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### **Discourse studies in neurologically impaired populations:**

#### **A quest for action**

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## ***Abstract***

Organism and environment are in a state of constant interaction, and discourse is viewed as one form of manifestation of this interaction. Through the study of discourse insights can be gained into those components that bring about mental events. Verbal structure, communication of beliefs and action/interaction are highly interactive dimensions of discourse. Taking this perspective as a framework, the findings of discourse studies with particular emphasis on right-hemisphere brain damaged individuals are discussed. Neurolinguistic studies of discourse can be divided into four categories: (1) studies that focus primarily at providing a detailed description of the structural and interactional abilities of brain-damaged individuals, (2) studies that are mainly concerned with investigating the processing aspects of discourse, (3) studies that investigate the influence of cognitive systems such as attention or memory on discourse processing, and (4) studies that try to relate discourse processing mechanisms to underlying biological substrates or neurophysiological mechanisms. A quest is made for future research to base discourse studies on well-defined processing theories, to include different processing components and levels, and to systematically investigate the impact of facets of cognitive systems on such processing. Established methodological approaches should be complemented by electrophysiological procedures (such as the event related potentials technique), or functional imaging techniques (such as fMRI) to tackle relationships between discourse processing mechanisms, cognitive systems and underlying biological mechanisms. Consideration of the influence of biochemical processes (such as asymmetries of neurotransmitters, endocrine functions or influence of pharmacological agents) on component processes may add to our insights.

## ***Introduction***

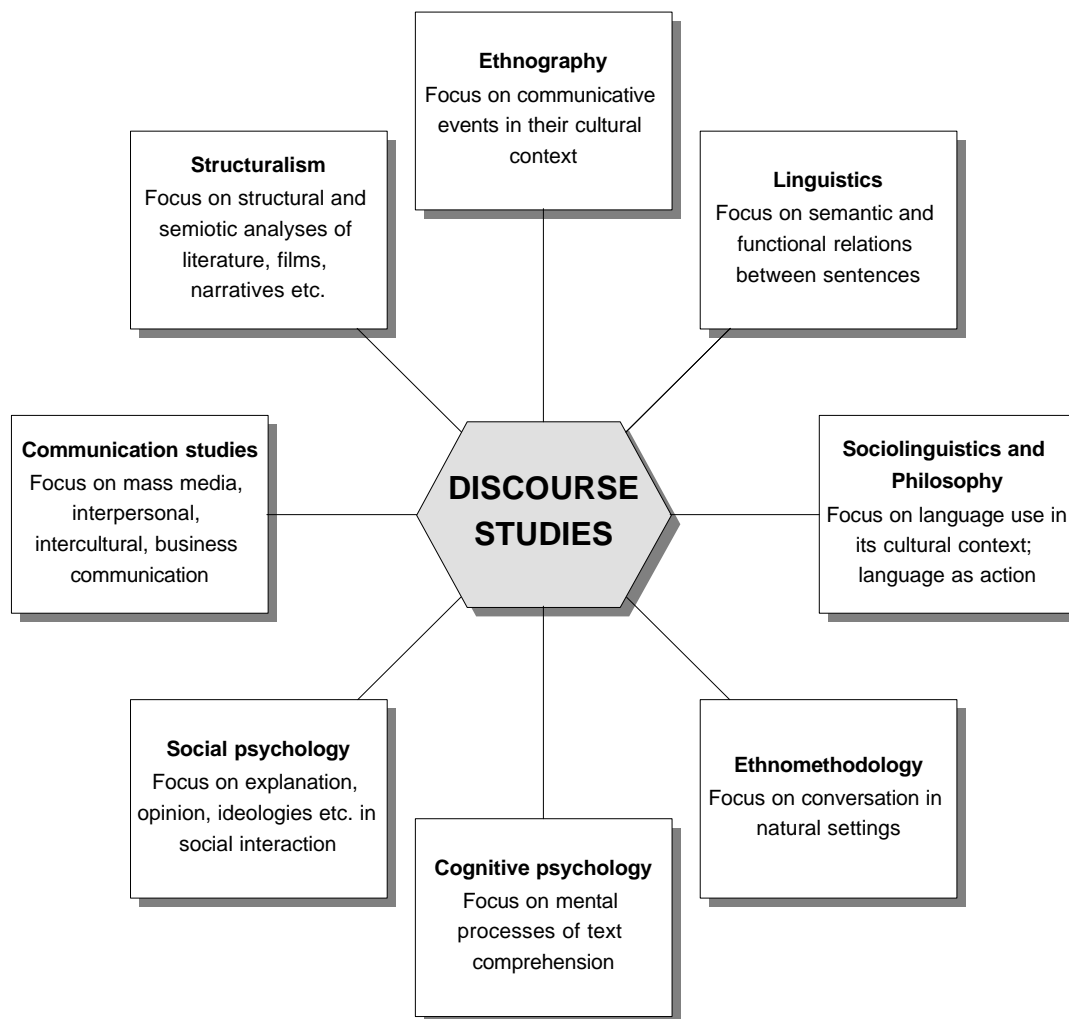
Discourse is a form of social action and interaction, text and talk are social and cultural, discourse is contextual, and discourse enacts and reproduces power. These basic concepts are exceedingly complex and, despite the advances of discourse studies in recent years, they are not fully understood. Applying currently discussed concepts of discourse to the study of discourse in brain-damaged populations and placing such studies into a theoretical framework that views human behavior as a constant interaction of the organism with the environment, can, on the one hand, contribute to our understanding of how the mind works, and, on the other hand, reveal impaired and preserved processing mechanisms in this population that help advance interventional approaches. Although we are only at the very beginning of understanding the complex interactions and relations that determine the way brain-damaged populations act, talk or write, it is time to reflect on our current state of knowledge and to determine future avenues.

The first part of this contribution explores the main dimensions of discourse and its relation to the environment and the organism. Next, taking this perspective as a framework, the findings of discourse studies are discussed with emphasis on studies investigating the right hemisphere. Finally, I will conclude by suggesting future research directions.

### ***The interactive nature of discourse***

The study of discourse has been shaped by a number of disciplines (see Figure 1; for a discussion see van Dijk, 1997). Some of these disciplines have been particularly influential in the study of discourse in brain-damaged populations such as linguistics (for example, investigating text grammar aspects such as cohesion, coherence, or theme development), philosophy and sociolinguistics (for example, exploring pragmatic aspects of language use such as speech acts, politeness phenomena, conversational maxims), ethnomethodology (for example, applying conversational analysis to the discourse of neurogenic populations), and cognitive psychology (for example, studying mental processes during text comprehension and production).

**Figure 1. Disciplines that contribute to the study of discourse**



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Human behavior is the result of constant interaction of the organism with the environment.<sup>1</sup> The organism responds with neuronal activities that ultimately make it possible for mental events to come into existence. The way such interaction takes place depends on the state of our organism, that is its knowledge and goals, and the environmental configuration at a particular time (see also Kintsch, 1998). Through interaction with the environment the organism is in a state of constant reorganisation: new knowledge and

<sup>1</sup> Järvillehto (1998a,b) rejects a two fold system that separates environment from the organism and advocates one unitary organism-environment system. According to Järvillehto behavior is expressed in the organism-environment system as a whole. Within such a framework, mental activity cannot be explained by looking at the properties of neu-

experience is acquired and merged with previously gained knowledge and experience thus creating mental models. The organism responds with an overt motor action or a mental event. Whereas overt motor actions can be observed directly, it is much more difficult to get insight into the nature of mental events<sup>2</sup>. Viewing discourse as one form of interaction of the organism with the environment and thus as one form of manifestation of mental events can help advance our understanding of the nature of mental events, and, possibly, their coming into existence.

### ***Dimensions of discourse***

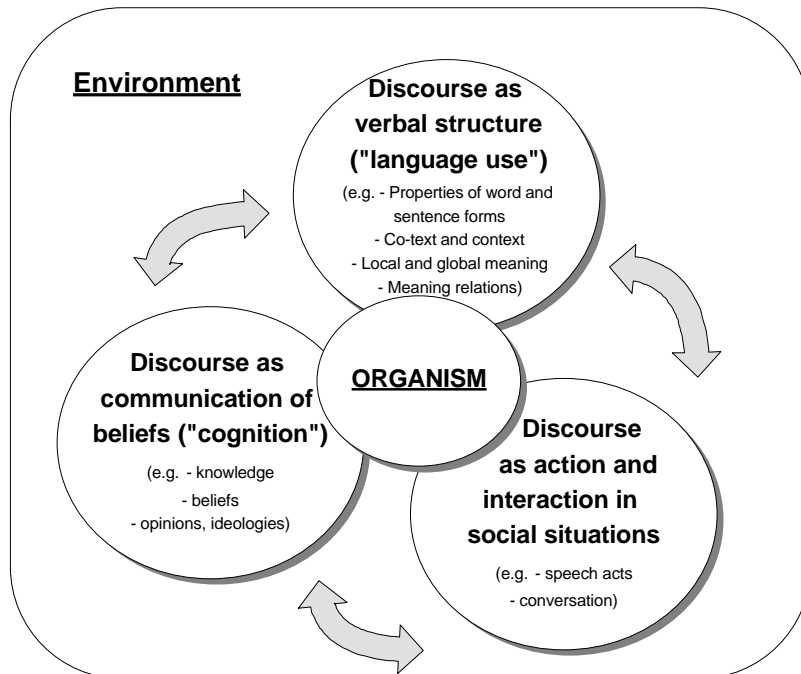
According to van Dijk (1997), there are three main dimensions of discourse: (1) discourse as verbal structure (also called „language use“ by van Dijk) (2) discourse as communication of beliefs (also called „cognition“ by van Dijk), and (3) discourse as action and interaction in social situations. Figure 2 depicts the dimensions of discourse as elements in an organism and environment system.

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rons but the properties of neurons may form dynamic systems producing behavioral results, which, in turn, affect the metabolism of neurons and through this the whole organism.

<sup>2</sup> Note that no claims are made „where“ mental models and mental events are to be placed, that is within the organism or the environment. For a discussion of this issue see Järvillehto (1998a,b).

**Figure 2 Dimensions of discourse within the larger framework of the organism and the environment**



Discourse as verbal structure is concerned with structures of auditory sound and visual graphics, with properties of words and sentence forms and their relation to co-text and context, with the complex structures of local or global meaning (in discourse analysis often expressed by so-called propositions and topics or themes) and with meaning relations (such as coherence and reference phenomena). Style and rhetorics as well as the schematic structure and organization of talk and text are further aspects of the structural aspects of discourse. The way such rather abstract structures are actually used in social situations by language users concerns the „action and interaction“ dimension of discourse. How a speaker makes sense of what the other person says and how people accomplish and comprehend speech acts such as requesting, complaining, apologizing and so forth are well studied aspects of pragmatics. When people interact they continually make sense of the environment and interpret any (verbal and non-verbal) activity in its social and cultural context. Such interaction is structurally organized, contextually oriented and takes place in „real life“ encounters. Therefore, researchers in the tradition of

conversational analysis consider the „real life“ conduct of participants as the central resource out of which the units of analysis, the formulation of rules and the structural organization emerges. They reject a priori generalizations or idealizations of events since anything that develops and is negotiated between the participants can be of relevance. Units of analysis that have received particular attention by conversational analysts are, for example, units of local management organization such as „adjacency pairs“ („How are you? - Fine, how about you?“) and turntaking, or the overall organization operating in conversation such as opening and closing sections. Organizational aspects of conversations have been the most common phenomena investigated in clinical populations. It should, however, be mentioned that organizational aspects have not been the major focus of „classical“ conversational analysis<sup>3</sup>.

### ***Mental representations***

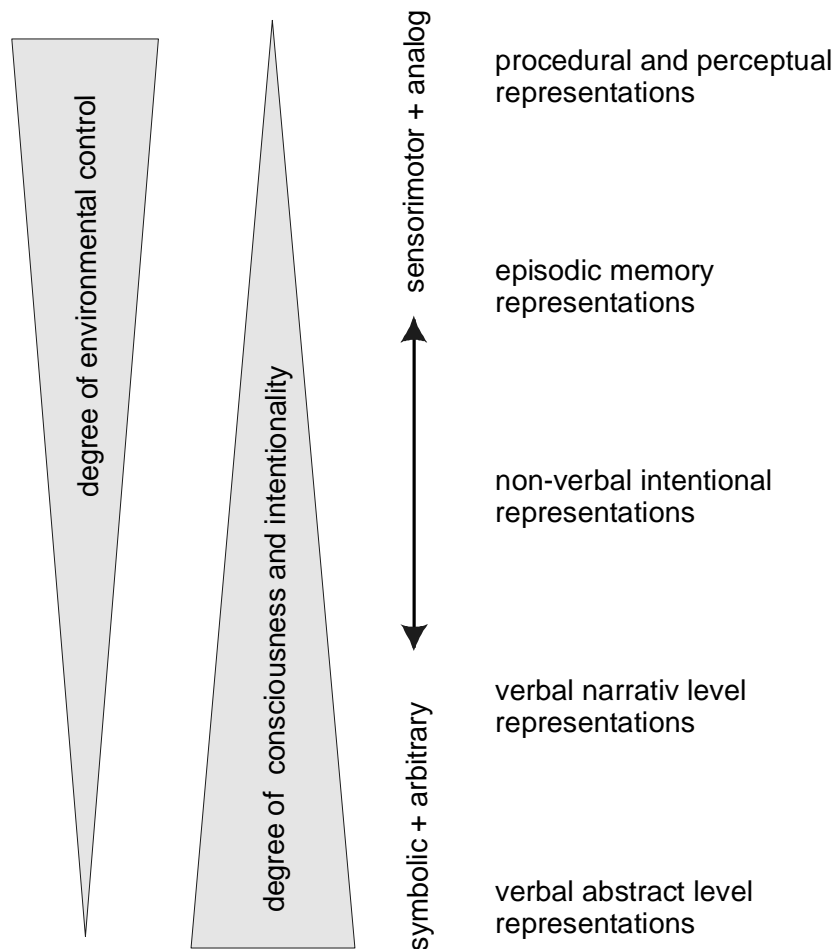
Structural and interactional aspects of discourse cannot exist without the mind of the language user, its knowledge, cultural beliefs, opinions and ideologies. Psychological theories have tried to formulate how such knowledge and belief systems are mentally represented, activated, and processed. It is assumed that the knowledge and experience that manifests itself in mental events is hierarchically represented forming layers of abstractness and different levels of independence from the environment (Kintsch, 1998). Procedural and perceptual mental representations are directly tied to the environment and the degree of environmental control is highest at this level, while, at the same time, the degree of consciousness and intentionality is lowest. Mental representations at the verbal abstract level are relatively independent of environmental control whereas their degree of consciousness and intentionality is high. Figure 3 shows the layers of mental representations and the changes in their characteristics such as the weakening of environmental control and the increase in consciousness and intentionality as we move from the procedural and perceptual level to the verbal abstract level. Representations change from sensorimotor and analog at the most basic procedural and perceptual level to sym-

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<sup>3</sup> As Pomerantz and Fehr (1997: 65) point out: „The organization of talk or conversation (whether ‘informal’ or ‘formal’) was never the central, defining focus in CA. Rather it is the organization of the meaningful conduct of people in society, that is, how people in society produce their activities and make sense of the world about them. The core analytic objective is to illuminate how actions, events, objects, etc., are produced and understood rather than how language and talk are organized as analytically separable phenomena.“

bolic (i.e. conceptual) and arbitrary at the verbal abstract level. It is important to emphasize that the layers shown in Figure 3 are not all exclusive. Instead, lower layers of representations are encapsulated by higher layers, and higher layers of representation share characteristics with lower layers<sup>4</sup>.

**Figure 3. Hierarchy of mental representations (based on Kintsch, 1998)**



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It has been a common approach in neurolinguistics to study narrative discourse by investigating mental representations and processing mechanisms using propositional analysis techniques. However, the hierarchical aspect of mental representations and the

<sup>4</sup> Although the framework and context is a different one, Kintsch's (1998) approach is reminiscent of Tucker's (Tucker, 1993; Luu & Tucker, 1998) vertical integration approach which draws on ideas by Yakovlev (1948) and Pribram (1960). The organization of behavior is seen as a concentric system whereby the inner structures of lower centers (such as subcortical systems) are driven by homeostatic functions which regulate visceral states (inner sphere or first ring) and direct the action of the second (or intermediate) ring. The second ring, in turn, coordinates the activity of the homeostatic core and also influences the way in which internal states are expressed in behavior. The



relationship that exists between them has often been neglected. Furthermore, propositional analysis techniques have been employed without establishing a relationship to the theoretical framework they are part of. In addition, there is a lack of awareness that a theoretical framework that uses propositional systems as units of analysis need not be limited to structural aspects of discourse (such as the study of narrative recall) but can also be employed to study interactional aspects and establish relationships between the three dimensions of discourse (for details see Kintsch, 1998)<sup>5</sup>.

It is important to realize that the three dimensions of discourse are closely related as they influence and interact with each other. Furthermore, they are the product of underlying brain processes, that is biological substrates and neurophysiological and biochemical mechanisms of the organism. Many studies of discourse in brain damaged populations have provided detailed descriptions of the various aspects of discourse (for a summary see Beeman & Chiarello, 1998a; Brownell & Joanette, 1993; Brownell & Martino, 1998; Joanette & Brownell, 1990; Joanette, Goulet, & Hannequin, 1990; Paradis, 1998; Stemmer & Joanette, 1998; Tompkins, 1994). The necessity to ground psychological theories of discourse comprehension and production in general theories of cognition which would explain memory, learning, decision making, problem-solving, and other cognitive faculties in addition to language and discourse has been emphasized by Graesser, Gernsbacher, & Goldman (1997: 294). Some researchers have related their findings at the descriptive level to cognitive systems such as Chafe (1994) who investigated the referential management system in terms of memory activation, and Tomlin (1995, 1997) who looked at thematic and focus management in terms of attention processes in healthy populations. Many of the studies investigating brain-damaged populations are primarily descriptive, but some have gone beyond this level and tried to provide *integrated* descriptions and formulate theories and models that explain the relationship and interaction between these dimensions, or, between discourse and the organism.

In the next section, findings of discourse studies in brain-damaged populations that have tried to explain relationships and interactions between the dimensions of discourse will

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cortex of the cerebral hemispheres represents the most exterior ring (outer sphere, third ring) that mediates higher-order negotiations of internal states with the environmental context (see Luu & Tucker, 1998: 161).

<sup>5</sup> I will focus on the contemporary notion of discourse as a multidisciplinary field. For early concepts of discourse the reader is referred to de Beaugrande (1998), Jorion (1996), and Patry & Nespoulous (1990).

be discussed. An attempt is made to place currently discussed concepts of discourse impairment in brain-damaged populations into a theoretical framework that views human behavior as a constant interaction of the organism with the environment, and that employs the study of discourse as a means to gain insight into how our mind works.

### ***Discourse studies in brain-damaged populations***

Whereas communication impairment after left hemisphere (LH) lesions have been investigated systematically since Broca and Wernicke published their seminal papers, aspects of discourse in neurologically impaired individuals have been investigated *systematically* for only 10 or 15 years. Evidence has accumulated showing that pragmatic aspects of discourse are not subserved by the same brain systems involved in producing aphasia, and claims have been made that it is the right hemisphere (RH) that is important for discourse processing and pragmatic competence. Before turning to discourse studies in RHD patients, it must be mentioned, that despite these claims, the role of the RH in discourse processing is not as clearcut as it appears from numerous studies. Discourse impairments have also been identified in traumatic brain injury patients (Chapman et al., 1998; for a summary see Coelho, 1995, McDonald, 1998), patients with the frontal lobe syndrome (McDonald, 1993; McDonald & Pearce, 1996), children with early-onset hydrocephalus (Barnes & Dennis, 1998) or early focal brain injury (Reilly, Bates, & Marchman, 1998), patients with dementia of the Alzheimer type (for a summary see Caramelli, Mansur, & Nitrini, 1998), or confusional state patients (Stemmer, Lacher, & Schönle, 1998). Similar to studies directed towards the RH, these studies are very heterogeneous concerning methodological approaches, the patient population, and the aspects of discourse investigated. Furthermore, the site of lesion many times also included the RH. All these studies do not rule out the dominance of the RH in processing aspects of discourse but they point to problems that have not been considered. To further clarify the role of the RH in discourse processing, studies comparing different patient populations with similar methodological approaches and investigating similar aspects of discourse processing using the same theoretical processing framework are needed.

## **Dimensions of discourse in right hemisphere-damaged (RHD) patients**

At a descriptive level it has been shown that patients with right hemisphere damage (RHD) have problems in understanding the main point of stories or fables, in comprehending non-conventional indirect requests, sarcasm or jokes, metaphoric language, and in making use of affective information. Their conversational or narrative productions have been described as embellishing, rambling, tangential, noninformative, irrelevant, repetitive, confabulatory, and/or intrusive. In short, problems have been shown to exist at the structural and the interactional dimension of discourse. A common explanation for these observed difficulties has been that RHD patients have problems integrating information, or making the appropriate inferences (for a summary of the various hypotheses see Stemmer & Joannette, 1998). However, notions such as „integration“ or „drawing inferences“ remain vague if not investigated within a processing framework. Stemmer & Joannette (1998) tried to accommodate the various hypotheses by showing that the mental representations investigated seemed to be intact in RHD patients and that it was *the manner in which* these representations were processed to build *new* conceptual models that seemed impaired. However, no attempt has been made to establish a link to underlying brain mechanisms.

Another line of argument recently discussed places the observed difficulties into the realm of *social* cognition, that is at the „cognition“ and „interaction“ dimension of discourse. The difficulties exhibited by RHD patients are seen as an impairment in building a „theory of mind“: the ability to form representations of other people’s mental states and to use such representations to understand, predict, and judge utterances and behavior (Brownell and Martino, 1998; Siegal, Carrington, & Radel, 1996; Winner et al., 1998). However, it has been shown that RHD patients were able to take over fictitious mental states and act accordingly (Stemmer, Giroux, & Joannette, 1994) although these same patients had problems inferring correctly the communicative intentions of an interlocutor if they had to reconcile certain contextual variables with a specific linguistic encoding. Doubts that the theory of mind mechanism is the *underlying cause* for the interactional impairments observed have also been raised by Bara, Tirassa, & Zettin (1997) whose subjects were not impaired at solving the classical „Maxi“ and „Smarties“ theory of mind tasks.

At the beginning of this section an argument was advanced that also applies to the theory of mind hypothesis: If we want to study social cognition, that is people's knowledge of the social world in which they live, speak and act (Condor & Antake, 1997), then we need to also investigate *how* people mentally construct and represent such knowledge, the mechanisms by which such knowledge is processed and the mechanisms that may influence such processing. Processing theories and models suitable to provide such a framework are, for example, Kintsch's (1998) recent expansion of his construction-integration model or Frederiksen et al.'s (1990) multilayered processing model. Central to both models is a language-independent propositional notation by which mental representations and mental models can be described and by which processes can be modelled.

### **Dimensions of discourse and the organism**

We have argued that the behavior of RHD patients has been described in detail at the various dimensions of discourse, and explanatory accounts of the phenomena observed have been provided. We have pointed out that such accounts need to be grounded in psychological theories and models of discourse processing if we want to uncover the underlying processing mechanisms that are impaired. One of the most challenging endeavours, however, is to establish a link between processing theories and the organism, that is to the underlying brain processes, the biological substrates and mechanisms. In the next section we will investigate research that look at cognitive systems such as attention, emotion, memory, learning, or perception and influence on discourse processing. The biological substrates and mechanisms subserving these mental phenomena still need to be determined. However, first steps in this direction have been made.

### ***Attention and executive functions***

Although there is consensus that the neural substrate for language resides in the LH, it has been shown that the RH contributes to language comprehension. Whereas the perisylvian area in the LH is viewed as particularly important for language, no particular brain areas implicated in language processing have been identified for the RH. Beeman and Chiarello (1998b) discuss the relationship between behavioral and biological hemispheric asymmetries in language processing. In their view, there are intrinsic computa-

tional asymmetries of the two hemispheres that vary across brain regions and cognitive domains, and that may be enhanced by attentional processing. The effects of attention deficits, or specific facets of attention, have been shown to affect language use (for a summary see Eviatar, 1998). Although there are no studies that have systematically investigated the effect of attention, and more specifically, of facets of attention, on discourse processing, some studies have raised this issue. For example, Stemmer, Giroux, and Joannette (1994) noted that RHD patients who showed some attention or neglect impairment were also more impaired on comprehending figurative language, and in particular non-conventional indirect requests. Investigating the conversations of deaf signers of American Sign Language (ASL) with Parkinson's disease, Kegel and Poizner (1998) showed that attention deficits in these patients contributed to the inability to successfully employ turntaking devices although it had previously been established that the patients knew these devices, that is the mental representation of such devices was intact. In a study investigating the discrimination of prosodic and semantic aspects of affect in sentences, LaLonde et al. (1992) pointed out that a number of tasks on which their RHD patients' performance was impaired required divided attention. Receptive and expressive discourse management has been related to attention processes and speed of information processes in closed head injury patients (Watt, Penn, & Jones, 1996).

The relationship of facets of executive dysfunction in brain injured patients and request performance was investigated by McDonald & Pearce (1998). Although the authors could show that the production of nonconventional, socially effective requests was impaired in their patients, no clear relationship emerged between facets of executive dysfunction and request performance. Loss of inhibition, however, did influence „the capacity to produce novel requests that take into account the listener's potential reluctance to comply“ (101).

Most commonly, attention and its various facets is measured by pencil and paper tests or reaction time batteries in brain-damaged patients. Pencil and paper tests provide a rough estimate of the quality of the deficit. Reaction time measures are overt motor actions that only indirectly reflect on-going processing. It must also be considered that nearly all brain-damaged patients show delayed reaction times to variable degrees. Therefore, although these tests and measures are valuable tools, their value is limited if

we want to investigate underlying brain mechanisms in this population. A method more suitable to reflect on-going processing is the Event Related Potential (ERP) technique which is based on EEG recordings during which a series of events (such as auditory or visual stimuli) are presented (Näätänen, 1992; for a summary of the method see Segalowitz & Chevalier, 1998a). Although this technique has been used to investigate attention processes in, for example, severely brain-damaged patients (such as vegetative state patients), it has not been used to investigate attention processes during discourse processing. Functional imaging techniques such as functional Magnetic Resonance Imaging (fMRI) may also contribute to our understanding of attention processes in brain-damaged populations (for a summary on this technique see Démonet, 1998).

### *Memory*

Besides attention deficits and executive dysfunction, the question of the impact of memory problems on discourse comprehension has also been raised. It has been shown that a deficit in working memory influences sentence comprehension, and, possibly, speech production (for a summary see van der Linden & Poncelet, 1998). Limited memory capacity and resource allocation problems have been shown to compromise the performance of aphasic patients (Caplan & Waters, 1994; Haarmann, Just, & Carpenter, 1997; Miyake, Carpenter, & Just, 1994). Leonard, Waters, & Caplan (1997) investigated the ability of RHD patients to use contextual information to resolve ambiguous pronouns. They did not find a deficit in context use at the level of a minimal discourse of two sentences. They speculate that this could be due to the relatively automatic nature of the linguistic task which may have reduced the processing load. This hypothesis would be in line with Tompkins and her colleagues' work who propose that deficits in the use of contextual information only emerges as a function of increased processing demands. Based on the capacity-constrained comprehension theory, Tompkins et al. (1994) investigated the impact of working memory on inference revision in RHD and LHD patients. The RHD patients' performance on two types of discourse comprehension tasks did not differ from the LHD and non brain-damaged control groups. However, the authors did find a meaningful correlation between tasks that involved elements of discourse comprehension and working memory capacity. Based on experimental evidence from aphasic patients and patients with poor short term or working memory, Caplan & Waters

(1998) suggest specialized verbal working memory systems for different verbal processes involved in the determination of the meaning of discourse (that is discourse at a sentential level). More specifically, these authors believe that distinct working memory systems are responsible for assigning the syntactic structure of a sentence and for using that structure in determining sentence meaning, and for the use of sentence meaning to accomplish future functions. It would be interesting to follow up this hypothesis for discourse processing above the sentence level.

### *Inhibitory and excitatory mechanisms*

Inhibitory or excitatory mechanisms such as spreading activation or spreading inhibition have also been implicated in discourse processing. Beeman (1998) assumes that the LH and RH differentially activate semantic information: strong activation of a narrow semantic field, that is fine semantic coding, is a characteristic of the LH, and weak activation, that is coarse semantic coding, of the RH. The RH diffusely activates broad semantic fields resulting in an increased probability of semantic overlap, which, in turn, is useful for integrating distantly related semantic information from discourse. According to Beeman (1998: 257), predictions based on assumptions of coarse and fine semantic coding would be consistent with the observation that there is a higher ratio of white to gray matter in the RH, that dendritic branching and density of interneurons differ in language areas of the RH and LH, and more diffuse neurological deficits are produced by RH lesions.

Fiore and Schooler (1998) suggest that the RH has less of an inhibitory mechanism than the LH. The ability of the RH to avoid fixedness or perseveration, for example, could be explained by this mechanism. This ability would be advantageous when solving insight problems such as the comprehension of metaphor or humor.

### *Quest for integration*

Most researchers trying to establish a link between observed discourse behavior, psychological processes and brain mechanisms, have focused on one particular aspect of the organism. However, Luu & Tucker (1998) have pointed out that the integration of multiple levels of neural hierarchy and various cognitive operations, such as memory, attention, motor control and language, need to be considered: „In everyday language,

the organization of the communication process requires the coordination of both left- and right-lateralized attention/memory systems. Within each system there must be an effective vertical integration across the neuraxis to achieve elementary arousal control, the appropriate scope of working memory, and the recruitment of cortical systems in the representational process. This vertical integration requires that neurolinguistic mechanisms are not restricted to neocortex, but must operate across the phylogenetic hierarchy of the brain... it becomes clear that the product of the overt communicative behavior only reflects the final contribution of neocortical areas“ (171-172).

### **Conclusion**

Mental events are created through interaction of the human organism with the environment. Discourse is one form of manifestation of this interaction and the study of discourse allows insights into those components that create mental events. Within this framework, neurolinguistic studies of discourse can be divided into four categories: (a) studies that focus primarily at providing a detailed description of what brain-damaged individuals can or cannot do at the structural or interactional dimension, (b) studies that are mainly concerned with investigating the processing aspects of discourse, (c) studies that investigate the influence of cognitive systems such as attention or memory on discourse processing, and (d) finally, studies that relate discourse processing to underlying biological substrates or neurophysiologic mechanisms.

Most discourse studies in brain-damaged populations have concentrated on (a), that is supplying a list of discourse impairments such as those described in RHD patients. Attempts have been made to relate these findings to impaired processing mechanisms. However, few studies have been based on a well defined discourse processing framework which is necessary to clearly define the units of analysis, the operations and computations involved, and the interactions across discourse levels. Although there are only few studies that are primarily concerned with (c), it is clear that attention and memory does have an impact on discourse processing. What is unclear is the extent of such impact. Unless we *systematically* investigate the influence of *facets* of attention or memory processes on discourse processing, the picture will remain vague. Furthermore, we need to consider that cognitive systems such as attention or memory work in a coordi-



nate and interactive fashion. In addition, these systems may contribute differently to the processing of discourse depending on the level at which processing occurs.

Least is known about the relationship between psychological processing hypotheses and biological processes such as neurophysiological or biochemical mechanisms. It is clear that there is asymmetry between the two hemispheres concerning the processing of language. Anatomical asymmetries and asymmetries in hormonal and neurotransmitter concentrations and distributions have been described (Tucker & Williamson, 1984). However, whether or the extent to which such asymmetries lead to different processing mechanisms is unclear.

The commonly used methodology in discourse studies does not seem sufficient to gain such insights. Methodological procedures such as reaction time measures, verbal responses to carefully designed verbal or non-verbal stimuli, or thinking-aloud protocols are still the most frequently used techniques. These techniques investigate the *product* of underlying processes. They are necessary and useful tools to build processing theories which allow hypothesis-guided approaches. However, they should be considered as a starting point that helps refine our research questions and dig deeper into the underlying component processes that bring about such products. With the recent advancement in technologies, it seems now possible to complement such „indirect“ with more „direct“ measures. Procedures such as recording electrical or magnetic activity from the scalp (EEG or MEG) during presentation of visual or auditory stimuli (event-related potentials), or using functional imaging techniques such as fMRI seem suitable techniques to tackle relationships between discourse processing, cognitive systems and underlying biological mechanisms. However, even the best technology will fail to provide interpretable results if the particularities of the system investigated are not considered, or if a theoretical framework is lacking (for critical remarks on the interpretation of neuroimaging studies in this context see Beeman & Chiarello, 1998b).

Finally, consideration should also be given to studying the influence of pharmacological agents on component processes and their influence on discourse processing. There are numerous efforts to investigate the influence of pharmacological agents (e.g., Tacrin,

Donepezil, Piracetam<sup>6</sup>) in patients with impaired cognitive functions (for aphasic patients see Huber et al., 1997; Small, 1994; for a summary concerning the treatment of patients with Alzheimer's disease with Tacrin see Steinwachs, 1998). Most studies report some improvement of cognitive functions at least for short periods of time. Such studies may provide insights into psychological models, and the question to pursue would be which component processes are influenced and to what degree by such medication. This may open up another direction for the study of discourse.

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<sup>6</sup> Newer drugs with less side effects (particularly concerning Tacrin) are currently investigated in larger patient populations. Although no final conclusion can be drawn, it seems that these drugs do not affect one particular cognitive function such as memory, learning or language but rather more basic functions such as arousal and alertness, which, in turn, influence „higher“ cognitive functions.

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