to sociala huset*

The hand gestures and the pausing might indicate word retrieval difficulties. Carl might be searching for specific words as he describes his work with the garbage bin in a rather detailed way. There is also a short passage with slurred articulation or mumbling which makes the speech impossible to interpret and transcribe. Although pausing might be considered as a common OCM phenomenon, the sequence in extract 12 above is an example of what might constitute processing difficulties although not obviously considered as word retrieval difficulties. They might equally well be considered as manifestations of impaired memory or attentional lapses.

Instead of showing more obvious OCM phenomena such as pausing and basic OCM expressions, Carl often tends to change his speech plan:

Extract 13: Carl (RHD)

S: 67 \$P: men du hur var det där på sprängkullen innan det blev sån musik eh [¹⁰ / innan punkarna kom dit]¹⁰

E: 67 \$P: but what was it like there at sprängkullen before it was turned into that music uh [¹⁰ / before the punks got there]¹⁰

S 68 \$C: [¹⁰ (nä det si+ jag vet inte det siste)]¹⁰ tror jag inte det har varit det var väl lite / <¹ lu+ (...) >¹ det var allt (lite lit+) prat också <² / >² va jag (...) jag har / i synnerhet nu på många år att jag <³ / >³ jag vet inte vissa saker jag vill själv bilda mej en uppfattning

E: 68 \$C: [¹⁰ (no in the en+ I don't know in the end)]¹⁰ I don't think it has been I guess there were some / <¹ wh+ (...) >¹ I guess it was (a little lit+) gossip too <² / >² right I (...) I have / in particular now in many years that I <³ / >³ I don't know certain things I want to form an opinion myself

@ <¹ comment: checking on and touching freezer to the right of the table >¹

@ <² head movement: P nods >²

@ <³ clearing throat >³

S: 69 \$P: [¹⁰ nä]¹⁰

E: 69 \$P: [¹⁰ no]¹⁰

S: 70 \$P: ja

E: 70 \$P: yes

S: 71 \$C: om jag ser

E: 71 \$C: if I see

S: 72 \$P: var det [¹¹ lite]¹¹

E: 72 \$P: was it [¹¹ a little]¹¹

S: 73 \$C: [¹¹ stället]¹¹ om man ser på atmosfären < (...) >

E: 73 \$C: [¹¹ the place]¹¹ if you look at the atmosphere < (...) >

@ < head movement: P nods

S: 74 \$P: hade det dåligt rykte menar du

E: 74 \$P: did it have a bad reputation is that what you mean

S: 75 \$C: ja det hade väl lite sämre

E: 75 \$C: yes I guess it was a bit disreputable

Carl seems to be searching for the right words in C68 in extract 13, as indicated by change-related OCM operations like self-interruption and initiations of phrases that are abandoned. While using choice-related basic OCM phenomena like short pauses, but no hesitation sounds or expressions, Carl continues to speak, initiating one phrase after the other before his conversational partner in C74 contributes with a suggestion of inference from his utterances in C68.

Johan's word retrieval difficulties often force him to change his speech plan:

Extract 14: Johan (LHD)

S: 10 \$P: får får du skrivuppgifter eller får du skriva utifrån [³ /]³ utifrån dej själv liksom

E: 10 \$P: do do you get writing exercises or do you get to write from [³ /]³ from yourself so to speak

S: 11 \$J: [³ jag]³

E: 11 \$J: [³ I]³

S: 12 \$J: **jag brukar skri+ de+ ja+ eller / ta uppgifter ifrån öh/ ifrån öh/ ja typ eh jag skriver om shakespeare å så där**

E: 12 \$J: *I usually wri+ it+ I+ or / bring assignments from uh / from uh / yes type uh I write about shakespeare and so*

S: 13 \$P: < m >

E: 13 \$P: < m >

@ < head movement: P nods >

S: 14 \$J: skriver jag ner eh

E: 14 \$J: *I write down uh*

The example in C12, in extract 14, shows several choice-related OCM phenomena such as simple OCM expressions. He also performs change-related OCM operations like self-interruption and self-repetition.

Johan also demonstrates longer passages with consecutive changes of speech plan, as in C115 in extract 15.

Extract 15: Johan (LHD)

S: 112 \$P: så jag kan <¹ tänka mej att det ä väldigt <² lätt >¹ att du tar >² till den

E: 112 \$P: *so I can <¹ imagine that it <² easily >¹ happens that you make use >² of that*

@ <¹ head movement: P shakes >¹

@ <² hand gesture: P demonstrating grip in the air with left hand >²

S: 113 \$J: väldigt lätt ä det

E: 113 \$J: *it so easily happens*

S: 114 \$P: <¹ ja >¹ <² m >² m //

E: 114 \$P: <¹ yes >¹ <² m >² m //

@ <¹ ingressive >¹

@ <² head movement: P nods >²

S: 115 \$J: **ja så så ä det men eh / det ä så som man drabbas av det det ä bara å konstatera det att eh sen kvittar det vad man säger men // jag tror att det det enda ä för mej det det <¹ ä helt enkelt å1 binda bak den eller binda fram den så jag inte inte <² öve+ [¹⁶ ö+ ö+]¹⁶ >² <³ nä >¹ kan inte [¹⁷ över]¹⁷ huvudtaget kan jag måste >¹**

E: 115 \$J: *yes that that is what it's like like but uh / it is the way you are affected from it I I can merely state that uh and then it does not matter what ever you say but // I think that the only thing for me that that <¹ is to simply tie it behind me or in front of me so that I can't can't <² po+ [¹⁶ po+ po+]¹⁶ >² <³ no >³ can not [¹⁷ possibly]¹⁷ I have to >¹*

@ <¹ hand gesture: J demonstrating by putting his right hand to his back and then to stomach >¹

@ <² head movement: J shakes >²

@ <³ head movement: J shakes >³

S: 116 \$P: [¹⁶ så att du inte kan]¹⁶

E: 116 \$P: [¹⁶ so you can't]¹⁶

117 \$P: [¹⁷ nä]¹⁷

E: 117 \$P: [¹⁷ no]¹⁷

S: 118 \$P: ja

E: 118 \$P: yes

S: 119 \$J: < sträcka med den >

E: 119 \$J: < reach with this >

@ < hand gesture: J demonstrating by moving his right hand on the table >

Nevertheless he most often seems to find a way to continue expressing what he was planning to say.

Thomas only shows a few examples of having to change speech plan; see extract 1 in section 3.7.1.1 above. In C51, Thomas seems to be forced to change his speech plan because of word retrieval difficulties indicated by choice- and change-related OCM phenomena, but most of the time he actually seems able to fulfil his initiated speech plans and convey the intended message.

Nils' word retrieval difficulties also force him to change his speech plan. See, for example, C85 in extract 18 in section 3.7.2.1. In that extract, Nils demonstrates choice-related OCM phenomena and seems to have difficulty finding the right words to get his message across. Nils finally seems to abandon the attempt in C85 and instead initiates a related, and previously discussed, topic in C87.

3.7.2 Turn-taking

In this section, turn-taking issues will be analysed. It was hypothesised that the patterns of turn-taking would be qualitatively different for the LHD and RHD subjects due to their different symptoms of word-processing difficulties.

First, examples of turn transition will be explored. This will be followed by a discussion of the tendency to keep their turn, and the length and level of detail of the contributions by the four subjects.

3.7.2.1 Turn transition

Word retrieval difficulties might affect the ability to accept a turn and initiate a response. Both declining a turn and latency of response might be the result of word retrieval difficulties.

There are several indications in the video-recorded material that these problems are evident in Johan's conversational interaction:

Extract 16: Johan (LHD)

S: 8 \$J: < så de så att jag jag får med den handen så >

E: 8 \$J: *so i+ so that I I bring along that hand like that >*

@ < hand gesture continued: J shows right hand >

S: 9 \$P: < **ja just det / m1** > ///

E: 9 \$P: < **yes right / m** > ///

@ < head movement: P nods >

S: 10 \$P: får får du skrivuppgifter eller får du skriva utifrån [³ /]³ utifrån dej själv liksom

E: 10 \$P: do do you get writing exercises or do you get to write from [³ /]³ from yourself so to speak

S: 11 \$J: [³ jag]³

E: 11 \$J: [³ I]³

S: 12 \$J: jag brukar skri+ de+ ja+ eller / ta uppgifter ifrån öh/ ifrån öh/ ja typ eh jag skriver om shakespeare å så där

E: 12 \$J: *I usually wri+ it+ I+ or / bring assignments from uh / from uh / yes type uh I write about shakespeare and so*

In C9 in extract 16, above, the conversational partner leaves the floor open for Johan to further develop the topic of his writing exercises. However, Johan does not accept the turn and the conversational partner then asks him another question on that topic. This pattern repeats itself a few contributions later in C18; see extract 25 in section 3.7.3.2, below. In C18 the conversational partner again offers the floor and topic development to Johan, but he does not agree to embellish on the topic and the conversational partner initiates a new topic in C19.

The need for and benefit of extra time to be able to accept the turn and initiate a contribution is demonstrated in extract 15 above. The topic is the use of Johan's left hand to compensate for his weak right hand. Although there is some latency before Johan initiates a contribution in C115, he eventually accepts the turn and elaborates on the topic.

In extract 17 below, Thomas has frequent choice-related initial basic OCM expressions in the form of pauses, simple hesitation expressions and sounds indicating that he sometimes needs extra time for word retrieval and speech planning before he can initiate his utterances:

Extract 17: Thomas (LHD)

S:1 \$P: <¹när ni började bygga här >¹ hur <²hur / hur många var det som höll på å bygga samtidigt då >² // <³runt omkring här >³

E: 1 \$P: <¹when you started to build here >¹ how <²how / how many were building at the same time then >² // <³around here >³

@ <¹hand gesture: P pointing movement with left hand >¹

@ <²hand gesture: P pointing out through window with right hand >²

@ <³hand gesture: P pointing with circular movement with right hand >³

S: 2 \$T: <¹öh m / dom / <²det var >² s+ >¹samtliga / <³i första omgången för (...) >³

E: 2 \$T: <I uh mm / they / <²it was >² a+ >¹all of them / <³in the first round because (...) >³

@ <¹hand gesture: T pointing with left hand towards P >¹

@ <²head movement: T shakes >²

@ <³hand gesture: T pointing around in the air with left and right hand >³

S: 3 \$P: ja

E: 3 \$P: yes

S: 4 \$T: eh å dom var nog eh f+ färdiga före mej < eh / >

E: 4 \$T: uh and I think they were uh f+ finished before me < uh / >

@ <head movement: P nods >

S: 5 \$T: som regel var dom mm var dom gifta nåt nåt eh hade barn redan var <¹några >¹ <²år äldre >² å'

E: 5 \$T: generally they were mm they were married somewhat somewhat uh had children already were <¹a few >¹ <²years older >² and

@ <¹head movement: P nods >¹

@ <²hand gesture: T showing size with both hands >²

S: 6 \$P: < ja > / ja just det

E: 6 \$P: < yes > / right

@ <head movement: P nods >

S: 7 \$T: (...)

E: 7 \$T: (...)

S: 8 \$P: så ni var < några stycken som var igång här samtidigt > [/ med byggandet]

E: 8 \$P: so there were < some of you that were in progress here at the same time [/ building]

@ <hand gesture: P pointing circular movement in the air >

S: 9 \$T: [ja ja ja ja]

9 \$T: [yes oh yes]

The initial simple OCM expressions in C2 allow him to indicate that he is accepting the offered turn. Still, the conversational partner seems to be ready to hand over the floor to Thomas earlier in C1. The second pause in C1 demonstrates some latency in Thomas's turn-taking. This results in the conversational partner's specifying the question verbally and in a hand gesture in C8, uncertain whether the reason for Thomas's hesitation in taking the turn is that he does not understand. In C2, Thomas uses simple OCM expressions to show that he wants to keep the turn even though he is pausing due to need for word retrieval or other speech planning.

Both of the RHD subjects, Carl and Nils, apparently have more fluent speech than the LHD subjects. Carl seems somewhat reluctant to hand over the turn to his conversational partner. He dominates the floor throughout the recorded conversation, often interrupting and overlapping the conversational partner's speech. Neither Carl nor his spouse reported any change in frequency of difficulties in the initiation of speech or frequency of interrupting. However, if there are any word retrieval difficulties this does not show up in latency of response or difficulty initiating conversation. The analysis of turn-taking in the sample of recorded conversational interaction with Nils shows that he too tends to produce overlaps and interrupt the conversational partner but, as reported by both Nils himself and his wife, this is not a new post-stroke phenomenon.

In the analysed sample, there are also occasions when Nils seems to hesitate to accept or elaborate on a turn.

In the example of latency for response in extract 18, the conversational partner offers the floor to Nils by pausing in C80 and C82. However, Nils limits his contributions to minimal responses before he takes the floor in C85 by means of an overlap with the previous contribution by the conversational partner:

Extract 18: Nils (RHD)

S: 80 \$P: <¹ ja >¹ // ja // <² >² ja <³ jag vet ju att dom har ju >³ det ä ju ett <⁴ jä+ väldigt tryck alltså [³³ på >⁴ // på dom]³³
E: 80 \$P: <¹ yes >¹ // yes // <² >² yes <³ I do know that they have >³ it is a <⁴ gia+ great pressure you know [³³ on >⁴ // them]³³
@ <¹ ingressive >¹
@ <² inhalation sound: P >²
@ <³ head movement: P shakes >³
@ <⁴ head movement: P nods >⁴
S: 81 \$N: [³³ < > ja]³³ ja
E: 81 \$N: [³³ < > yes]³³ yes
@ < inhalation sound >
S: 82 \$P: skulle ju finnas / de skulle ju be+ få eh < vad heter det utvidga > eller det borde finnas fler ställen alltså // de kan ju omöjligt på rehab centret hinna med //
E: 82 \$P: there ought to be / they should ne+ let them < what's it called expand > or it ought to be more places you know // they can't possibly at the rehab centre manage //
@ < hand movement: P right hand moving up >
S: 83 \$N: < nä >
E: 83 \$N: < no >
@ < inhalation sound: N >

S: 84 \$P: det ä [³⁴ ett sånt jättestort behov]³⁴
 E: 84 \$P: *there is [³⁴ such a gigantic need]³⁴
 S: 85 \$N: [³⁴ <¹ >¹ nä jag hörde]³⁴ jag hörde ju öh det skulle ju bli nåt eh annat dom skulle bygga till där på rehab centret <² dom fick eh nåt för strokedrabbade där upp så att dom liksom slås samman >² jag menar rehabilitering /
 E: 85 \$N: [³⁴ <¹ >¹ no I heard]³⁴ why I heard uh there was going to be something uh else they were to extend over there at the rehab centre uh <² they got uh something for people who suffered a stroke up there such as they kind of are going to be joined >² I mean rehabilitation /
 @ <¹ inhalation sound: N >¹
 @ <² hand movement: N both hands held up and moving>²
 S: 86 \$P: < ja >
 E: 86 \$P: < yes >
 @ head movement: P nods
 S: 87 \$N: eh det det finns ju eh det var samma när jag kom från < name >
 E: 87 \$N: *uh there isn't is there uh it was the same when I got home from < name >*
 @ < comment: name of hospital >*

It is actually possible that Nils is already planning to initiate the new topic in C81, but that he is constrained by word retrieval difficulties or having problems initiating speech for some other reason.

3.7.2.2 Length and level of detail in contributions

Johan produces several very short responses, especially at the beginning of the conversation. This is in accordance with the post-stroke change reported by Johan and his spouse. His longer, more detailed responses are often the result of word retrieval difficulties forcing him to engage in self-initiated self-repair. More detailed responses due to word-processing difficulties can also be noticed as Johan is sometimes forced to exemplify, describe or demonstrate instead of producing more comprehensive and efficient verbal expressions for what he intends to say; see, for example, extract 15 presented in section 3.7.1.2.

The long and detailed utterances made by Nils, one of the RHD individuals, might also often be the result of word retrieval difficulties, forcing him to list and exemplify several of the parts included in a superordinate notion that he does not have access to; see, for example, C66 and C70 in extract 7 above. Nils also sometimes produces very short utterances, seemingly hesitating to elaborate on his turn, as in extract 18 above.

The level of detail in Thomas's contributions in the analysed sample seems to be adequate in the context. However, he and his spouse reported an increase in short responses and a decrease in long and detailed responses.

Carl was described by a member of his family as being unusually talkative post-stroke, and he also self-reported that his responses were long and very detailed more often since the stroke. Carl seldom produces short responses or minimal acknowledgement. His narratives are often filled with sometimes unnecessary details. These details often seem to lead to topic drift where Carl is led away from the initiated speech plan, and seemingly even the intended message, by activating further associations. When the example in extract 19 below starts, the previous topic had been polite behaviour and how to teach politeness to children. In C32, it suddenly develops into the topic of fear of a specific group of people, punks, who used to visit a club at Sprängkullsgatan in Gothenburg; it then turns into the detailed description of the background of a planned meeting with a person:

Extract 19: Carl (RHD)

S: 29 \$P: nä det gör man inte men man kan ju vara en bra förebild så

E: 29 \$P: *no you don't but you can serve as a good model like that*

S: 30 \$C: ja man försöker å så förklara då / så / [⁵ att]⁵ att det finns en del

E: 30 \$C: *yes you try and then explain then / so / [⁵ that]⁵ that there are some*

S: 31 \$P: [⁵ < m >]⁵ m

E: 31 \$P: [⁵ < m >]⁵ m

@ head movement: P nods

S: 32 \$C: för det ä man noga för jag har jag sett på motorpojkar å pojkar inte vågar åka till / p+ att de inte vågar åka å hämta punkare / på sprängkullsgatan innan de byggde [⁶ högskolan]⁶ där < >

E: 32 \$C: *because that you do make a point because I have I seen motor boys and boys don't dare to go to / p+ that they don't dare to go and pick up punks / at sprängkullsgatan before they build the [⁶ university]⁶ there < >*

@ < laughter: C >

S: 33 \$P: [⁶ ja]⁶ nä just det på sprängkullen ja

E: 33 \$P: [⁶ yes]⁶ *no right at sprängkullen right*

S: 34 \$C: (ja)inte gamla sprängkullen det var

E: 34 \$C: *(well) not the old sprängkullen it was*

S: 35 \$P: [⁷ men det var inte (...)]⁷

E: 35 \$P: [⁷ but that was not (...)]⁷

S: 36 \$C: [⁷ (...)]⁷ dans det var väl / nä jag var inte å dansa jag gick inte jag kunde dansa så jag gick inte dit så var det en tjej som blev sur / för att jag inte kom in men < (...) (istället) >

E: 36 \$C: [⁷ (...)]⁷ *dance it was I guess / no I was never there and danced I didn't go I could dance and such I didn't go and then there was a girl that got cross / because I didn't go in but < (...) (instead) >*

@ < laughter: C >

S: 37 \$P: du du vad
 E: 37 \$P: you you what
 S: 38 \$C: (...) (träffades)
 E: 38 \$C: (...) (met)
 S: 39 \$P: du skulle ha gått på sprängkullen
 E: 39 \$P: you should have gone to sprängkullen
 S: 40 \$C: ja det hon sa det /
 E: 40 \$C: yes it she said so /
 S: 41 \$P: ni skulle [⁸ mötas]⁸
 E: 41 \$P: you were supposed [⁸ to meet]⁸
 S: 42 \$C: [⁸ det var]⁸ (en mor) som bjudit hem / två / en till å så mej
 E: 42 \$C: [⁸ it was]⁸ (a mother) who had asked us to her home / two / one other and me
 S: 43 \$P: ja
 E: 43 \$P: yes
 S: 44 \$C: när vi jobba vid järnvägen
 E: 44 \$C: when we worked on the railroad
 S: 45 \$P: ja ja < >
 E: 45 \$P: yes right < >
 @ < head movement: P nods >
 S: 46 \$C: hon jobba själv vid järnvägen
 E: 46 \$C: she worked on the railroad herself
 S: 47 \$P: < m >
 E: 47 \$P: < m >
 @ < head movement: P nods >
 S: 48 \$C: vi bodde i gårda gamla gårda
 E: 48 \$C: we lived in gårda old gårda
 S: 49 \$P: m
 E: 49 \$P: m
 S: 50 \$C: hon hade (två tj+) flickor ja / det blir ju så
 E: 50 \$C: she had (two chi+) girls yes / it is like that isn't it
 S: 51 \$P: m
 E: 51 \$P: m
 S: 52 \$C: < (...) >
 E: 52 \$C: < (...) >
 @ < laughter: C >
 S: 53 \$P: men då då skulle ni mötts på sprängkullen
 E: 53 \$P: but then then you were supposed to have met at sprängkullen
 S: 54 \$C: ja
 E: 54 \$C: yes
 S: 55 \$P: < **men du** [⁹ **hade** > **kunde inte komma**]⁹
 E: 55 \$P: < but you [⁹ had > couldn't make it]⁹
 @ < head movement: P shakes >
 S: 56 \$C: [⁹det blev inte]⁹ nä det blev jag vet inte vad jag varit ute på
 E: 56 \$C: [⁹ it didn't come]⁹ no it didn't come I don't know what I was up to

In extract 12 presented in section 3.7.1.2 above the sample from the recorded interaction with Carl also offers examples of excessive detail. He is initiating a narrative about his visit to a medical clinic because of a rash on his hand. The main message of the narrative is actually that he went by mistake to a clinic specialising in

venereal disease. Even though he eventually gets to the main point of his narrative, it starts in C167 with a detailed description of how he got the rash in the first place. The information about the ownership of the house, the amount of work he did (C169) and how the work with the garbage bins was done (C171) is not important for the main message of the narrative. In the example in extract 20, Carl is talking about the recommended treatment for the rash:

Extract 20: Carl (RHD)

S: 184 \$C: frågade doktorn nä det var bara till å tvätta med bristvål [²³ det]²³ var bris tvål fanns inte **jag har la några provtvålar sen jag / jobbade på snabbgr+ det var en snäll tant som / gav oss mej då som prov då när hon skulle sluta**

E: 184 \$C: *asked the doctor no it was just to wash with bris soap [²³ it]²³ was bris soap wasn't to be found why I have some sample soaps since I worked at the wholesa+ it was a nice lady who / gave us me then as a sample then when she was to leave*

Although the details about where and why he had got the soap are in some sense related, they are perhaps not fully relevant in this context.

3.7.3 Repair

Word-processing difficulties and strategies to handle these problems might result in the need for repair. It was hypothesised that the RHD subjects would show less obvious difficulty in managing self-repair than the LHD subjects. The presentation of repair issues in the recorded conversational interaction is divided into self-initiated repair and other-initiated repair due to the results of the data-driven analysis of the video-recordings, which indicate that the pattern of other-repair might be different between the four subjects.

3.7.3.1 Self-initiated repair

Johan, one of the LHD subjects, often engages in self-initiated self-repair. In extract 2, presented in section 3.7.1.1, there are both hesitation sounds in the form of basic simple expressions and basic OCM operations like self-interruption and self-repetition. The word-processing difficulties force him to change his speech plan

several times in an effort to repair and search for an appropriate expression for his main message. He also seems to use the possibility of visually demonstrating by showing his right and left hands as a supplement to the verbal expressions. See, for example, C76–C78 in extract 6, also in section 3.7.1.1 above, where he is able to successfully self-repair his discourse even though he sometimes needs other-repair.

Word-processing difficulties sometimes make the utterances unspecific in a way that induces the conversational partner to initiate repair; see section 3.7.3.2 below.

Thomas, the other LHD individual, also shows several examples of self-initiated self-repair through change-related OCM operations in the form of self-interruptions and self-repetitions of speech sounds and words. In extract 8, in section 3.7.1.2 above, Thomas produces examples of self-initiated self-repair. This takes the form of specifying in C123. The reformulation in C125 is probably due to word retrieval difficulties, forcing Thomas to change his speech plan. In the analysed sample of conversational interaction, Thomas successfully performs self-repair.

Carl, one of the RHD individuals, also sometimes engages in self-initiated repair, often successfully:

Extract 21: Carl (RHD)

S: 11 \$C: å de har de ju lagt igen (...) det var såna här <¹ (tjocka) järndörrar som går så här det hade vi i (...) >¹ <² >² det var en pojk som <³ öppna dörren >³ åt / för å sticka ut det var en sån här <⁴ liten han var väl lite lite högre än bordet >⁴ **å hon eh frun stod i kassan / eller mamma / i kassakön** jag eh stod också men jag var väl inte / behövde inte stå så / å så tittade jag hela <⁵ tiden >⁵ på den här

E: 11 \$C: and that have been closed up (...) it was such <¹ (thick) iron doors that moves like this we had that in (...) >¹ <² >² it was a boy who <³ opened the door >³ for / to run out it was a like about this <⁴ size he was just a little above the table I guess >⁴ and **she uh the wife was standing at the counter / or the mother / in line at the counter** I uh was also standing but I guess I was not / didn't have to stand like that / and so I <⁵ kept >⁵ watching this

@ <¹ hand gesture: C showing thickness with both hands >¹

@ <² head movement: P turning head to look into other room where spouse goes by >²

@ <³ hand gesture: C showing opening door with left hand >³

@ <⁴ hand gesture: C showing size with left hand >⁴

@ <⁵ hand gesture: C pointing with left hand >⁵

S: 12 \$P: m

E: 12 \$P: m

In the example in extract 21, in C11 Carl himself initiates and performs successful self-repair in changing the semantic paraphasia ‘wife’ to the more appropriate

'mother'. The paraphasia is preceded and followed by the basic simple OCM expressions 'uh' related to choice and speech planning and the change-related 'or'. He also demonstrates that he is monitoring his speech production in orientation to the listener's perspective by choosing to specify his utterance in changing the phrase 'standing at the counter' to the phrase 'in line at the counter'.

Other examples from the conversational interaction with Carl also show that he is able to perform successful self-initiated self-repair. In C50 in extract 19 presented in section 3.7.2.2 above, Carl uses the change-related self-interruption, perhaps to adapt his choice of words from the more casual 'chicks' to 'girls'.

Several of the examples of self-initiated repair from the conversational interaction with Carl are related to change and take the form of substitution of one word for another.

However, instead of engaging in repair sequences, Carl sometimes seems to abandon his initial speech plan and sometimes his planned message as well. In C18 in extract 30, in section 3.7.3.2 below, Carl abandons the narrative of the encounter with a young boy when he fails to recall what was said. Instead of engaging in self-repair, he starts recalling a meeting with another young boy.

There are several examples of Carl abandoning his initial speech plan and instead starting to speak about something else. These occurrences may appear in association with word-processing failures. In C196 in extract 22 below, Carl seems to be planning to talk about something a friend had told him, although this attempt is abandoned in C200 where he instead initiates a new topic.

Extract 22: Carl (RHD)

193 \$P: < jasså du såg [²⁵ träffade]²⁵ honom på > kliniken där
E: 193 \$P: < **I see you saw** [²⁵ met]²⁵ **him at the clinic there**
@ < head movement: P nods
S: 194 \$C: [²⁵ ja]²⁵
E: 194 \$C: [²⁵ yes]²⁵
S: 195 \$C: ja
E: 195 \$C: yes
S: 195 \$P: jaha < >
E: 195 \$P: I see < >
@ < laughter starts: P >

S: 196 \$C: <¹ **så sa han** då träffade jag honom sedan på kvällen>¹ <² **så sa han** >² men det var då
 E: 196 \$C: <¹ **then he said** then I met him later in the evening >¹ <² then he said >² but that was then
 @ <¹ laughter continued: P>¹
 @ <² laughter: C and P>²
 S: 197 \$P: vad lustigt
 E: 197 \$P: how funny
 S: 198 \$C: **gäng ja**
 E: 198 \$C: **gang yes**
 S: 199 \$P: ja
 E: 199 \$P: yes
 S: 200 \$C: det hade jag < // > det har jag varit inne på / s+ skogome en gång då fick jag gå å titta på barackerna så jag hitta ut när jag skulle hämta en frisör där en tjej
 E: 200 \$C: I had < // > it I have been in at / s+ skogome once then I had to go and look at the barracks so I could find my way out when I was to pick up a hairdresser there a chick
 @ < head movement: P nods >

There are no obvious OCM phenomena or other signs of active word processing in C196–C198. Still, the preceding sequence, C188–C193, see extract 23, below, involves other-initiated self-repair:

Extract 23: Carl (RHD)

S: 186 \$C: å sen / jo så träffa jag // en fångvaktare /
 E: 186 \$C: and then /oh yes then I met // a warder /
 S: 187 \$P: uhum
 E: 187 \$P: uhum
 S: 188 \$C: ifrån skogome / han hade en massa <¹ **pa+** >¹ / den träffa jag sen för han jobbade på liseberg som vakt där (för jag träffa ...) haft ett gäng <² med >² sig dit då va / ifrån skogome
 E: 188 \$C: from skogome / he had a lot of <¹ **pa+** >¹ / that one I met later because he worked at liseberg as a guard (because I met ...) had a gang <² with >² him there then see / from skogome
 @ <¹ head movement: P nods>¹
 @ <² head movement: P nods>²
 S: 189 \$P: på liseberg
 E: 189 \$P: at liseberg
 S: 190 \$C: /n+ / nä [²⁴ nä på där]²⁴
 E: 190 \$C: /n+ / no [²⁴ no at there]²⁴
 S: 191 \$P: [²⁴ < var träffade du honom >]²⁴
 E: 191 \$P: [²⁴ < where did you meet him >]²⁴
 @ < body movement: leans towards P >
 S: 192 \$C: på / på det här sociala huset
 E: 192 \$C: at / at this sociala huset

Carl's fragmented utterance in C196 in extract 22 is partly involved in self-repair. He is trying to clarify that he had met the same person twice on the same day, once in the clinic, and then in the evening at the amusement park Liseberg. After this effort to

repair and clarify the time and place of the encounter, in C196 and C198 in extract 22, he fails to account for what the person actually said.

Nils, the other RHD individual, shows examples of change-related OCM phenomena that may be associated with self-repair in his conversational interaction. In C44 in extract 9, in section 3.7.1.2 above, he first produces simple basic OCM expressions such as hesitation sounds; this is followed by an OCM operation in the form of self-interruption and then another hesitation sound and a change of speech plan before he successfully completes his contribution.

In the next example, Nils realises that the conversational partner has misunderstood his contribution in C127; see extract 24 below. The OCM phenomena in the form of choice-related hesitation sounds and a long pause in C127 indicate that Nils might be having word retrieval problems here:

Extract 24: Nils (RHD)

S: 127 \$N: men eh å <¹ där var ju >¹ bra dom var ju eh /// det klart det ä ju inte annorlunda än <² där >² än <³ det ä >³ på rehab centret

E: 127 \$N: but uh and <¹ that was all right >¹ I guess they were **uh** /// naturally it is not different than <² there >² than <³ it is >³ at the rehab centre

@ <¹ head movement: N shakes >¹

@ <² head movement: N nods >²

@ <³ hand movement: N pointing with right hand >³

S: 128 \$P: < nä det ä dom räcker ju inte till > // [⁴⁴ de]⁴⁴

E: 128 \$P: < no it is they can't manage > // [⁴⁴ they]⁴⁴

@ < head movement: P shakes >

S: 129 \$N: [⁴⁴ nä]⁴⁴ men det ä ju <¹ samma >¹ **eh** <² liksom öh[⁴⁵ /]⁴⁵ samma // >²

E: 129 \$N: [⁴⁴ no]⁴⁴ but it is isn't it <¹ the same >¹ **uh** <² sort of uh [⁴⁵ /]⁴⁵ the same // >²

@ <¹ head movement: N nods >¹

@ <² hand movement: N moving both hands in front of him >²

S: 130 \$P: [⁴⁵ ja ja samma /]⁴⁵

E: 130 \$P: [⁴⁵ yes yes the same /]⁴⁵

S: 131 \$P: < typ av > träning å [⁴⁶ så ja]⁴⁶ dom har

E: 131 \$P: < type of > training and [⁴⁶ such yes]⁴⁶ as they have

@ < head movement: P nods >

S: 132 \$N: [⁴⁶ ja]⁴⁶

E: 132 \$N: [⁴⁶ yes]⁴⁶

S: 133 \$N: det ä samma

E: 133 \$N: it's the same

S: 134 \$P: ja

E: 134 \$P: yes

S: 135 \$N: ungefär

E: 135 \$N: more or less

Though he initiates repair in C129 in extract 24 above, he is not able to complete it successfully. His word retrieval difficulties, indicated by the OCM phenomena and a gesture, limit him to repeating the same word. He does not seem to be able to produce any circumlocutions either. In C131 his conversational partner performs the repair in suggesting an interpretation confirmed by Nils in C132.

There are also other occasions when Nils seems to abandon his urge to perform self-repair; see, for example, extract 18 presented in section 3.7.2.1. In extract 18, Nils is initiating and trying to perform self-repair through a change of speech plan in C85. He is not successful in accounting for the planned development of the rehabilitation clinic and abandons the topic, instead returning to the topic discussed before that.

3.7.3.2 Other-initiated repair

The analysis of the video-recorded conversational interactions indicates that, although there were sequences of other-initiated repair in all four samples of conversational interaction, the occurrences of other-initiated repair differed for the two RHD cases and the two LHD cases. Contributions where the conversational partner suggests an interpretation of an earlier contribution by the subject were collected for comparison.

Those suggestions generally involve:

1. a request for confirmation of an inference made about the intended meaning of a previous utterance, or
2. a request for confirmation of an inference made about the intended referent of a pronoun or an adverb of place.

In extract 17 presented in section 3.7.2.1 above, there is an example that can be considered as a request for confirmation of an interpretation made by Thomas's conversational partner. In this case, in C8 the conversational partner reformulates and summarises Thomas's contributions as a response to the question asked in C1. The

conversational partner suspects that Thomas did not understand the question as intended. This might explain his somewhat unspecific answer.

In the analysed sample of conversational interaction with Johan, there are several cases where the conversational partner requests confirmation of an interpretation. There are examples that can be regarded as requests for confirmation of an inference made: in extract 25, in C15 and C17 the conversational partner infers from the statement Johan made in C12 that he is interested in Shakespeare. This is an inference made by the conversational partner based on her knowledge that Johan is interested in the theatre and in an attempt to determine the relevance of the information expressed in C12.

Extract 25: Johan (LHD)

S: 12 \$J: jag brukar skri+ de+ ja+ eller / ta uppgifter ifrån öh/ ifrån öh/ ja typ eh jag skriver om shakespeare å så där

E: 12 \$J: I usually wri+ it+ I+ or / bring assignments from uh / from uh / yes type uh I write about shakespeare and such

S: 13 \$P: < m >

E: 13 \$P: < m >

@ < head movement: P nods >

S: 14 \$J: skriver jag ner eh

E: 14 \$J: I write down uh

S: 15 \$P: <¹ <² m >¹ >² sånt som känns [⁴ /]⁴ som du ä intresserad av

E: 15 \$P: <¹ <² m >¹ >² such that feels [⁴ /]⁴ as you are interested in

@ <¹ head movement: P nods >¹

@ <² hand gesture: P points to J >²

S: 16 \$J: [⁴ < ja >]⁴

E: 16 \$J: [⁴ < yes >]⁴

@ < head movement: J nods >

S: 17 \$J: ja

E: 17 \$J: yes

S: 18 \$P: < m > / m //

E: 18 \$P: < m > / m //

@ < head movement: P nods >

S: 19 \$P: du hade ju var inte du så / du / ä skådespelare egentligen (...)

E: 19 \$P: you had hadn't you weren't you such / you / are an actor really (...)

S: 20 \$J: < ja >

E: 20 \$J: < yes >

@ < head movement: J nods >

Again Johan's word retrieval difficulties force him to give an example (Shakespeare) and an unspecific reference, 'and such', instead of providing more comprehensive

information such as *'I get to choose the topic for my writing myself'*. Johan often uses the expression *'and such'* to round off his contributions. The conversational partner is not certain that her interpretation is correct and she initiates repair through a request for confirmation. This is also provided by Johan, who confirms the interpretation in his feedback in C16.

In another example from the interaction with Johan, his past as an actor has been established and the topic is his interest in the theatre:

Extract 26: Johan (LHD)

S: 24 \$J: det ä // men / < det ä inget som jag pysslar med nu i alla fall >

E: 24 \$J: *that is // but / < that is not something I do now anyway >*

@ < head movement: J shakes >

S: 25 \$P: < nä >

E: 25 \$P: < no >

@ < head movement: P nods >

S: 26 \$J: < nä > /// (det ä det inte)

E: 26 \$J: < no > /// (it is not)

S: 27 \$P: < // > men du har ett teaterintresse ändå som du /

E: 27 \$P: < // > *but you do have an interest in theatre anyhow which you /*

@ < head movement: P nods >

S: 28 \$J: < ja / > jag har men det klart jag har ett teaterintresse visst har jag det ///

E: \$J: < yes / > *I have but certainly I do have an interest in theatre by all means ///*

@ < head movement: J nods and shakes >

S: 29 \$P: men du ä ingen < fanatiker / [⁵ eller]⁵ >

E: 29 \$P: *but you are not < fanatic about it / [⁵ or]⁵ >*

@ < laughter starts: P >

S: 30 \$J: < [⁵ nä]⁵ det ä jag inte > ///

E: 30 \$J: < [⁵ no]⁵ *I am not > ///*

@ < laughter stops: P >

S: 31 \$J: sen finns detså mycket omkring det alltså / det var så mycket med buss å med det **ena å andra å så där**

E: 31 \$J: *there is also so many things involved in that see / it was a lot with buses and **one thing and another like that***

S: 32 \$P: m //

E: 32 \$P: *m //*

S: 33 \$J: m när allt skulle fungera å så

E: 33 \$J: *m when everything had to work and things like that*

S: 34 \$P: <¹ // >¹ **mycket fixande runt [⁶ omkring som var <² / >²]⁶**

E: 34 \$P: <¹ // >¹ *a lot of arrangements with other things [⁶ involved that was <² / >²]⁶*

@ <¹ head movement: P nods >¹

@ <² head movement: P nods >²

S: 35 \$J: [⁶ ja väldigt]⁶ /

E: 35 \$J: [⁶ yes very]⁶ /

S: 36 \$P: jobbigt å /

E: 36 \$P: *tough and /*

S: 37 \$J: ja tidlig tids+ / ö+ ödande

E: 37 \$J: *yes timely time+ / c+ consuming*

S: 38 \$P: **ja så ni var ute å turnerade du var med i någon / < fri grupp [7 eller]7 >**

E: 38 \$P: *yes so you were out on tour you were a member of an / < independent theatre group [7 or]7 >*

@ < head movement: P shakes and nods >

S: 39 \$J < [7 ja just det]7 >

E: 39 \$J < [7 yes right]7 >

@ < head movement: J nods >

S: 40 \$P: **å så var det mycke att ligga på landsvägen då [8 (å sånt där)]8**

E: 40 \$P: *and it was a lot about travelling around on county roads then [8 (and such)]8*

S: 41 \$J: [8 ja]8

E: 41 \$J: [8 yes]8

Johan's word retrieval difficulties again force him to make a vague contribution in C31 above. The conversational partner has to make an inference from the given information in association with general knowledge about life as an actor in an independent theatre group and requests confirmation of the suggested interpretation in C38 and C40. C34 involves a suggestion of a referent for the expression 'one thing and another' (C31), which however, is also vaguely defined: 'a lot of arrangements with other things involved' (S: *mycket fixande runtomkring*).

One of the most prominent impressions from the bottom-up analysis of the conversational interaction with Carl, one of the RHD individuals, in addition the stream of new topics and his domination of the floor, are the numerous occasions of other-initiated repair. Carl's fluent speech, topic development and numerous, sometimes irrelevant, details sometimes make it difficult to follow his narratives. There are several examples of the conversational partner's initiating repair. In extract 19 in section 3.7.2.2 above, the conversational partner initiates repair in C37 with a request for clarification. In C39, a suggested interpretation is presented. Carl confirms this in C40, but does not specify it any further. The conversational partner makes another, more specified, suggestion in C41. Carl then begins to specify and gives several details about who he was supposed to meet in C42–C50. However, this is not information requested by the conversational partner, who still seems to be struggling with whether Carl had actually met the girl in Sprängkullen or not. In C53, the conversational partner again initiates a suggested interpretation, which is completed in C55.

C67 to C74 in extract 13, in section 3.7.1.2, represent another example of other-initiated repair in the conversation with Carl, due to several abandoned speech plans in this case.

Although Nils, the other RHD individual, often actually recalls the names of people and places, his contributions are often unspecific nonetheless:

Extract 27: Nils (RHD)

S: 116 \$N: nä nä det ä inte så dom pratar ju om detta med rehabilitering å ^{[⁴¹ <¹ <² >² >¹]⁴¹ å <³ hon eh >³ som var där ute på <⁴ name >⁴ <⁵ name >⁵ (...) det ä så jättefint här <⁶ va >⁶}

E: 116 \$N: oh no it's not like that they talk about this with rehabilitation and ^{[⁴¹ <¹ <² >² >¹]⁴¹ and <³ she uh >³ who was out there at <⁴ name >⁴ <⁵ name >⁵ (...) it is so very nice here <⁶ you know >⁶}

@ <¹ inhalation sound: N >¹

@ <² click: N >²

@ <³ hand movement: N pointing with right hand >³

@ <⁴ comment: name of hospital >⁴

@ <⁵ comment: name of doctor >⁵

@ <⁶ hand movement: N both hands moving outwards >⁶

S: 117 \$P: [⁴¹ ja]⁴¹

E: 117 \$P: [⁴¹ yes]⁴¹

S: 118 \$P: ja //

E: 118 \$P: yes //

S: 119 \$N: så kom vi så fick vi gå en dag i veckan

E: 119 \$N: and then when we got there we could come once a week

S: 120 \$P: på på [⁴² dagrehabiliteringen där]⁴²

E: 120 \$P: at at [⁴² the day care rehab over there]⁴²

S: 121 \$N: [⁴² ja ja]⁴² men det räcker inte vet du

E: 121 \$N: [⁴² yes right]⁴² but it is not enough you know

In this example, Nils mentions the name of the hospital but he does not make it clear that he is speaking about the day care rehabilitation centre. The conversational partner makes the inference that this is the case from C119, but initiates repair as a request for confirmation of the inference in C120.

Nils produces other examples of unspecific contributions, probably due to word retrieval difficulties:

Extract 28: Nils (RHD)

S: 47 \$N: men det ä ju men jag har sett det det ä många som ger fan i å gå dit å det eh det ä ju ont om platser också va

E: 47 \$N but it is isn't it but I have seen it it is many who don't bother going and it uh there is not enough seats in the courses too see

S: 48 \$P: ja då ä det ju synd om dom tar [¹⁹ upp en plats å inte]¹⁹

E: 48 \$P: yes why then it is a pity if they take up [¹⁹ a seat and don't]¹⁹
S: 49 \$N: [¹⁹ ja ja ja ja]¹⁹ men som inte ä så där <¹ eh >¹ <² >² en del eh lägger märke till å /
E: 49 \$N: [oh yes oh yes]⁹ but whom isn't like that <¹ uh >¹ <² >² like some uh notices and /
 @ <¹ head movement: N shake >¹
 @ <² clear throat: P >²
S: 50 \$P: m / men menar du att det ä många som har anmält sig å börjar [²⁰ på en kurs å så]²⁰
E: 50 \$P: m / but do you mean that it is many who has registered and starts [²⁰ on a course and then]²⁰
S: 51 \$N: [²⁰ ja < å så]²⁰ rätt vad det ä så försvinner dom > då va
E: 51 \$N: [²⁰ yes < and then]²⁰ all of a sudden they disappear > see
 @ < head movement: N shakes >
S: 52 \$P: ja
E: 52 \$P: yes

In this example, in C48 the conversational partner actually seems to have grasped the main message in C47. Nevertheless, when Nils confirms the inference in his positive feedback in C49 but also produces the adversative conjunction ‘but’ in association with an unspecific contribution, the conversational partner has to revise the inference made and in C50 requests confirmation of the inference.

In extract 7, presented in section 3.7.1.1, Nils’ word-processing difficulties, indicated by the frequent use of basic OCM phenomena, again result in unspecific contributions forcing the conversational partner to initiate repair in a request for confirmation of the inferences made. Nils describes his physical training activities. In C63 the conversational partner infers from C61 that Nils was using exercise machines instead of participating in group training. In C65 the conversational partner tries to find out whether this actually is the case or whether Nils was taking a physical training program, without machines, on his own. The repair sequence initiated in C65 is continued in C71, where the conversational partner explicitly suggests that Nils had been using exercise machines instead of the planned group training. Nils seems to confirm this in C72.

There are also other-initiated repair sequences associated with the anaphoric use of pronouns and place adverbs. In the example with Johan in extract 29, the conversational partner requests clarification and more specific information in C47 and C49. C47 also involves a request for confirmation of the inference made of referent for ‘it’ in C46.

Extract 29: Johan (LHD)

S: 46 \$J: men sen ä de / kanske man inbillar sej det också men / jag tror att ett / <¹ kans+ >¹ // <² det ä en sån känsla jag har >² / att på nåt sätt de{t] ä / tror jag att eh / men det ä <³ såna de{t] ä såna >³ känslor det det ä sån // men att det // alltså det skulle vara u+ <⁴ bidragande orsak >⁴ orsak att jag fick stroke det tror jag faktiskt / men <⁵ det det det >⁵ / det säger en del att det <⁶ ä inte så >⁶ att det ä helt fel å så där

E: 46 \$J: *but then it is / maybe it's all in my imagination too but / I think that a / <¹ may+ >¹ // <² it is a feeling I have got >² / that in some way it is / I think it uh / but it is / <³ such it is such >³ feelings it it is such // but that it // I mean it should be the tr+ <⁴ contributory cause >⁴ cause for me having the stroke I really think so / but <⁵ that that that >⁵ / that some say it <⁶ is not like that >⁶ that it is completely wrong and so*

@ <¹ head movement: J shakes >¹

@ <² head movement: J nods >²

@ <³ head movement: J shakes >³

@ <⁴ head movement: J nods >⁴

@ <⁵ head movement: J shakes >⁵

@ <⁶ head movement: J shakes >⁶

S: 47 \$P: **m hur hur tänker du då att att det skulle vara bidragande eh det < livet > menar du [° /]° att det**

E: 47 \$P: *m but how are your thoughts about this that that it would be contributory uh that < life > do you mean [° /]° that it*

@ <hand gesture: P points to J>

S: 48 \$J: [° <¹ nä >¹]° / <² ja kanske lite livet också >² ///

E: 48 \$J: [° <¹ no >¹]° / <² yes maybe a little that life too >² ///

@ <¹ head movement: J shakes >¹

@ <² head movement: J nods >²

S: 49 \$P: **på vilket < sätt tänker > du att det skulle vara /**

E: 49 \$P: *in what < way do you think > that it would be /*

@ <hand gesture: P points with left hand to J >

S: 50 \$J: < nja > //

E: 50 \$J: < well > //

@ < head movement: J shakes >

S: 51 \$P: **det runt < omkring > menar du att vara ute på turné å [° så där]°**

E: 51 \$P: *things < involved > do you mean being on tour and [° things like that]°*

@ <hand gesture: P makes circular movements in the air with left hand >

S: 52 \$J: < [° ja]° > lite grann tror jag men

E: 52 \$J: < [° yes]° > a little bit I think but

@ < head movement: J nods >

S: 53 \$P: m

E: 53 \$P: m

S: 54 \$J: men det ä ett väldigt väldigt eh / speciellt liv

E: 54 \$J: *but it is a very very uh / special life*

Johan does not successfully clarify matters in C48, and in C51 the conversational partner suggests an interpretation which Johan at least partly confirms in C52.

Except for the example from Johan above, most of the other-initiated repairs due to reference use are seen in the interaction with the two RHD individuals. There are several examples of this in the recorded conversational interaction with Carl:

Extract 30: Carl (RHD)

S: 18 \$C: men jag var på sekunden jag <¹ rusa >¹ på / så sa du får akta dej så sa // å det var ungefär en pojke i samma ålder / samma längd / som öppna en dörr på ett annat ställe det var också en ung mamma / å jag sa tack <² å >² hon blev så himla förvånad för det

E: 18 \$C: *but I was there in half a tick I <¹ ran >¹ forward / then said you have to watch out then said // and it was pretty much a boy in the same age / same length / that opened a door in another place that was a young mother too / and I said thank you <² and >² she got so very surprised because of that*

@ <¹ hand gesture: C left hand up showing fist >¹

@ <² head movement: P nods >²

S: 19 \$P: **för** [³ **att du sa tack**]³

E: 19 \$P: *because* [³ *you said thank you*]³

S: 20 \$C: [³ det gör en inte]³ ja det sa [⁴ jag]⁴ respekterar det < han ([⁵ kommer]⁵ju sn+) > växer ju han också han ska väl lära sig

E: 20 \$C: [³ *you don't do that*]³ *yes I told* [⁴ *I*]⁴ *respect that < why he ([⁵ will]⁵ soo+) > is also growing up he ought to learn*

@ < hand gesture: C pointing with right hand >

S: 21 \$P: [⁴ **nä**]⁴

E: 21 \$P: [⁴ *no*]⁴

S: 22 \$P: [⁵ **ja**]⁵

E: 22 \$P: [⁵ *yes*]⁵

In this example in extract 30, the conversational partner requests in C19 a confirmation of the inference made from the utterance in C18. Carl uses the pronoun ‘it’ anaphorically, referring back to his saying ‘thank you’ to the young boy who opened the door for him. Even though the pronoun refers to the linguistic entity last mentioned, the conversational partner is not certain, probably due to the topic drift in C18, and needs confirmation.

The topic development in the conversation with Carl often results in uncertainty about referents of anaphora:

Extract 31: Carl (RHD)

S: 104 \$P: ja

E: 104 \$P: *yes*

S: 105 \$C: å det var det sa dom också lite skumt det var lite (många) sjömän där / [¹⁴ (...)]¹⁴

E: 105 \$C: *and that was they said also a little fishy it was rather (many) sailors there / [¹⁴ (...)]¹⁴*

@ < head movement: P nods >

S 106 \$P: / [¹⁴ **var det i vad**]¹⁴ **sa du på café oriental eller**

E: 106 \$P: / [¹⁴ *was that in what*]¹⁴ *did you say at café oriental*

S: 107 \$C: oriental / orientals salonger (...) ja

E: 107 \$C: *oriental / orientals salonger (...) yes*

Although in C105 Carl refers to the café last mentioned, the conversational partner again is not sure about the referent and requests confirmation in C106. Given that the

name of the café was last mentioned 27 contributions earlier in C78, the request for clarification from the conversational partner is not surprising.

Extract 23, presented in section 3.7.3.1 above, contains another example of other-initiated repair from the interaction with Carl. Probably the extra details about the line of work of the friend (C188) he met at a clinic causes the conversational partner to make an inappropriate inference about the referent of the anaphoric use of the locative adverb ‘there’. After the first other-initiated repair in C189, the conversational partner again initiates repair in an overlap in C191 and Carl finally specifies the referent in C192. In order to make really sure, the conversational partner reformulates the utterance in C193.

The rapid topic development and level of detail induce uncertainty in the conversational partner about the main message and the referent being spoken about. Moreover, Carl often seems to abandon his own urge to repair and specify his contributions:

Extract 32: Carl (RHD)

S: 78 \$C: men vi gick på orientals salonger

E: 78 \$C: *but we went to orientals salonger*

S: 79 \$P: på

E: 79 \$P: *to*

S: 80 \$C: på kungstorget

E: 80 \$C: *at kungstorget*

S: 81 \$P: jaha

E: 81 \$P: *I see*

S: 82 \$C: då var det andra våningen det var närheten av kungshall

E: 82 \$C: *then it was the second floor it was near kungshall*

S 83 \$P: det [¹³ som ä rivet]¹³ nu det huset

E: 83 \$P: *that [¹³ which is torn down]¹³ now that house*

S: 84 \$C [¹³ (...)]¹³ /

E: 84 \$C [¹³ (...)]¹³ /

S: 85 \$C: ja nä det blir det var det som brann upp det mesta

E: 85 \$C: *yes no it would be it was the one that burned down most of it*

S: 86 \$P: jaha

E: 86 \$P: *I see*

S: 87 \$C: < eller det nä > det (...) (det vara) det ä kultur i det

E: 87 \$C: *< or it no > it (...) (it be) it is culture in that*

@< hand movement: P points towards C >

S: 88 \$P: jaha

E: 88 \$P: *I see*

S: 89 \$C: det var ju där uppe där gick vi

E: 89 \$C: *why it was up there we went there*

S: 90 \$P: < där atelieteatern å det> låg
 E: 90 \$P: < where atelieteatern and that > was
 @< hand movement: P points towards C >
 S: 91 \$C: ja där gick vi där uppe på å där var en / rockvaktmästare
 E: 91 \$C: yes we went there up there and there was a / cloakroom attendant

Carl leaves it up to the conversational partner to make sure in C90 that they agree on the referent. Note that the Swedish preposition used in C78 ('to') and in C80 ('at') is the same (*på*). While in C79 the conversational partner requests a repetition of the name of the café mentioned in C78, Carl instead describes where the café is situated.

The conversational interaction with Nils, the other RHD individual, also shows evidence of the need for other-initiated repair due to reference problems. In the example in extract 33 below, Nils had been talking about an activity that occurred in a place referred to earlier, but a long time had passed since the actual location was mentioned:

Extract 33: Nils (RHD)

S: 12 \$N: ja det var så att jag jag <¹ brukar gå på jag
 gå på gymnastik **där uppe** va // <² >² å så / >¹
 E: 12 \$N: well it was like this I I <I usually go to I <¹ us+ go to gym class **up there** see // <² >² and then / >¹
 @ <¹ hand movement starts: N tapping on table with right hand >¹
 @ <²click: N >²
 S: 13 \$P: **på rehab center**
 E: 13 \$P: **at rehab centre**
 S: 14 \$N: på rehab center ja
 E: 14 \$N: at rehab centre yes
 @ < hand movement continues: N tapping on table with right hand >

In this and the next example, Nils uses 'there' in a way that makes the conversational partner request confirmation of the inference made about the referent:

Extract 34: Nils (RHD)

S: 150 \$N: nä jag ser ju dom som ä med här < dom har ju tydligen gått **där** ganska länge också >
 E: 150 \$N: no I do see these who are in here < they seem to have been going **there** for a rather long time too >
 @ < head movement: N shakes >
 S: 151 \$P: < **på** [⁵³ < **på rehab center** >]⁵³
 E: 151 \$P: < **at** [⁵³ < **at the rehab centre** >]⁵³
 @ < head movement: P nods >
 S: 152 \$N: [⁵³ har de väl]⁵³ kommit [⁵⁴ in]⁵⁴ så går de bara på då va

E: 152 \$N: [⁵³ once they have]⁵³ come [⁵⁴ in]⁵⁴ I guess they just keep coming
S: 153 \$P: [⁵⁴ < ja >]⁵⁴
E: 153 \$P: [⁵⁴ < yes >]⁵⁴
@ < head movement: P nods >

Extract 34 above has the same context as extract 33 – that is, the referent was introduced some time ago and the conversational partner needs to make sure that it is still valid.

3.7.4 Summary: Analysis of conversational interaction

In this section, the results of the analysis of the video-recordings will be summarised and discussed, starting with the conversational categories *Word retrieval*, *Turn-taking* and *Repair*. In section 3.7.5, the conversational interaction of each individual will be summarised and discussed in the light of personal data and his results on the cognitive tests.

According to the first hypothesis made, *the two LHD subjects would express their word-finding difficulties in a more salient way than the two RHD subjects*. This was not entirely confirmed, but other interesting differences were found in association with the manifestation of word retrieval difficulties: the results do indicate that it is important to consider more subtle tokens of word-processing difficulties, such as short pauses, change of speech plan and topic, click sounds and sighing, in association with RHD.

All four subjects reported that they had noticed a change in the frequency of word retrieval difficulties, but there were both similarities and differences in the expressions of these problems in terms of OCM phenomena in conversation. All four subjects used similar OCM phenomena. The occurrences of basic OCM expressions and operations seem more prominent in the discourse of the two LHD subjects, which might be the result of more *frequent* word retrieval problems rather than the result of different *expressions of symptoms* of word retrieval difficulties. One of the RHD subjects, Carl, reported a decrease in the frequency of episodes where he had to struggle to find the appropriate word, but also a negative impact of this change (issue

14 in the questionnaire). This is also evident in the recorded conversational interaction, where Carl tends to change the subject rather than engage in effortful word processing.

All four subjects use gestures when they have word retrieval difficulties. Explicit OCM phrases, such as '*what is it called?*', were rare, only occurring on one occasion each in the samples from the interaction with Johan (LHD) and Carl (RHD).

However, change of speech plan might be considered a subtle symptom of word retrieval difficulties as well as a repair strategy associated with word retrieval difficulties. The outcome of this seems to differ in the two groups: while the two LHD subjects often seem to be able to initiate and complete or successfully revise a speech plan to express what they wanted to say, the two RHD subjects often fail to do so. There are several examples from the video-recorded interaction with the two RHD subjects where they seem to be abandoning an initiated speech plan, as well as their intended message, since they are unable to successfully implement a new plan. The LHD individuals also seem to use circumlocutions, when needed, more successfully than the RHD individuals.

Although the two LHD subjects also demonstrate more subtle tokens of word retrieval difficulties, such as basic OCM sounds and abandoned speech plans, these tokens are very evident in the speech of both of the RHD subjects. There is a risk that these symptoms will not be attended to in a clinical assessment, resulting in an overstatement of language ability.

The second hypothesis was that *the pattern of turn-taking was believed to be qualitatively different between the two RHD subjects and the two LHD subjects*. This was also partly confirmed. However, the analysis indicates that word retrieval difficulties might affect turn-taking in different ways in different individuals: The most prominent impression of the turn-taking pattern actually differs for the four individuals and between the LHD subjects and the RHD subjects, but this may not be solely due to the site of the brain damage. Latency of response and reluctance to take the floor and elaborate on a topic are more prominent in the two LHD subjects than in the RHD subjects. The two RHD individuals tended to interrupt more and overlap the

speech of their conversational partner but, according to the reports in the questionnaires, both of them had done this before they had a stroke too.

Still, there was a change in one of the RHD individuals, Nils, who since the stroke has sometimes found it difficult to initiate a response, just like the two LHD subjects. Given that the patterns of word retrieval difficulties were as similar as they were in the two LHD subjects and Nils, this is not surprising. However, the other RHD individual, Carl, does not show any signs of having problems initiating a response or elaborating on a topic. Still, this does not mean that turn-taking in the conversational interaction with Carl functions satisfactorily. Carl's long and detailed contributions are characterised by quite irrelevant details, which sometimes confuse the main message. Still, it is not impossible that these long and sometimes excessively detailed contributions are also the result of impaired word processing. The other RHD individual, Nils, sometimes produces long and detailed responses as well, probably also due to impaired word retrieval; the difference is that, in conversation with Nils, there are opportunities for the conversational partner to make contributions and elaborate or introduce new topics. Long and detailed responses that can be linked to word retrieval difficulties also occur in the discourse of one of the LHD individuals, Johan.

The third hypothesis was *that the conversational interaction with the two RHD subjects would be characterised by a need for other-initiated repair and the interaction with the two LHD individuals would be characterised more by trouble performing self-repair*. This hypothesis was partly verified and the analysis also indicates that there are problems in the repair area not captured by the questionnaire: the analysis of the recorded samples revealed frequent examples of other-initiated repair in the form of requests for confirmation of inferences made by the conversational partner. This issue is not properly covered by the questionnaire used in study 3; see the general discussion of the results of studies 3 and 4 in section 3.8. There are examples of other-initiated repair in the discourse of all four subjects but they are most frequent in conversation with Johan (LHD), Carl (RHD) and Nils (RHD). The form of the other-initiated repair used in the samples means that the

subjects only have to confirm an inference to be considered as successfully performing other-initiated repair.

Especially in the examples from the two RHD individuals, the need for other-repair in this form can be linked to topic development and sometimes to excessive level of detail, in particular in the interaction with Carl. It is well known that anaphoric pronouns are often introduced without a clear referent in aphasic speech (Chantraine et al., 1998). However, in this study, other-initiated repair in the form of requests for confirmation of the referent of a place adverb is only seen in the conversations with the two RHD individuals.

All four subjects sometimes engaged in self-initiated repair, often successfully. However, failure to implement self-initiated self-repair is seen in the recorded samples from both Johan (LHD) and Nils (RHD).

In the interaction with the two RHD subjects, there is often a need for repair and the message conveyed is not always clear to the conversational partner. But instead of making successful repairs, the RHD individuals sometimes seem to abandon their self-initiated attempts at self-repair. This does not seem to occur to the same extent in the samples from the LHD individuals. Furthermore, the production of circumlocutions might also be considered as a form of self-repair and there are several occasions in the analysed samples of the two RHD subjects where they fail to produce effective circumlocutions. Compared to the two LHD subjects, the same OCM phenomena do occur in the self-repair sequences of the RHD individuals, Nils and Carl. However, the occurrences of self-initiated repair in the samples from the LHD individuals are more salient. This means that the analysis of the video-recorded samples does not confirm that the RHD individuals manage better than the LHD individuals in making repairs, although this might be indicated by the group results on the questionnaire.

3.7.5 Individual features of cases – Summary and discussion

In this section, the results of the analysis of the video-recorded samples for each subject will be summarised and discussed in light of the individual results on the

cognitive tasks in studies 1 and 2, as well as the reports in the questionnaire from the individual subjects and their conversational partners in study 3.

3.7.5.1 Nils (RHD): Individual features

The analysis of the conversational interaction shows that Nils presented more obvious symptoms of word-processing difficulties than Carl, the other RHD individual, but fewer than Johan, one of the LHD individuals. His word retrieval difficulties were reported as having a negative impact on his conversational interaction by both Nils and his spouse.

Nils uses the same OCM phenomena as the LHD subjects. The occurrences of audible inhalations and the fact that he actually seems to be forced to change and abandon his initiated speech plans on several occasions are considered to be more subtle symptoms of word retrieval difficulties. In the production of circumlocutions Nils, like Johan, sometimes seem to list parts of the concept he wants to describe, but he does this in less specifically and less successfully. This is also reflected in the responses by Nils and his spouse in the questionnaire. They both report a high degree of change and a negative impact of this change on the production of circumlocutions and ability to specify to repair utterances and favour conversational partners' comprehension.

The analysis of Turn-taking shows that Nils has a pattern of overlapping and interrupting his conversational partner's speech. According to the reports in the questionnaire from Nils and his spouse, this is nothing new. He exhibited this pattern of interaction before the stroke. In the video-recorded sample, he also demonstrates how turn-taking may be affected by word-processing difficulties post-stroke. He sometimes seems to have difficulties initiating a response or elaborating on a turn. His responses might be shortened due to word retrieval difficulties. The increase in the number of short responses was only reported by Nils' spouse in the questionnaire. Nils himself feels that he has increased his production of long and very detailed responses, which may sometimes be the result of word-finding difficulties. The increase in the number of detailed responses may result from an impaired ability to

sum up the intended information with a more comprehensive term or to find a superordinate concept, forcing Nils to mention several of its parts instead.

The analysis of the repair area shows that Nils often initiates self-repair, and often, but not always, does so successfully. Still, there are several occasions where he does not manage self-repair, and this was also reported by Nils' spouse. He sometimes seems to abandon his self-initiated attempts to self-repair and there are several occasions of other-initiated repair. The tendency to abandon self-initiated self-repair sequences might be an effect of Nils' reduced ability to sustain attention and his reduced VWM capacity. The process of active search for a specific concept or word is complex and puts high demands on cognitive resources. An impaired ability to sustain attention, and reduced VWM capacity as well, might result in the abandoning of both an initiated speech plan and any intended message.

The other-initiated repairs in the analysed samples take the form of requests for confirmation of an inference made from a previous utterance. Nils has only to confirm that the suggested interpretation is the intended one, which he almost always does. This suggests that the conversational partner is usually able to follow the intended meaning of Nils' contributions, but sometimes doubts whether the inference made is the correct one. Still, there are occasional misinterpretations and it is not always clear that the confirmed suggestion is actually the right one.

The other-initiated repair in the sample is generally due to unclear use of reference and sometimes uncertainty about the main message in a previous contribution. As Nils and his wife reported in the questionnaire, since the stroke Nils tends to raise new topics in the middle of a conversation. This was also something Nils' spouse and another member of the family spontaneously mentioned as an effect of the stroke. The problem seems to be a failure to introduce the new topic and orient the conversational partner to the topic by the use of reference. Both Nils and his spouse report an increase in failures to orient the conversational partner to a new topic, as well as an increase in the occurrence of reference failures, and both find that this often or very often has a negative impact on the conversational interaction.

Both self-initiated and other-initiated repair may be associated with word retrieval difficulties for Nils. An impaired ability to find the right words and build up the intended meaning in a composite way sometimes results in unspecific contributions. The tendency to abandon initiated topics and initiate new topics without a proper introduction may make it difficult for the conversational partner to follow the thread. The need for other-repair due to reference failure might be the result of the sometimes fragmented structure of the discourse, which makes the conversational partner uncertain about the intended referent. This type of discourse requires the conversational partner, partly through inference, to take on a major proportion of the responsibility for the success of the interaction.

The results of the Discourse Comprehension task also indicated a reduced ability to revise inferences, which may be an important ability in everyday conversation. Also, the ability to infer the motives and attitude of a conversational partner is important in understanding the intended meaning of a conversation. In the *revised inference tasks*, Nils is obviously using the information given in the text in his response but perhaps not integrating that information with his knowledge of the world and the objects in it. According to his results on tasks requiring *inference of a character's attitude or motive*, it seems that Nils either does not grasp the emotional or attitudinal information signalled by the words used or fails to use that information in a process of integration in building a situation model of the narratives. One way to describe this is in terms of the coarse semantic coding theory (Beeman, 1998) in combination with a left-hemisphere interpreter, as described by Gazzaniga and Cooney (2003). When right-hemisphere processing of semantics fails, not all of the relevant aspects implicated by the narratives are activated or retrieved in the construction-integration process. The left-hemisphere interpreter might then provide more or less plausible explanations in an effort to create coherence.

Nils' problems in the Discourse Comprehension tasks and conversation might also be viewed as the result of his brain damage, in combination with personality traits and the ability to compensate with strategies. Nils used to be a hot-tempered man. His impaired ability to sustain attention and reduced alertness may cause him to

miss important cues in conversation and make it difficult for him to perform effortful retrieval processing to aid comprehension and speech production. Still, a hot-tempered personality combined with attention deficits might make it difficult for Nils to establish well functioning compensating strategies. His way of handling the Discourse Comprehension tasks and his results on the SART, in combination with the results of study 4, indicate that even though he is aware of having problems with comprehension and conversational interaction, he has not yet been able to develop strategies that work when the problem actually occurs.

3.7.5.2 Johan (LHD): Individual features

The spontaneous impression from watching the video-recorded conversational interaction is that Johan understates the negative impact on his conversational ability of changes due to the stroke in his responses on the questionnaire. His reports of low perceived negative impact make him a bit unusual when his reports are compared to the results from the questionnaire on a group level. Still, he often seems to cope with his impaired language ability, being able to produce circumlocutions and successful repairs. In the recorded sample, Johan seems to have more word-processing problems than the most of the other LHD subjects included in studies 1 to 3. He shows both explicit and more subtle symptoms of word-processing difficulties. In his use of circumlocutions, he is often forced to list, for example, sub-activities to describe an activity. That is, he uses the same circumlocution strategies as Nils (RHD), but does this more successfully. He is often forced to change his speech plan but does not tend to abandon his intended message as the two RHD individuals sometimes do. The reports from Johan and his spouse in the questionnaire also indicate that they do not perceive any negative impact of the production of circumlocutions or self-repair. Although there is a frequent need for self-repair, Johan seems to manage this well.

The video-recorded sample shows that turn-taking is affected, as reported by Johan in the questionnaire, although he did not report any change in frequency of latency for response. Johan sometimes has problems initiating a response and also produces several very short responses, especially at the beginning of the recorded

conversation. This is also in accordance with the post-stroke change reported by Johan and his spouse. His longer, more detailed responses are often the result of word retrieval difficulties, forcing him to engage in self-initiated self-repair. More detailed responses due to word retrieval difficulties can also be noticed, as Johan is sometimes forced to exemplify, describe or visually show instead of finding more comprehensive and efficient verbal expressions for what he intends to say.

Johan demonstrates an ability to initiate and perform self-repair successfully. He often initiates repairs himself, as indicated by OCM operations such as self-interruption as well as changes of speech plan and self-initiated rephrasing of utterances. However, he sometimes needs help from his conversational partner. According to his report in the questionnaire, Johan felt that he initiated self-repair less often now than before the stroke. This seems to indicate that he feels that he ought to initiate self-repair more often than he actually does. Although this report was not confirmed by Johan's spouse in the questionnaire, it might be the case that the occurrences of other-initiated repair in the recorded samples are the result of such abandoned attempts at self-repair. Most of the other-initiated repair in the video-recorded sample was in the form of requests for confirmation of an inference made. That is, Johan's word retrieval difficulties sometimes made his contributions unspecific and the conversational partner needed to make sure that the intended message was correctly interpreted. Johan might have felt that before the stroke he would have continued to act on his urge to make his intended message clear until no other repair was needed. However, there are also occurrences of other-initiated repair due to the unspecific use of pronouns. Johan's spouse reported that his unspecific use of reference had increased, but Johan himself did not report any awareness of this.

Johan's results on the VWM test indicated that he had low VWM capacity, while his results on the SART may indicate fluctuations in arousal. Such impairments might, of course, affect the conversational interaction and comprehension in inference tasks even though sustained attention, as measured with the SART, was equivalent to that of the control group. Johan reports a change in his ability to make inferences, although he does not feel that this change has a negative impact on his

conversational ability. In performing the inference tasks, and in conversation as well, he takes his time. The strategy used in the inference tasks, of suspending his interpretation until he is given the chance to see the information again helps him to manage explicit information and inferences of a character's attitude/motive. Johan's reduced VWM capacity may restrain his ability to produce appropriate responses in tasks requiring revised inference. Even though he has frequent word retrieval problems in conversation, Johan has developed strategies to manage them, like circumlocution, that seem to work well for him.

3.7.5.3 Carl (RHD): Individual features

Carl reported that he experienced *less* struggle to find the right words post-stroke than he did before. In the analysed sample, his speech is characterised by a stream of related associations. It is possible that this is a strategy, maybe unconscious, to avoid effortful word retrieval processing. Instead of engaging in effortful word processing, Carl seems to abandon his initiated speech plan, perhaps because he is unable to suppress the related associations evoked by his own narratives. Although he sometimes pauses, he does not seem to use choice-related OCM phenomena to the same extent as the other three individuals. Carl's brain damage has frontal involvement. Frontal brain damage is often associated with disinhibition. Nevertheless, in his results on the SART, Carl does not produce too many *Erroneous responses*, which would have been expected if he was having trouble inhibiting responses. However, his reaction time is slow and he misses several correct and erroneous targets in the SART. Furthermore, other measures from the SART indicate that he has a reduced ability to monitor and flexibly adapt the pace of response in the SART; his vigilance also seems to fluctuate. A restriction in flexibility was also reflected in Carl's performance on the Discourse Comprehension task, where he performed fairly well in his spontaneous responses on the tasks requiring *inference of a character's attitude or motive* but had great trouble with the tasks that required revised inference. This is in accordance with the results from Champagne et al. (2003), who found problems with flexibility when evaluating executive function in

two RHD individuals. Even though he often chose to read the narratives, with the intention of checking his responses, he usually decided that his initial responses were correct. The stream of related associations was also evident in the performance on the VWM task, where the content of the task released several associations that were irrelevant for the completion of the task.

The most prominent impression of Carl's turn-taking is his domination of the floor. One way of dominating the floor is his stream of associations, leading to sometimes overly detailed narrative and rapid topic development. The change in frequency of long and very detailed responses and the initiation of new topics were two of the few issues that Carl reported had changed and had a negative impact in the questionnaire. The conversational partner gets little opportunity to make contribute or to elaborate on the initiated topics. This tendency in conversational interaction with RHD individuals has been discussed by Hird and Kirsner (2003) as a possible symptom of attentional deficits. It is also possible that the excessive level of detail – sometimes as a result of a stream of associations, sometimes in itself generating new associations – might be the result of impaired word processing. Instead of being able to inhibit irrelevant associations and slow down to make a more effortful search for the relevant associations, Carl seems to be constrained by left-hemisphere processing of semantics with fast activation and selection of closely related concepts at the expense of a thematically more comprehensive and coherent perspective.

In the Discourse Comprehension task, although Carl uses general world knowledge in his reasoning, he sometimes fails to incorporate relevant aspects of the semantics of the narratives into his inferences. One might speculate that his sometimes inadequate responses are the result of a left-hemisphere interpreter (Gazzaniga and Cooney, 2003), making the picture coherent in the absence of relevant activations that could have been provided by right-hemisphere processing of semantics.

Carl often performs self-initiated self-repair successfully, but he sometimes seems to avoid engaging in repair and abandons the initiated speech plan or intended message instead. The other-initiated repair in the conversational interaction with Carl

is often due to uncertainty about reference use and the intended message, which is often related to the rapid topic development and level of detail. Word-processing difficulties might be involved in some way.

Carl's loquacity may be a personality trait, although it seemed to have increased since the stroke, as reported by both Carl himself and another member of the family. It is likely that the brain damage interacts with Carl's personality, producing the results seen in inference tasks and conversational interaction. Neither Carl nor his spouse reports any change in the comprehension areas of the questionnaire. Even though he actually took the opportunity to read the narratives in the Discourse Comprehension task, Carl was not able to increase the production of appropriate responses on tasks requiring revised inference. His reasoning about the plausibility of different interpretations shows that he is aware of the problem, but he does not seem to be able to stay focused on the task at hand. He often produces irrelevant associations or opts for the response he gave first. Some of his verbosity in conversational interaction might be the result of a non-functioning strategy to avoid effortful cognitive processing in relation to word retrieval difficulties, and some of it might be explained by an intensified personality trait. However, even though the reports from the questionnaire indicates that Carl is somehow aware of the negative impact of his verbosity, he does not seem to be developing any functional strategies to aid conversational interaction.

As with Nils, the other RHD individual, conversational interaction with Carl requires the ability to generate inferences and keep track of the fragmented discourse structure. Carl's speech and interaction might be described as typical for frontal brain damage, but it is important to keep in mind that both the participating LHD individuals also had frontal involvement in their brain damage.

3.7.5.4 Thomas (LHD): Individual features

Thomas has low VWM capacity, as shown by the test in study 2. He may also have fluctuations in his level of arousal. Furthermore, he has word retrieval problems, but in the analysis of his conversational interaction, he seems to be able to handle these

difficulties quite well by using OCM phenomena. He demonstrates obvious as well as more subtle manifestations of word retrieval difficulties, needing extra time for word processing, but manages to get his intended message across most of the time. His need for extra time is also evident in the latency in initiating responses and he also uses OCM expressions to indicate that he is willing to accept a turn, and also to keep and elaborate on his turn. Thomas also has an ability to successfully initiate and perform self-repair. The rare occurrences of other-initiated repair take the form of the conversational partner rephrasing a preceding utterance to make sure that the inference made is correct. On one of these occasions, this is probably due to a suspected comprehension failure by Thomas, whose response to a question is somewhat unspecific.

Although the sample did not show any evidence of problems performing self-repair, the results of the analysis of the recorded interaction are very much in accordance with the reports of change in the questionnaire. Still, Thomas and his spouse rated the degree of change and the negative impact very high compared to the other participants in study 4. Although problems in the areas of word retrieval and turn-taking are evident in the sample, Thomas seems to manage very well when he is given some extra processing time. It is possible that time since onset may play a role here. At only six months post-stroke, Thomas and his wife are probably very aware of the changes and still struggling with how to manage these new situations.

The results on the SART may indicate that Thomas has a poor ability to sustain attention. It is possible that the slow response rate is a strategy he used to avoid making erroneous responses. In conversational interaction, Thomas makes use of extra time for processing, a strategy that seems to function well for him. Even though Thomas does not respond with latency too often in managing the Discourse Comprehension tasks, he took the time to read most of the narratives and check on his responses. It is most likely that his performance on the tests and in conversational interaction is the result of interaction between personality traits, brain damage and strategies to compensate for deficits caused by the brain damage.

3.8 General discussion: Studies 3 and 4

The results of the questionnaire in study 3 show a tendency toward more reports of change and of a higher degree of negative impact of this change from LHD subjects and their conversational partners than from the RHD individuals and their conversational partners. This indicates that pragmatic language deficits are more common and induce more problems in association with LHD than in relation to RHD. The time post-onset in the RHD group tended to be longer than in the LHD group, but the difference was not statistically significant. It is possible that it was difficult for some individuals in the RHD group, and their conversational partners, to evaluate any change since a longer time had passed since the onset. They had also had more time to adapt to the circumstances and develop strategies that might compensate for any negative impact induced by the change. The report by one of the LHD subjects in study 4, Thomas, who had had his stroke recently, in combination with the results from the analysis of the video-recorded conversational interaction, indicates that time since onset might affect the perception of change and negative impact. On the other hand, one of the RHD subjects in study 4, Carl, had experienced a comparable time since onset but did not report as much change and negative impact. The implication of studies 3 and 4 is that, although pragmatic language disturbances affecting the conversational interaction tend to be more common following LHD, they may nevertheless be just as severe in an individual with RHD.

In this section, the results of the questionnaire in study 3 and of the analysis of the individual subjects' conversational interaction in study 4 will be discussed in relation to each other and to current theories about the effect of pragmatic language disturbances on conversational interaction.

3.8.1 The need to assess conversational interaction

Both the two LHD subjects and the two RHD subjects and their spouses reported word retrieval difficulties in the questionnaire, and such problems were evident in the analysed samples of conversational interaction, where the same types of OCM phenomena were present. However, the occurrence of more subtle symptoms of OCM and word-processing difficulties in the two RHD subjects needs to be considered. Such symptoms can easily be overlooked in the clinical assessment of language ability in association with brain damage. The two RHD subjects' tendency to abandon urges to self-repair or circumlocutions in association with word-processing difficulties and reference failures is not easy to detect with traditional aphasia tests. Tasks in these traditional tests are often restricted to requirements for convergent processing in focusing on the denotative, central meanings of words in both naming tasks and picture description tasks. Nevertheless, these kinds of difficulties do have a negative impact on conversational interaction. The fact that RHD individuals might be able to name objects and activities in a clinical naming task, or even able to provide a comprehensive and coherent verbal account of the content in a picture description task or recall the content of a text, does not reflect their actual pragmatic ability. An on-line, more complex, conversation makes other demands on pragmatic ability. The results of study 4 indicate that, when analysing discourse in association with RHD, it is important to also consider less obvious symptoms of word-processing difficulties. For example, short pauses, sighs, clicking sounds and changes of speech plan or topic might mistakenly be perceived as reflecting an attitude towards the situation rather than processing difficulties.

The assessment of language abilities in association with RHD, or other brain damage often associated with pragmatic impairment, such as traumatic brain damage, frontal brain damage in general and progressive brain damage, therefore requires analysis of the subject's conversational interaction with casual acquaintances as well as the involvement of conversational partners who are familiar with the brain-damaged individual. However, it is likely that the everyday, natural conversational

interaction between a brain-damaged individual and his or her spouse makes fewer demands on the pragmatic ability of the brain-damaged individual than conversational interaction with a stranger, or topics that involve new or unusual pieces of knowledge. Demands on the conversational partner increase when reference use is uncertain or the brain-damaged individual is not able to fulfil his or her speech plan or is forced to abandon the intended message.

Hird and Kirsner (2003) discuss RHD subjects' impaired ability to assume equal responsibility for the development of the discourse structure. In their study, impaired use of prosody was detected, as well a pattern of topic development that indicated that their RHD subjects might have attentional impairments. Those impairments resulted in a disrupted capacity to keep a record of important properties and their relationships to each other in the discourse. The results of the analysis in the present study, for example, the notion of strategies associated with word-processing difficulties and the need for other initiated repair in association with reference use, also make the impact of the conversational interaction on the conversational partner quite obvious. This kind of conversational interaction requires the conversational partner to make effortful inferences. If the partner is well acquainted with the brain-damaged individual and hence shares a large amount of knowledge with him or her, the bridging inferences will be easier to make, and any change in pragmatic ability might not be apparent, or at least, not seen as symptoms of a communication impairment. Still, any decrease in the brain-damaged individual's ability to express an intended message also increases the burden on the conversational partner in the interaction. The awareness of such impairment in association with brain damage will increase the conversational partner's ability to compensate for and facilitate the brain-damaged individual's communicative efforts. For example the conversational partner can help induce structure when needed. The role of the conversational partner in communication with individuals who have aphasia in association with LHD is well established, at least among most speech-language pathologists (Kagan, 1998; Booth and Swabey, 1999; Laakso and Klippi, 1999; Oelschlaeger and Damico, 2000; Lock

et al., 2001). It is important to also examine effective strategies that can be used by RHD individuals and their conversational partners to facilitate discourse.

3.8.2 Interaction between conversational partners

The brain-damaged subjects and their conversational partners do not always perceive the same issues as having changed or as having the most negative impact. The diverging ratings here might mirror the different perspectives of the person with pragmatic language disturbance and their conversational partner. All conversational interaction demands the cooperation of the individuals involved. However, problems with repair, word retrieval and comprehension, and topic management place obvious restraints on the conversational interaction of both partners. Monotonous intonation, which is an issue the brain-damaged individuals focused on a lot when rating negative impact, might not raise evident obstacles to conversational interaction. The absence of voice timbre might not even be noticed by the conversational partner. Still, it restricts the brain-damaged individuals' ability to fully express themselves in social interaction.

With a few exceptions, the RHD individuals seem to be more concerned than, or at least just as concerned as, their conversational partners with the problems affecting their interaction in conversation. Since the literature describes RHD individuals as sometimes experiencing anosognosia, it would not have been surprising if the RHD subjects' conversational partners had perceived a greater negative impact than the brain-damaged subjects themselves. LHD is not associated with anosognosia in the same way as RHD is. However, it is possible that, since the left hemisphere is more associated with language, the LHD individuals' conversational partners are more used to the thought that the brain damage could result in language and communication disorders. This might make it easier for them to perceive and express their perception of a negative impact on the conversational interaction in a way that the conversational partners of the RHD subjects did not. Reports of limited perceived negative impact might be a consequence of solidarity with the brain-damaged partner, but there is no reason why the conversational partners of the RHD subjects should

feel that more than the partners of the LHD subjects. It is more likely that the RHD subjects' problems in conversational interaction may be difficult to identify, especially since most of these individuals and their conversational partners did not receive any information about possible language and communication deficits associated with RHD. The nature of pragmatic problems, especially when they are subtle, can make them difficult to pin down and describe. The lack of information and terminology might make it difficult to analyse and get the hang of exactly what is going wrong in the conversational interaction. The LHD subjects' ability to apprehend and describe their problems might make it easier for their conversational partners to identify and report what actually happens in conversation.

There are also several disadvantages with questionnaires as compared to personal interviews. It is not always possible to be certain that the respondents have understood the questions or how to fill in the form. The responses must also be assumed to be sincere without any opportunity to establish trust in the contact between the respondent and the researcher. Furthermore, valuable information and nuances may never be captured.

The disagreements, even though sometimes subtle, between the brain-damaged individuals and their conversational partners on what issues cause the largest negative impact on conversational interaction also have implications for the treatment of pragmatic language disturbances. They point to the importance of careful and comprehensive mapping of the conversational interaction between specific dyads in order to pinpoint which areas ought to be the target of treatment. They also make it apparent that language disturbances and communication problems are not isolated to the brain-damaged individual, but are shaped by the interaction between the brain-damaged individual and his or her conversational partner(s).

3.8.3 The issue of repair

Neither the RHD subjects nor their conversational partners focused on Repair issues to same extent as the LHD subjects and their conversational partners. This might not be surprising since LHD is more associated with language disturbances than RHD.

Still, it is important to bear in mind that the LHD subjects included in this study all performed well on a standard aphasia battery. Obvious inappropriate semantic paraphasias were rare but there were several occurrences of phonemic paraphasias in the video-recorded speech samples of the subjects in both groups. Given that no formal assessments have been done of the RHD subjects' word retrieval ability, it is not possible to compare the word retrieval problems in the two groups. Still, both groups, and their conversational partners, agree that increased word retrieval problems have the greatest negative impact on the subjects' conversational interaction. Furthermore, the conversational partners of the RHD subjects report an increase in, and also a high degree of negative impact from, comprehension problems. Nevertheless, the Repair area is not cited as a trouble spot very often by the RHD subjects and their conversational partners. A change in the frequency of Repair issues is reported but not to the same extent as the changes in Word retrieval and Comprehension. The RHD subjects are sometimes more concerned about the negative impact of repair issues than their conversational partners. The questionnaire responses show that a majority of the RHD subjects try to correct mistakes in their own speech or specify information (questions 12 and 14) to about the same extent as before and with about the same success (question 13). Most of the RHD subjects also seem to produce circumlocutions in association with word retrieval problems to the same extent as before the stroke (question 17).

At a group level, the conclusion to be drawn from the questionnaire in study 3 would be that RHD subjects generally do not have any problems with repair in conversational interaction. Still, the results of the case studies indicate that there actually are problems related to repair and also that different strategies are used in association with word retrieval difficulties by the RHD subjects and the LHD subjects.

The issues in the questionnaire are worded to explore any change in frequency of behaviours by the brain-damaged individual. That means that changes in the behaviour of the conversational partner in the interaction are not really reflected in the responses to the questionnaire. The brain-damaged individual might initiate and

successfully perform repairs to the same extent as before the stroke, although the need for repair may have become more frequent. The conversational partners might automatically assume the most of the responsibility for initiating and making repairs. In some cases, they may not even perceive a need for repair, using their ability to make bridging inferences due to their familiarity with the topic. Such changes would not be reflected by the questionnaire used in this study.

The two LHD subjects and the RHD subjects managed repairs differently; in fact, the LHD subjects often seemed to self-repair more successfully than the RHD subjects. This was not reflected in the group responses to questions 11 to 14 in the questionnaire, which are the questions considered to cover the Repair area. These results indicate that the questionnaire does not fully address the issue of repair, especially other-initiated repair. One question that might be relevant is whether there is a change in the frequency of the need for other-repair post-stroke.

The questionnaire has one question about the ability to specify when the conversational partner needs it (question 14, see Appendix 3). In the group results from the questionnaire, this issue was not reported to have changed by most of the RHD subjects and their conversational partners. However, among those subjects for whom a change was reported, several of them rated the negative impact of this issue as high. The change in the production of circumlocutions was also reported to have a negative impact by all the RHD individuals who reported it to have changed. Furthermore, several occasions when other-initiated repair was induced in the conversational interaction with the RHD individuals in study 4 related to reference use. This issue was covered in the questionnaire (question 19), and it was one of the issues where at least 50% of the conversational partners of the RHD individuals participating in that study reported change.

Another possibility is that the need for repair might not seem to have changed or to have a negative impact on conversational interaction if the brain-damaged subject himself or herself does not perceive and express any such change. It might be difficult for the conversational partner to perceive and analyse what is actually happening in the interaction. Perhaps the partner sees the forced choice of other

words than the preferred and intended ones in a response as reflecting a misinterpretation of the question due to comprehension problems. Or maybe a comprehension failure is sometimes apprehended as a change of topic; and the maintaining of a topic or a long detailed response might actually camouflage word retrieval problems.

3.8.4 Processing of semantics and topic management

It is often claimed that aphasics are able to compensate for their language impairments by means of their pragmatic ability. The LHD subjects in study 4 do experience several cases of word-processing difficulties and they seem to be able to handle them well, either by taking extra processing time or by using circumlocutions to facilitate the conversational partner's ability to generate inferences of the intended message. The results of the questionnaire in study 3 showed that the LHD subjects as a group were more concerned about the negative impact of the change in frequency of successful self-repairs than the RHD subjects. A majority of the LHD subjects' conversational partners also reported a negative impact of the change in frequency of circumlocutions among the LHD subjects.

The RHD subjects in study 4 also seem to sometimes benefit from extra processing time and sometimes try to use circumlocutions. But they also have a tendency to abandon an initiated message. The importance of the ability to sustain attention and stay focused on the intended message and to maintain effortful cognitive processing in relation to word retrieval difficulties needs to be considered here.

The tendency to abandon an initiated message might also be associated with the notion of the different modes of processing semantics in the two hemispheres. According to Beeman (1998) and Beeman et al. (2000), several of the symptoms of impaired language ability seen in association with RHD can be explained by the *coarse semantic coding theory*. In this theory, left-hemisphere processing of semantics is characterised by activation that rapidly restricts access to one possible

concept. Right-hemisphere processing, on the other hand, maintains the activation of several, more diffusely localised areas for a longer period of time, which might allow the activation of, access to, and integration of several less closely related concepts. One might hypothesise that circumlocutions benefit from right-hemisphere activation. RHD might result in an impaired ability to produce efficient circumlocutions because of the loss of activation of relevant associations, and thus circumlocutions might be inefficient. When right-hemisphere activation of semantics is impaired, semantic processing might be characterised by the left hemisphere's rapid activation and inhibition. This kind of processing could result in the activation of less relevant associations, leading further and further away from the first initiated topic, or in the abandonment of an attempt to produce a circumlocution. The *coarse semantic coding theory* was proposed primarily to explain the impaired ability to make inferences and comprehension (Beeman, 1993), but it might also be suitable to consider in association with word retrieval difficulties in conversational interaction.

One of the RHD subjects, Carl, in study 4 produced speech that was characterised by topic drift, excessive detail and unclear reference use. Carl often seemed to, almost automatically, abandon his initiated speech plans and intended messages; even though he sometimes showed signs of word-processing difficulties, he seemed to have trouble inhibiting irrelevant associations and slowing down so he could make a more effortful search for the relevant concept. This might be partly explained by the frontal involvement of the brain damage, but it could also be considered as a symptom of a left-hemisphere mode of semantic processing. Carl also reported in the questionnaire that since the stroke he had experienced fewer word retrieval difficulties, which does not necessarily mean that he finds it easier to express himself post-stroke. He also reported an increase in the frequency of long and very detailed responses and in the initiation of new topics, and this was something he reported as having a negative impact on his conversational interaction. The other RHD subject, Nils, does actually sometimes try to produce circumlocutions in association with word-processing difficulties. The problem is that he seems to have trouble finding appropriate or functional substitutes. On several occasions, Nils also

seems to abandon his attempt to produce effective circumlocutions or even an intended message. According to Beeman (1998), it is possible that the right-hemisphere mode of semantic processing is especially important in the effortful search for appropriate concepts and words when the rapid and more automatic left-hemisphere semantic processing is not sufficient, and this might of course also be evident in conversation.

These results may also be interpreted in the light of Hird and Kirsner's (2003) discussion of the possibility that a reduced capacity to maintain intentional focus would make it difficult to keep a record of the discourse structure and the relationships between different contributions to the discourse. This might, in their view, result in a tendency on the part of the RHD individual to 'maintain the floor' or a reduction of his or her contributions to marginally relevant associations. In this study, such an impairment might explain the production of long and detailed responses. That is, when the intentional focus is lost, a somewhat relevant association with the previous topic induces the initiation of a new topic. Furthermore, a stream of associations, closely connected to the topic at hand although less relevant to the intentional goal of the discourse, might be apprehended as prolonged maintenance of the topic. It comes down to whether the associations produced and expressed by the brain-damaged subject are perceived by the conversational partner to be related and relevant to the topic at hand. The production of long and detailed responses (question 5), or the lack of them, might also be considered as a Topic management issue when perceived as a question about the tendency to not only keep one's turn for a longer time but also to be willing to dwell on the present topic. Change in this regard was reported by a majority of conversational partners of the LHD group as well as by the conversational partners of the RHD group and by the RHD subjects themselves.

3.8.5 Comprehension in conversation

A majority of the conversational partners of the RHD group report that general comprehension and inference making had changed. Furthermore, a majority of the conversational partners report that the change in inference making has a negative

impact in the conversational interaction. Several, but not the majority, of the conversational partners of the LHD group also report changes in the frequency of comprehension failures in general. Some of the brain-damaged individuals themselves, in both groups, do recognise comprehension failures in general as well as complex language comprehension to have been affected by the stroke, and a few of the subjects in the RHD group report a high negative impact of this change.

The tendency for the RHD subjects and their conversational partners to disagree about changes, for example in comprehension problems, might be a symptom of lack of insight among some of the RHD individuals. The analysis of the samples of video-recorded conversational interaction with the four cases did not provide enough opportunities to study comprehension in conversational interaction more closely. The results of studies 1 and 2 do show that comprehension is impaired in both groups. The discrepancies in the reports from the questionnaire show that this is sometimes perceived as a bigger problem by the conversational partners than by the brain-damaged individuals themselves. This may be because the brain-damaged individuals perceive other communicative problems to be more limiting or perhaps because they are simply not aware of the lost nuances and missing inferences.

3.8.6 Individual subjects' pragmatic ability

Both the RHD subjects and the LHD subjects as a group reported in study 3 that losing the thread while speaking had a high degree of negative impact on their conversational interaction. Three of the four individuals in study 4 also rated an increase in attentional slips as having a negative impact on their conversational ability. All four subjects in the case studies also had impairments in the area of VWM and attention or arousal. This, along with the results of studies 1 and 2, emphasises the impact of the interaction between attentional and other cognitive systems in pragmatic language disturbances. In the vocabulary of Perkins (2000), the pragmatic disturbances observed in these studies are considered as compound (or complex) pragmatic disabilities due to disturbances in both linguistic and non-linguistic cognitive systems.

In the analysing the results in studies 1 to 4 on an individual level, it is possible to see the outcomes as consequences of the interaction between pre-stroke personality traits, brain damage and functional or non-functional strategies employed in an effort to handle the deficits caused by the brain damage. This is best seen in the two RHD individuals, where an inability to sustain attention may interact with personality traits and hinder the development of useful compensatory strategies. Although at least one of the RHD subjects, Nils, was aware of the negative impact of changes in comprehension on his conversational interaction, this did not help him to employ functional strategies to deal with the problem when it occurred in the inference tasks. The interaction between several different factors in association with brain damage is also seen in one of the LHD subjects, Johan. His strategy of waiting to respond until after he had read the narrative resulted in low scores for tasks that depend on explicit information and inference of a character's attitude/motive. This kind of strategy might also explain the low number of correct responses in the SART for Thomas, the other LHD subject. Both LHD subjects take their time in conversational interaction, which is a strategy that affects Turn-taking patterns but at the same time seems to result in their getting their intended messages across.

The results of studies 3 and 4 are highly dependent on the specific individuals who took part. Especially when it comes to pragmatic performance in conversational interaction, the results of any analysis depend on individual traits. The individuals in the case studies were chosen as being somehow representative of the group results in studies 1 to 3. Still, there are several individuals in the RHD group who have less obvious pragmatic problems than the two who took part in study 4. One of the participating LHD subjects, Johan, was also one of the subjects who had the most apparent semantic problems in the conversational interaction. The results of study 4 are an outcome of the aim to describe the consequences of pragmatic language impairment in the individual. This means that the results of this study cannot be generalised to a whole population of LHD or RHD individuals. However, they may serve the basis of further research and as guidance in understanding the problems of other RHD and LHD individuals.

4. SUMMARY AND CONCLUSIONS

In this part of the thesis, first a short summary of the most important results of all four studies will be given. This will be followed by a presentation of avenues for future research and clinical implications of the results of this thesis.

4.1 General summary

The notion that communication emerges through the interaction of language-specific and non-linguistic cognitive processes, as well as through interaction between conversational partners and the use of compensatory strategies, is fundamental to this thesis. Although current views of the relationships between linguistic and non-linguistic aspects of communication may diverge, it has become clear that RHD can result in deficits that have a serious negative impact on communication for the individual and his or her conversational partners.

The aim of studies 1 and 2 was to investigate the associations between the ability to generate inferences from implicit information in discourse, sustained attention and VWM in two groups of brain-damaged individuals. One implication of the results is that different types of inference, and the type of content in the discourse, may tax the ability to make inferences differently in brain-damaged individuals, depending on the site of the lesion. This variation may be explained by altered requirements of processes involved in comprehension.

The results indicate that it is possible to discriminate between groups of brain-damaged individuals and a group of healthy controls based on their ability to infer from implicit information in verbal discourse. Though it is not possible to entirely separate language from other cognition, or basic cognitive functions from higher-level cognitive functions, the results of this study indicate that it is possible to relate RHD individuals' problems with tasks that require *revised inference* to their ability to sustain attention. This makes sustained attention relevant to the understanding of pragmatic deficits in association with RHD, although in these studies, it is not considered to be a single sufficient factor. In the LHD group, on the other hand,

performance in the Discourse Comprehension tasks tended to be associated with VWM capacity.

It is also inferred that problems with alertness, sustained attention and VWM might also affect the strategies used to perform the tasks.

Theoretically, deficits in sustained attention might also explain RHD individuals' problems in making adequate inferences of a character's attitude or motive. However, no associations were revealed between measures of sustained attention and results on this task. Instead, there were indications that alertness, as measured by reaction times, might be somehow involved.

The results obtained in studies 1 and 2 only concern the ability to generate adequate inferences of meaning and understand narratives. Still, it is possible that misinterpretations and inadequate inferences can explain some elements of the dysfunctional interaction described in relation to RHD, for example, off-topic comments.

The main aim of studies 3 and 4 was to investigate the impact of impaired pragmatic ability on conversational interaction.

The questionnaire distributed to a group of brain-damaged individuals with either LHD or RHD and their conversational partners showed that there are wide variations among individuals in both groups. *More individuals* in the LHD group and among their conversational partners than in the RHD group and their conversational partners perceive a change in frequency of behaviours affecting conversational interaction. Furthermore, *more of the different behaviours* inquired about in the questionnaire are perceived to have changed and to have a negative impact by the majority of the LHD subjects and their conversational partners than is the case with most RHD subjects and their conversational partners. Still, on an individual level, there are several RHD individuals who perceive more changed behaviours and a higher degree of negative impact than several of the LHD individuals. These results indicate that site of lesion is not the determining factor when it comes to pragmatic language and communication disturbances and ability to interact in conversation.

The pragmatic areas in conversational interaction that were reported as changed and as having a negative impact by a majority of the brain-damaged subjects in both groups are Attention, Word retrieval, Initiation and Turn-taking.

The brain-damaged individuals and their conversational partners do not always agree on which areas have changed and which areas have the largest negative impact. This indicates that it is important to map the perception of the conversational interaction of both the brain-damaged individual and his or her conversational partner. Any diverging perceptions might mirror their different perspectives and all conversational interaction depends on the co-operation of the individuals involved.

The disagreement is greater between the RHD subjects and their conversational partners than between the LHD subjects and their conversational partners, which might reflect a lesser degree of insight into impaired pragmatic ability in RHD. The area of Comprehension, and more specifically, more complex aspects of language comprehension tended to be reported most often as having changed and as having a negative impact by the RHD subjects' conversational partners.

Neither the RHD subjects nor their conversational partners focus on Repair issues to same extent as the LHD subjects and their conversational partners. It is believed that, as discussed by Hird and Kirsner (2003), the conversational partners might automatically take over the greater part of the responsibility for conversational interaction; they may not even perceive a need for repair, using their ability to make bridging inferences due to their familiarity with the topics discussed. Even though such compensatory efforts in conversational interaction may be cognitively demanding on the conversational partner, those changes would not be reflected by the questionnaire used in this study.

The cases in study 4 show that individual features such as pre-stroke personality traits and communicative style interact with post-stroke deficits and compensatory strategies in the comprehension and conversational interaction of the brain-damaged individual. The two RHD individuals in study 4 did not seem to have the kinds of functional strategies to handle their comprehension and speech production problems that the two LHD individuals had. Lack of insight might be involved, but the results

also show that being aware of one's problems is not sufficient to allow one to develop and employ strategies to compensate for them.

In study 4, the analysis of the video-recorded conversational analysis made it clear that problems in the production of discourse, for example word-processing difficulties, were more salient in the interaction with the two LHD individuals than with the two RHD individuals. However, importantly, it was shown that both RHD and LHD subjects also demonstrated more subtle symptoms of processing difficulties.

The results also reveal that turn-taking patterns are affected by individual traits as well as by brain damage. One conclusion from the study is that impaired word processing, for example, might change turn-taking patterns in different ways. That is, such problems might not simply create a need for more time to be able to make a contribution, with the result that the individual is sometimes obliged to turn down an offer to take the floor, or to elaborate on a topic. The need for extra processing time might also result in longer contributions, affected by self-repair. But impaired word processing can also result in turn-taking patterns where the brain-damaged individual dominates the floor, producing a stream of associations and making it difficult for any interaction with the conversational partner to come into play. The excessive level of detail and changes of topic sometimes seen in association with RHD might be either a conscious or an automatically triggered strategy used in association with word retrieval difficulties.

It was also shown that, although there are instances of other-initiated repair in the interaction with the LHD subjects as well as the two RHD subjects, other-initiated repair due to impaired reference, especially in the case of place adverbs like 'there' or 'here', is only seen in the interaction with the two RHD individuals. This might be linked to topic development and the sometimes excessive level of detail. Even though the RHD individuals often made successful self-repairs, they sometimes seemed to have more trouble with self-repair than the two LHD subjects. The occurrences of self-repair in the two LHD subjects were more salient and, in the end, often more successful. The RHD subjects, on the other hand, tended to abandon self-initiated

self-repair, for example when they failed to produce circumlocutions; sometimes they did not even engage in the repair process at all, unless requested by the conversational partner. These findings also indicate that the questionnaire used in study 3 needs to be further developed as there are problems in the repair area that it does not capture.

4.2 Implications for further research

The results of studies 1 and 2 indicate that it is relevant to search for a possible cause of at least some RHD individuals' problems in comprehension and other pragmatic deficits in the functioning of different attentional systems. Arousal and sustained attention might be considered as basic functions relevant to any complex cognitive process, and it is probably wise to have a clear picture of these basic functions in any individual who is included in a study of pragmatic performance in association with RHD. Measures of more basic cognitive functions should be complemented with measures of higher-level functions like executive functions. But, as recently discussed by Martin and McDonald (2005), sustained attention might be crucial in any process requiring executive function.

The human attention system and more complex cognitive functions are compound matters. As it is not obvious how they should best be analysed and described, it is important that the models and methods used be well defined and reliable, or at least that the researcher be well aware of the pros and cons of the theoretical framework used.

It is likely that the SART, used in study 2 to obtain a measure of sustained attention, is more sensitive to attention deficits in relation to traumatic brain injury than in relation to stroke. The inhibitory aspect of sustained attention, as measured by the SART, is probably more affected by frontal lobe lesions, although this needs to be further explored in studies comparing the SART to other tests of sustained attention in association with stroke.

The results of study 2 indicate that the ability to sustain attention in itself may not be sufficient to explain the difficulties making inferences. Instead, the ability to sustain attention needs to be viewed as incorporated in other cognitive functions and mechanisms, theoretically described as, for example, *coarse semantic coding theory* (Beeman, 1998), a left-hemisphere interpreter (Gazzaniga and Cooney, 2003), and Ramachandran's (1995) right-hemisphere anomaly detector.

Now, the results in the RHD group on tasks requiring *inference of a character's attitude or motive* could not be related to any of the cognitive functions measured, although level of alertness most likely has a great impact. One implication of this might be that we should search for the possible cause in another, at least theoretically separate, cognitive mechanism. Another implication of the results of this study is that it would be worthwhile to further explore the functions of semantic processing, especially of the emotional and attitudinal aspects of words, in association with RHD. Furthermore, theories of social cognition as presented by Adolphs (1999) and Adolphs and Damasio (2000), and the HERA model as presented by Habib et al. (2003) might provide a promising framework for future studies of social inference in association with RHD.

Kintsch's (1998) construction-integration model provides a framework for this thesis. It is considered as a functional theoretical tool in the analysis of comprehension in association with RHD. The model makes it possible to analyse and describe the different processes required in comprehension. It was used here as a basis for discussing the different requirements for making adequate inferences of a character's attitude or motive and revising inferences made earlier. However, due to the method and stimuli used in these studies, it was not possible to establish which phase of the comprehension process was involved in any impaired ability to generate inference. To do that, the stimuli used would have to be supplemented with, for example, other measures of the subject's ability to flexibly activate and suppress several meanings of ambiguous words and of emotionally tinged words. The construction-integration model might therefore serve as guidance in the construction of a methodology and stimuli in future research. Furthermore, this model was found

to highlight the role of different attentional processes and the significance of mechanisms such as retrieval and encoding in the process of comprehension.

The results of studies 3 and 4 also indicate that research on pragmatic disturbances should include an analysis of conversational interaction and involve the conversational partners of the brain-damaged individual. One issue that might be interesting to look into is *strategies* associated with word processing in RHD. Further research in this area might shed more light on the processes involved, both those causing the impairment and the strategies that might compensate for the impairment and facilitate communication.

The results of study 3 show that, on a group level, brain damage to either hemisphere may result in subtle communication deficits that have a negative impact on the conversational interaction. Although only a few of the individuals included in the study had been diagnosed as mildly aphasic, in a clinical setting, both most of the brain-damaged individuals themselves and their conversational partners perceived a negative impact of their deficits. The distribution of an adapted questionnaire might make it possible to grasp several aspects of the pragmatic ability affected by brain damage. Furthermore, there is a need for incidence data on pragmatic communication disturbances in association with both RHD and LHD. To obtain reliable data on the occurrence of pragmatic deficits in such a study, it is important for the questions asked to be relevant for patient groups with more subtle symptoms. The questionnaire used in study 3 needs to be further adapted and tested. Structured interviews, as presented in the CAPPCI (Perkins et al., 1997), might be one way of finding the right questions to ask, while factor analysis of larger quantities of data could refine the instrument.

In the end, group studies can provide a lot of important information about cognitive functions in association with brain damage, but they need to be complemented with case studies. Given that pragmatic abilities are dependent on various cognitive functions, and also on personal traits and strategies employed, it is most likely that pragmatic deficits associated with RHD manifest themselves in different ways. That makes it even more important to base any conclusion concerning

such deficits on research with patients whose cognition and pragmatic function have been carefully analysed and described.

4.3 Clinical implications

One important implication of the results of studies 1 and 2 is that tasks used to assess the ability to generate inferences in discourse have to be well defined with respect to the demands they make on the processes involved. For example, the results of study 1 and 2 indicate that complex tasks requiring *revised inference* may capture problems in both RHD individuals and LHD individuals with subtle language disorders. Nevertheless, these problems might have different causes in the different individuals. It might be more important to assess the ability to generate social inferences, which requires other kinds of inference tasks, and in part involves other cognitive processes, in RHD individuals than in LHD individuals. These problems might be best understood as symptoms of a different kind of impairment than the one that underlies other inference problems.

The pragmatic deficits seen in association with RHD are often referred to as a cognitive-communicative impairment. The connection between cognition and communication is still more often acknowledged in the case of RHD than in association with LHD and aphasia. But since this connection is not always made explicit in clinical settings, physicians, nursing staff and rehabilitation team members are often uncertain about the role of speech-language pathologists in the management of RHD patients. In addition to all the individuals who suffer from traumatic brain damage and neurological diseases, every year about 25,000 to 30,000 individuals suffer from stroke in Sweden (Socialstyrelsen, 2000). It is difficult to estimate how many of the individuals with RHD actually suffer from communicative impairments related to cognitive-linguistic deficits. However, there is no doubt that RHD individuals with pragmatic deficits tend to be under-referred to speech-language pathologists. The speech-language pathologist most often becomes involved because the patient has a swallowing disorder or motor speech disorders. As discussed by, for

example, Lehman-Blake, Duffy, Myers and Tompkins (2002), there is a need for standard terminology and increased knowledge about those issues among clinicians. Furthermore, the effects of more subtle communicative difficulties can be difficult to observe in a hospital setting. Pragmatic deficits are often not really noticed, even by family members, until the RHD individual has left the hospital. The nature of the pragmatic problems in communication also makes it clear that it is necessary to involve the conversational partners in the assessment of the brain-damaged individual's pragmatic ability, partly to get a picture of individual traits present before the disease. The assessment also needs to be performed or followed up some time after the initial rehabilitation phase.

The results of this study do not present any clear-cut implications for the assessment and treatment of pragmatic deficits in association with RHD. The indications from this and other studies that non-linguistic areas, such as arousal and sustained attention, are involved highlight the importance of teamwork in the assessment and clinical management of these patients.

In line with Myers (1999b), the results of the studies presented here indicate that in addition to an assessment of the ability to make more elaborate inferences in comprehension, semantic processing needs to be assessed with tasks that require the activation of a wide range of alternate meanings and associations with a single concept. This might be done with open-ended questions about more complex matters and situations and word classification, including word meanings involving emotional or attitudinal aspects. To get a clear picture of a brain-damaged individual's pragmatic ability, it is also necessary to assess the ability to interact in conversation with strangers as well as with familiar conversational partners. A complete assessment of the ability to interact in conversation would also have to include several different situations that make different demands on the ability to flexibly adapt to the needs and expectations of conversational partners. It is also important for the clinician to be alert to less obvious and more subtle symptoms of possible word-processing difficulties. Even short pauses and other basic OCM expressions such as sighing and clicking sounds might be considered as symptoms of processing

difficulties in association with more subtle language disturbances. Furthermore, an increase in changes of speech plan and topic drift post-stroke might be a symptom of a pragmatic language deficit.

Several English-language assessment protocols and tools for pragmatic or cognitive-communicative deficits associated with RHD have been published (e.g. Burns et al., 1999; Myers, 1999b; Schneider et al., 1999). The problem with some of the existing assessment batteries is that they are not totally abreast of current research on language and communication in association with RHD. There is also a Swedish test battery, developed for assessment of high-level language: *Testbatteri för subtila språkstörningar (TBSS)* (Laakso et al., 2000). This test battery includes tests of comprehension of ambiguous words and metaphors and ability to generate inferences from implicitly expressed information in discourse. Unfortunately there is no control over the types of inference required and processes involved, but the tasks primarily require bridging inference without any requirement for social inference. An English test battery published by Bryan (1993), the *Right Hemisphere Language Battery*, has been translated and adapted in Swedish by Hofling and Saldert (1998), but the test was not found to be totally reliable or sufficient. This test battery also assesses the ability to infer from implicitly stated matters in discourse, and some of the tasks involve emotional content.

Since the processes underlying different aspects of pragmatic deficits in association with RHD are not always clear, task-oriented therapy – focusing on a specific task and addressing the symptoms – is common. Nevertheless, as discussed by Myers (1999a), process-oriented treatment is often preferable as it is believed to generalise to other tasks more than task-oriented therapy does, since any given process may affect several aspects of communication. Process-oriented therapy often involves facilitation techniques in which the disrupted processes are stimulated. Working with process-oriented therapy means that the clinician has to have a theory of the nature and cause of the pragmatic deficit. A problem with inference of, for example, attitude or motives or with emotionally tinged discourse needs to be managed differently if it is caused by a general attentional disorder or by an impaired

ability to process this specific type of semantic content. Myers (1999a, 1999b) and Tompkins (1995) present several different methods and therapy tasks for both task-oriented and process-oriented approaches. Treatment in the form of training programs for attentional deficits does exist, some in computerised versions, and some have also been evaluated with varying results; see, for example, Sturm (1996) and Palmese and Raskin (2000).

In order to manage specific communicative interaction problems, these problems can be mapped in a patient and his/her communication partner through interviews and videotaping of the interaction. This makes it possible to adjust the training to cover strategies that are relevant to that particular dyad. There is, however, a great need for treatment studies to evaluate different kinds of speech and language therapy for RHD.

In any case, until the pragmatic deficits associated with RHD are well understood, an important task for speech-language therapists must still be to inform the brain-damaged individual and his or her presumed communication partners, such as family members, the rehabilitation team and nursing staff, of these potential problems. This is especially important since a patient's misinterpretation of emotionally and attitudinally tinged communication might lead to his or her 'insensitivity' being understood as a personal characteristic instead of a symptom of impairment. Strategies used in association with word retrieval difficulties might also be mistaken for expressions of personality or attitude. In addition, impaired comprehension in general, which makes it difficult for the RHD individual to assimilate information and follow instructions, can interfere with the rehabilitation process. Well-informed communication partners can also aid in conversational interaction and comprehension by using facilitating and compensating strategies. After all, good communication is not a one-person affair.

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APPENDIX 1: Narratives

Categorisation of questions:

A/M – Inference of a character's attitude/motive

BI – Bridging inference

RI – Revised inference

M + RI – Both inference of motive and revised inference

E – Explicit

1. Den trasiga vasen

Johan plockade med darrande händer upp skärvorna efter vasen hon kastat. Det låg glasbitar i hela hallen. Han lyssnade utåt trapphuset. Det hade gått en halvtimme sedan Asta rusat iväg. Han hade inte fått någon chans att förklara alls. 'Om hon inte kommer tillbaka i kväll... eller kanske imorgon, om hon inte kommer tillbaka imorgon så ringer jag svärmor', tänkte Johan.

1a. Vem var Asta? (BI)

1b. Varför hade Asta rusat iväg? (A/M)

1c. Vem tänkte Johan ringa? (E)

Eng: 1. The broken vase

With shaky hands Johan picked up the pieces of the vase she had thrown. There was broken glass all over the hall. He listened for any sound from the stairwell. Half an hour had passed since Asta had run off. He hadn't had any chance to explain. 'If she doesn't come back tonight... or maybe tomorrow, if she doesn't come back tomorrow, I'll phone mother-in-law', Johan thought to himself.

1a. Who was Asta? (BI)

1b. Why had Asta run off? (A/M)

1c. Whom was Johan going to phone? (E)

2. Filen

Lisa var väldigt hungrig. Hon hade försovit sig och blivit sen till frukostmötet. Nu hade hon svårt att bestämma sig för vilken fil hon skulle ta. Den hon brukade välja var kanske inte den bästa så här på morgonen. 'Nej, nu prövar jag en annan', sa hon till sig själv, 'den kanske är snabbare'. Hon kastade en blick i backspegeln samtidigt som hon satte på blinkersen.

2a. Varför var kvinnan sen? (E)

2b. Varför ville hon pröva en annan fil? (M + RI)

2c. Var någonstans var kvinnan när hon skulle välja fil? (RI)

ENG: 2. The sour milk/the lane (Swedish: *Filen*)

Lisa was very hungry. She had overslept and was late for the breakfast meeting. Now she had difficulties in making her mind up about which sour milk/lane (Swedish: fil) she should take. The one she usually chose might not be the best one in the morning. 'No, now I will try another one', she said to herself, 'that one might be quicker'. She glanced in the driving mirror as she started the flasher.

2a. *Why was the woman late? (E)*

2b. *Why did she want to try another sour milk/lane (Swedish: fil)? (M + RI)*

2c. *Where was the woman when she had to choose a sour milk/lane (Swedish: fil)? (RI)*

3. En solig dag

Solen stod redan högt på himlen när katten med ett entusiastiskt spinnande ännu en gång försökte få henne att kliva upp och fylla på matskålen. Filten hon hade spikat upp framför fönstret för tre dagar sedan lyckades inte stänga ute de stickande solstrålarna. "Underbart, en ny härlig dag", suckade hon och drog täcket över huvudet. Brevet hon fått låg fortfarande sönderrivet på köksbordet.

3a. Varför hade hon inte klivit upp ännu? (A/M)

3b. Uppskattade hon det vackra vädret? (A/M)

3c. Vad försökte katten göra? (E)

ENG: 3. A sunny day

The sun stood already high above the rooftops when the cat, with its enthusiastic purring, once again tried to make her get up and refill its bowl. The blanket she had nailed up in front of the window three days ago didn't succeed in shutting out the stinging rays of sunshine. 'Lovely, a new wonderful day', she said with a sigh and pulled the cover over her head. The letter she had received was still lying torn up on the kitchen table.

3a. *Why hadn't she got up yet? (A/M)*

3b. *Did she appreciate the beautiful weather? (A/M)*

3c. *What was the cat trying to do? (E)*

4. Bandet

Musiken dånade i högtalarna på bilen. Han förstod inte hur hon kunde tycka om den sortens band. Själv avskydde han dem. "Du kan väl följa med dit och titta i alla fall", hade hon bett honom. När de kom fram hade hon på något sätt lyckats övertala honom att gå in ensam. "Ta tio meter av den vävda sorten", ropade hon innan dörren till butiken slog igen efter honom.

7. Mössan

”Va' fin du är idag”, sa Ove och klappade henne hårt på huvudet. Den nya yllemössan var varm och det kliade. Karin vågade inte svara. Det var sent i oktober men höstsolen värmdes bra ännu. Runtomkring dem stod de andra barnen i en tät ring. De var barhuvade och flinade åt henne. Plötsligt satt mössan i Oves hand och han viftade triumferande med den mot kamraterna vars skratt nu ekade över skolgården.

7a. Var det *mycket* kallt ute den dagen? (E)

7b. Varför tog Ove Karins mössa? (A/M)

7c. Hur hade Karin det med sina klasskamrater? (A/M)

ENG: 7. The cap

'Well, you look nice today', Ove said and patted her hard on the head. The new woollen cap was warm and it itched. Karin didn't dare to respond. It was late in October but the autumn sun was still warm enough. Around them the other children stood in a close circle. They were all bare-headed and they sneered at her. Suddenly the cap was in Ove's hand and he waved it in triumph at his friends, whose laughter now echoed over the schoolyard.

7a. Was it very cold outside that day? (E)

7b. Why did Ove take Karin's cap? (A/M)

7c. How did Karin get along with her classmates? (A/M)

8. Sprickan i pannan

Konstnären hade arbetat med ansiktet på skulpturen halva natten. Han hade sovit till långt in på förmiddagen när hans hustru kom in och väckte honom. ”Förlåt, men nu måste du vakna. De säger att det är en spricka i pannan”, hade hon sagt och pekade ut i hallen. Han gick ut i ateljén och lossade på duken runt skulpturen. Först nu kände han att det redan hunnit bli kallt i huset.

8a. Varför sov mannen så länge på morgonen? (E)

8b. Vad var det som hade hänt under natten? (RI)

8c. Hur visste hustrun att det var en spricka i pannan? (RI)

ENG: 8. The crack in the forehead/furnace (Swedish: panna)

The artist had worked on the face of the sculpture half the night. He slept until late in the morning, when his wife came in and woke him up. 'I'm sorry, but you have to wake up now. They say there is a crack in the forehead/ furnace (Swedish: panna)', she said and pointed towards the hall. He went out to the studio and loosened the cloth around the sculpture. Not until then did he notice that the house had already got cold.

- 8a. *Why did the man sleep so long in the morning? (E)*
8b. *What was it that had happened during the night? (RI)*
8c. *How did the wife know there was a crack in the forehead/ furnace (Swedish: panna)? (RI)*

9. Katten

Katten ställde sig på baktassarna och sträckte sig mot hans nypressade byxben. I köket skramlade matte med porslin och kaffevatten. ”Så, så”, muttrade Anders och försökte göra sig lös. Katten strök nu ihärdigt av sig hundratals mjuka hårstrån mot hans ben. Anders bet ihop käkarna samtidigt som han sköt bort den slingrande kattkroppen från de dyra byxorna. ”Det är verkligen en trevlig katt du har!” ropade han ut mot köket.

9a. Uppskattade Anders katten? (A/M)

9b. Vad höll kattens matte på med? (E)

9c. Vad ville Anders att matte skulle tro? (A/M)

ENG: 9. The cat

The cat stood up on its hind legs and pawed his newly ironed trousers. In the kitchen the cat's owner was clattering about with china and water for the coffee. 'There, there', Anders muttered and tried to free himself. Now the cat was persistently rubbing hundreds of soft hairs against his legs. Anders clenched his jaw as he pushed the cat's wriggling body away from the expensive trousers. 'That's a really nice cat you have!' he called out to the kitchen.

9a. Did Anders appreciate the cat? (A/M)

9b. What was the owner of the cat doing? (E)

9c. What did Anders want the mistress of the cat to believe? (A/M)

10. Masken

Hon såg masken på en gång när hon kom ut. Den var nästan helt grå och låg på den jordiga marken nedanför kökstrappen. Det var fullt med leksaker på gräsmattan fast klockan bara var tio på förmiddagen. Hon ropade på sonen som kom springande med sitt plastsvärd. ”Kan du inte ta reda på den där?” bad hon. Pojken tog upp masken och satte den på sitt ansikte innan han omfamnade sin mor.

10a. Vad tror Du fanns på masken så pojken kunde sätta den på sig? (RI)

10b Varför ville modern att han skulle ta reda på masken? (M + RI)

10c. Vilken tid på dagen var det? (E)

ENG: 10. The worm/mask (Swedish: mask)

She saw the worm/mask as soon as she came out. It was almost all grey and lay beneath the kitchen stairs on the ground that was soiled with earth. There were plenty of toys on the lawn although it was only ten in the morning. She called out to her son who came running with his plastic sword. 'Can you please take care of that?' she asked. The boy picked up the worm/mask (Swedish: mask) and put it on his face before hugging his mother.

10a. *What do you think there was on the worm/mask (Swedish: mask) so that the boy could put it on himself? (RI)*

10b. *Why did the mother want him to take care of the worm/mask (Swedish: mask) (M+RI)*

10c. *What time of the day was it? (E)*

11. I tullen

Hon följde efter strömmen av människor som passerade under den gröna skylten i tullen. Där framme kunde hon se en uniformerad tjänsteman. Svetten fick tejpen att skava mot huden i midjan och de små lätta plastbehållarna kändes blytung. Hon hade tagit en rymlig tröja på sig men tyckte nu att den tydligt putade ut i midjan. Hon drog in magen och fixerade utgången med blicken när hon passerade tulltjänstemannen.

11a. Varför svettades kvinnan? (A/M)

11b. Var någonstans var hon? (E)

11c. Varför hade hon en rymlig tröja på sig? (A/M)

ENG: 11. In the customs office

She followed the stream of people passing the green 'Nothing to declare' sign in the customs office. Up front she could see a uniformed official. Her sweat made the tape irritate the skin around her waist and the small plastic containers felt as heavy as lead. She had put on a roomy sweater but now she thought it was bulging over her waistline in an obvious way. She pulled in her stomach and looked fixedly at the exit as she passed the customs officer.

11a. *Why was the woman sweating? (A/M)*

11b. *Where was she? (E)*

11c. *Why did she have a roomy sweater on? (A/M)*

12. Boken

Han hade givit henne en bok på deras första bröllopsdag. Hon hade blivit så glad och kysst honom. Sedan hade hon ofta suttit i trädgården och tittat på den. Den hade blivit som en symbol för deras äktenskap, tyckte han. Det var många år sedan. Hon var död nu men boken fanns kvar. Han sträckte ut handen och rörde vid den. Den var så stor nu att den skuggade hela gräsmattan.

12a. Var det en stor bok hon hade fått för länge sedan? (RI)

12b. Vad hade hon gjort när han gav henne boken? (E)

12c. Var hade de gjort av boken när hon fått den? (RI)

ENG: 12. The book/beechn (Swedish: Boken)

He had given her a book/beechn (Swedish: bok) on their first wedding anniversary. She had been so pleased and had kissed him. After that, she often sat in the garden, looking at it. It had turned into a symbol of their marriage, he thought. That was many years ago. She was dead now but the book/beechn (Swedish: boken) was still there. He reached out and touched it. It was so large now that it shadowed the entire lawn.

12a. Was it a large book/beechn (Swedish: bok) she had been given long ago? (RI)

12b. What had she done when he gave her the book/beechn (Swedish: boken)? (E)

12c. What had they done with the book/beechn (Swedish: boken) when she got it? (RI)

APPENDIX 2: Examples of assessment scheme for Discourse comprehension

Question 1a): ‘Who was Asta?’ requires bridging inference and integration of information.

Adequate responses require an inference of the relationship between the main characters, integration of information in the discourse through bridging inference (for example ‘call mother-in-law’ and the expectation that ‘she might come back tonight’) and knowledge of the world (for example that misunderstandings and disagreement might affect a relationship).

It should be clear from the response that the main figures have some kind of close relationship.

Examples of correct responses: wife / fiancée / common-law spouse / girlfriend / the woman of the house.

Question 1b): ‘Why had Asta run off?’ requires bridging inference, integration of information and inference of attitude/motive.

The understanding of the motive requires the integration of information in the discourse through bridging inference (for example ‘With shaky hands’, a broken vase, ‘hadn’t had any chance to explain’, she had ‘run off’) and insight into the attitudes and emotions of the main characters (for example, that anger can result in a broken vase).

It should be clear from the response that some kind of conflict has come up between the main figures.

Examples of correct responses: they had had an argument / she was angry / she had thrown the vase.

Question 1c): ‘Whom was Johan going to call?’ (Adequate information is explicitly expressed in the discourse.)

It should be clear from the response that the person Johan was planning to telephone had some kind of family relationship with Asta/Johan.

Example of correct responses: mother-in-law/ Asta’s mother / the parents-in-law.

Question 2a): ‘Why was the woman late?’ (Adequate information explicitly expressed in the discourse).

The question inquires about the reason why she was late rather than a motive for her action, which is explicitly expressed in the discourse.

It should be clear from the response that the woman was late because she had slept too long.

Examples of correct responses: she had overslept.

Question 2b): ‘Why did she want to try another sour milk/lane (Swedish: *fil*)?’ requires bridging inference, integration of information and inference of motive (a correct response also might require a revised inference).

*For the correct inference of motive, the integration of information in the discourse and knowledge of the world through a bridging inference is required. To make the last sentence totally coherent, a revision of an ambiguous word is required. (Might include inference of attitude/motive as in ‘she was pressed for time/in a hurry’, but that is not necessary for producing a correct response.) Inquires about the motive for trying another kind of sour milk or lane (Swedish: *fil*).*

It should be clear from the response that the woman wanted to save time by changing lanes in a traffic situation. Responses like ‘she was fed up with the one she usually took/the old one’ are thus not acceptable.

Examples of correct responses: to get there faster/it was faster/there was a lot of traffic.

A response like ‘she was in a hurry’ must be judged in relation to responses to question 2c to find out whether the subject means *sour milk* or a *lane* in a traffic situation.

Question 2c): ‘Where was the woman when she had to choose a sour milk/lane (Swedish: *fil*)?’ requires bridging inference, integration of information and revised inference.

The right inference requires integration of information in the discourse and knowledge of (traffic in) the world. To make the last sentence coherent, an erroneous interpretation of an ambiguous word must be revised.

It should be clear from the response that the woman is in a ‘traffic situation’ rather than in a ‘food situation’.

Examples of correct responses: in a street / on the road / in a car / out in the traffic / in another lane.

Question 11a): ‘Why was the woman sweating?’ requires bridging inference, integration of information and inference of attitude/motive.

A correct response requires bridging inference through the integration of information in the discourse and knowledge of the world. An adequate response requires an inference of attitude/motive through a physical expression (she is perspiring).

It should be clear from the response that the woman is nervous or that she is trying to smuggle something (or both). A response that simply states that she had a thick sweater on is not enough if it does not include information about why she had it on (that is, that she was trying to smuggle something).

Examples of correct responses: she was nervous / afraid to get caught / was going to smuggle something.

Question 11b): ‘Where was she?’(Adequate information is explicitly expressed in the discourse.)

It should be clear from the response that she is about to cross a border, in the customs office or that she is in a situation associated with travelling.

Examples of correct responses: in customs / at the border / in an airport / at a ferry terminal / on a station / she went under the green sign.

Question 11c): ‘Why did she have a roomy sweater on?’ requires bridging inference, integration of information and inference of motive.

An adequate response requires integration of information in the discourse and knowledge of the world (for example, that small plastic containers taped to the body might imply smuggling), for the right inference of motive.

It should be clear from the response that she is hiding something or that she is trying to smuggle something (and thereby implicitly expressed that she wants to hide something).

Examples of correct responses: to hide what she was trying to smuggle / because she was smuggling something.

Question 12a): ‘Was it a large book/beechnut (Swedish: *bok*) she had been given long ago?’ requires bridging inference, integration of information and revised inference.

For coherence, the correct response requires integration of information in the discourse and knowledge of the world and bridging inference as well as the revision of an erroneous interpretation of an ambiguous word.

It should be clear from the response that it was not very big or that it was a sapling.

Examples of correct responses: No / it was a sapling / it was a young beech.

Question 12b): ‘What had she done when he gave her the book/beechnut?’ (Adequate information is explicitly expressed in the discourse.)

Some kind of *reaction or action* by the woman or some kind of *reason* why she got the beech should be explicitly stated in the response. ‘Sitting in the garden with it’ is not accepted if the responses to questions 12a or 12c indicate that the subject had interpreted the ambiguous word (Swedish: *bok*) as meaning a book.

Examples of correct responses: kissed him / planted it / she was glad / it was their wedding anniversary / she had put up with him a whole year

Question 12c): ‘What had they done with the book/beechnut when she got it?’ requires bridging inference, integration of information and revised inference.

An adequate response requires integration of information (for example, that she had sat in the garden looking at it and that it shadowed the lawn) and knowledge of the world as well as revision of an erroneous interpretation of an ambiguous word.

It should be clear from the response that it is something that is planted or can only be kept in the garden. Just ‘she had kept it’ is not acceptable.

Examples of correct responses: they planted it / it was out (in the garden).

APPENDIX 3: Questions in the questionnaire

1. Do you usually take the initiative and start a conversation with your friend/relative?
2. Do you ever fail to initiate a response when it is your turn to speak?
3. Are there occasions when there is a long pause before you answer when your conversational partner addresses you?
4. When you speak to your friend/relative, do you occasionally interrupt him/her?
5. When you speak to your friend/relative, are your responses very long and detailed?
6. Do you restrict what you say to minimal or very short responses?
7. Do you introduce new topics in a conversation?
8. When you introduce a new topic, does your friend/relative ever have trouble seeing how it fits in with previous topics?
9. Can you continue talking about the same topic for a long period of time?
10. Do you have favourite topics that you repeatedly bring up in a conversation?
11. Sometimes we get the impression that we don't really follow what a conversational partner is talking about. When that happens to you, do you usually say something or indicate that you can't really follow what your friend/relative is talking about?
12. When you make a mistake in your speech, do you try to correct yourself?
13. When you try to correct your speech, can you manage it by yourself, without help from your conversational partner?
14. Can you specify what you mean if your friend/relative does not understand?
15. Do you ever stop speaking in the middle of a sentence and leave it unfinished as if you had lost the thread or been distracted?
16. Do you sometimes have to struggle to find the appropriate word when you are going to speak?

17. If you can't find the appropriate word, do you try to describe what you mean?
18. Do you ever have difficulties understanding what your friend/relative says?
19. Do you ever use words like *he/she*, *it* and *here/there* without your conversational partner understanding who or what you are referring to?
20. Do you sometimes take things literally and therefore misunderstand them?
Example: If someone asks you to 'just hold on a minute', would you think that he/she meant literally 60 seconds?
21. Can you 'read between the lines' and understand what people really mean?
Example: If someone says 'It is really hot in here', would you understand that they wanted someone to open a window?
22. Do you sometimes miss the point of a joke?
23. Do you think you have a sense of humour?
24. Is your humour appreciated by others?
25. Do you think your speech sounds flat or monotonous?

APPENDIX 4: Reported change and degree of negative impact in study 3

Number of subjects and conversational partners reporting *change* (within brackets) and negative impact as well as median and range (within parentheses) of rated *degree of negative impact*. Figures in bold type denote issues that were reported by a majority of the subjects and/or their conversational partners.

Area	Issue	Subjects		Conversational partners	
		LHD n = 13	RHD n = 11	LHD n = 13	RHD n = 9
Initiation	1. Start conversation	[9] 8 <i>md: 2 (1–3)</i>	[5] 4 <i>md: 2 (0–3)</i>	[6] 6 <i>md: 2 (1–3)</i>	[4] 2 <i>md: 1 (0–2)</i>
	2. No response	[8] 7 <i>md: 2 (0–3)</i>	[6] 5 <i>md: 2.5 (0–4)</i>	[10] 10 <i>md: 2 (1–4)</i>	[2] 1 <i>md: 0.5 (0–2)</i>
	3. Latency response	[7] 7 <i>md: 3 (1–3)</i>	[6] 6 <i>md: 2 (1–4)</i>	[8] 7 <i>md: 2 (0–4)</i>	[3] 3 <i>md: 1 (1–4)</i>
Turn taking	4. Interrupt others' turn	[6] 6 <i>md: 2 (2–3)</i>	[1] 1 <i>(1)</i>	[7] 5 <i>md: 1 (0–3)</i>	[3] 2 <i>md: 1 (0–3)</i>
	5. Detailed responses	[6] 6 <i>md: 2.5 (1–3)</i>	[7] 6 <i>md: 2 (0–3)</i>	[8] 8 <i>md: 2 (1–3)</i>	[5] 4 <i>md: 2 (0–2)</i>
	6. Short responses	[9] 7 <i>md: 2 (0–3)</i>	[5] 4 <i>md: 2 (0–3)</i>	[10] 10 <i>md: 2 (1–3)</i>	[4] 3 <i>md: 1 (0–2)</i>
Topic management	7. Start new topics	[8] 6 <i>md: 1 (0–3)</i>	[4] 4 <i>md: 2 (1–4)</i>	[5] 5 <i>md: 2 (2–3)</i>	[3] 3 <i>md: 2 (2–4)</i>
	8. Coherence of new topics	[3] 3 <i>md: 2 (2–3)</i>	[2] 1 <i>md: 2 (0–4)</i>	[5] 5 <i>md: 2 (1–4)</i>	[3] 3 <i>md: 1 (1–4)</i>
	9. Maintain topics	[6] 5 <i>md: 1.5 (0–3)</i>	[2] 2 <i>md: 2.5 (2–3)</i>	[5] 5 <i>md: 2 (1–3)</i>	[4] 4 <i>md: 1.5 (1–4)</i>
	10. Recurring topics	[4] 3 <i>md: 1.5 (0–2)</i>	[1] 0	[3] 3 <i>2 (1–3)</i>	[3] 2 <i>md: 1 (0–2)</i>

Repair	11. Indicate compreh. problems	[7] 5 <i>md: 2 (0-3)</i>	[3] 3 <i>md: 3 (2-4)</i>	[10] 10 <i>md: 2 (1-4)</i>	[3] 3 <i>md: 2 (1-2)</i>
	12. Initiate self-repair	[8] 8 <i>md: 1 (1-3)</i>	[3] 3 <i>md: 2 (2-3)</i>	[7] 7 <i>md: 2 (1-3)</i>	[2] 1 <i>md: 1 (0-2)</i>
	13. Successful self-repair	[7] 7 <i>md: 2 (2-2)</i>	[2] 1 <i>md: 0.5 (0-1)</i>	[10] 10 <i>md: 2 (2-3)</i>	[3] 3 <i>md: 1.5 (1-2)</i>
	14. Repair through specifying	[7] 7 <i>md: 2 (1-3)</i>	[4] 3 <i>md: 3 (0-4)</i>	[7] 7 <i>md: 2 (2-3)</i>	[2] 1 <i>md: 1.5 (0-3)</i>
Attention	15. Lost thread when speaking	[9] 8 <i>md: 2 (0-3)</i>	[6] 6 <i>md: 2 (1-4)</i>	[9] 8 <i>md: 2 (0-3)</i>	[3] 3 <i>md: 1 (1-4)</i>
Word retrieval	16. Word retrieval difficulties	[9] 8 <i>md: 1 (0-3)</i>	[6] 6 <i>md: 1.5 (1-4)</i>	[1] 11 <i>md: 2 (1-4)</i>	[8] 6 <i>md: 1 (0-2)</i>
	17. Production of circumlocutions	[5] 2 <i>md: 0 (0-3)</i>	[5] 5 <i>md: 2 (1-3)</i>	[9] 9 <i>md: 2 (1-3)</i>	[2] 1 <i>md: 1.5 (0-3)</i>
Reference	19. Reference failure	[6] 6 <i>md: 2 (1-3)</i>	[3] 3 <i>md: 2 (1-3)</i>	[6] 6 <i>md: 1.5 (1-3)</i>	[5] 4 <i>md: 2 (0-3)</i>
Prosody	25. Monotonous intonation	[7] 7 <i>md: 2 (1-4)</i>	[4] 4 <i>md: 3 (2-4)</i>	[8] 7 <i>md: 1 (0-2)</i>	[3] 3 <i>md: 1 (1-3)</i>
Comprehension, general	18. Comprehension in general	[5] 5 <i>md: 2 (1-3)</i>	[2] 2 <i>md: 3.5 (3-4)</i>	[6] 6 <i>md: 2 (1-4)</i>	[5] 4 <i>md: 2 (0-3)</i>
Complex language comprehension	20. Metaphorical meaning	[3] 3 <i>md: 2 (1-2)</i>	[2] 2 <i>md: 3 (2-4)</i>	[3] 3 <i>md: 2 (1-3)</i>	[4] 3 <i>md: 1.5 (0-4)</i>
	21. Make inferences	[4] 3 <i>md: 1.5 (0-2)</i>	[3] 3 <i>md: 2 (1-4)</i>	[4] 4 <i>md: 1.5 (1-3)</i>	[5] 5 <i>md: 2 (1-4)</i>
	22. Comprehension of humour	[2] 2 <i>md: 1.5 (1-2)</i>	[2] 2 <i>md: 3 (2-4)</i>	[2] 2 <i>md: 1.5 (1-2)</i>	[4] 4 <i>md: 2 (1-3)</i>
	23. Use humour	[5] 4 <i>md: 1 (0-2)</i>	[4] 4 <i>md: 2 (1-2)</i>	[3] 3 <i>md: 1 (1-3)</i>	[2] 1 <i>md: 0.5 (0-1)</i>
	24. Humour appreciated by others	[2] 2 <i>md: 2 (1-3)</i>	0	[2] 2 <i>md: 1.5 (1-2)</i>	[1] 1 <i>(1)</i>

APPENDIX 5: Key to the symbols used in the transcriptions

Each contribution line starts with an indication of whether the contribution is in Swedish (S) or English (E). This is followed by a number indicating the number of the contribution in the whole transcription of that specific conversation.

Dollar sign \$ indicates that the line is a contribution line and is followed by the initial of the brain damaged individual (**T, J, N** and **C**) or **P** for the conversational partner. The contribution lines are numbered according to their place in the entire transcription.

Angle brackets < > signify contributions that are commented on. The comment is presented below the contribution on a comment line indicated with @.

@ indicates a comment line. The comment is presented within angle brackets. The comments are numbered when the contribution is associated with more than one comment. Comments might, for example, describe gestures, speech on inhalation (ingressive), own communication management expressions and other activities that are considered important in that particular sequence of interaction.

Square brackets [] signify overlapping speech and are numbered when speech overlaps on more than one occasion in that particular contribution.

Parentheses enclosing three dots (...) indicate speech that could not be transcribed due to limited audibility.

Parentheses () indicate that the transcriber is uncertain about the interpretation of the enclosed passage of speech.

Plus sign + signifies that the word is interrupted.

Colon : signifies that the vowel is prolonged.

The slash symbol / is used to indicate length of pauses. A short pause the length of a short word is denoted with one slash symbol (/); three slash symbols (///) signify a pause with a duration of several seconds, and two slash symbols (//) signify an intermediate pause.