Defining the Relation between Cognitive Neuroscience and Discourse Studies

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Abstract:

In contemporary linguistics, both cognitive and critical approaches to language have been elaborated in some detail. Unfortunately, the two perspectives have seldom converged, despite the potential theoretical advances such collaboration offers. Although historically and sociologically understandable, this separation of fields is bound to block progress. Only a handful of researchers and scholars in literature, music, film, esthetics, and art history have been attempting to follow and engage with developments in cognitive neuroscience. This represents a lost opportunity for scientists no less than for humanists, as critics and theorists of the arts are uniquely trained to pose questions and adduce examples that could bring more rigor and refinement, as well as cultural resonance, to the new sciences of mind.

This paper explores important and fruitful links between cognitive neuroscience and discourse. By adopting a non-reductive approach to literary and other cultural artifacts as records of high-level cognitive functioning evoking complex responses in their audiences, it seeks to contribute towards a more explicit and candid discussion of the methodologies that employ linguistic insights and analysis procedures in order to address cognitive representations and processes. Particularly, its goal is to eventuate, not in a set of answers, but in a set of pointed and provocative questions for further consideration and research.

The specific research questions addressed in this article are the following:

1) How can cognitive processes be accessed and understood sufficiently to enable reliable models to discourse analysis?

2) What practical problems challenge the design of a good discourse-relevant neuro-imaging study, or to develop a theory of discourse comprehension that takes into account what we know about language, about cognition, and about the brain?

Historically, research on language is at the roots of cognitive science. In the 1970s, relevant psycholinguistic models emerged, including pragmatics and discourse processing theories, which proposed an analysis of language beyond its basic structural facets. For example, speech acts model, proposed by Searle (1969), and the text organization model, proposed by van Dijk and Kintsch (1978), served as the basis for theories on pragmatics and discourse adopted today. Although these models could be an important theoretical basis for the assessment of language production and comprehension, language remains a topic scarcely studied by neuropsychologists compared with other cognitive processes.

Discourse analysis is a broad and fast-developing interdisciplinary field concerned with the study of language use in context which emerged between the mid-1960s and mid-1970s in such disciplines as anthropology, ethnography, microsociology, cognitive and social psychology, poetics, rhetoric, stylistics, linguistics, semiotics, and other disciplines in the humanities and social sciences (van Dijk, 2000).

Cognitive neuroscience comprises a wide field of investigation, encompassing an array of complementary domains like physiological psychology and neurobiology. It may be seen as perhaps the most promising and exciting intellectual initiative of the new century. Cognitive neuroscience is concerned with the scientific study of biological substrates underlying cognition, with a specific focus on the neural substrates of mental processes, and addresses questions of how psychological functions are produced by the brain.

Keywords: *Discourse and cognition, Mind and brain, Semio-pragmatics, neuro-imaging methodology, socio-cultural analysis.*

1. Problem and context

Linguists and literary theorists have proceeded in theory building on discourses and language processing. Each presents his own individually tailored list of element, aspects, components, strata, layers, levels, or facets that together make a discourse what it is. However, some of the existing theories chose to concentrate on only certain facets of cognition and structures of discourses. Those facets are of interest to a certain specialty or amenable to formal analysis. In particular, linguists frequently concentrate on sentence structure, ignoring narrative structures, characterization, metaphor, and other distinctly literary concerns. Conversely, literary analysts seldom make much of grammar or morphology. In my analysis I intend to encompass both literary and more linguistic specialties.

In contemporary linguistics, both cognitive and critical approaches to language have been elaborated in some detail. Unfortunately, the two perspectives have seldom converged, despite the potential theoretical advances such collaboration offers. Although historically and sociologically understandable, this separation of fields is bound to block progress. Only a handful of researchers and scholars in literature, music, film, esthetics, and art history have been attempting to follow and engage with developments in cognitive neuroscience. This represents a lost opportunity for scientists no less than for humanists, as critics and theorists of the arts are uniquely trained to pose questions and adduce examples that could bring more rigor and refinement, as well as cultural resonance, to the new sciences of mind.

As the 21st Century opened, Neuropsychology focused on the investigation of brain and cognitive processes (Bennett & Hacker, 2007). These two domains can be reconciled in a hybrid science that brings them together into a synthesis more powerful than anything researchers have achieved before. In this paper the project of setting up a hybrid science demands the dissolution of the mind-discourse problem, somehow setting it aside as an illusion, based on a mistaken presupposition.

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On the technological side, recent developments in neuro-imaging techniques are providing new tools to investigate neural structure, chemistry and function, and developments in machine-mediated text analysis tools, storage, and search capacities have made corpus-based discourse studies much more doable. The new technologies can make changes observable and measurable, and so present new possibilities both for understanding brain–behavior relationships and, consequently, for developing new therapies to help people with neurological/speech disorders or injuries. The absence of explicit knowledge of discourse patterns may be partly because research and practice associating neurocognitive function with language has tended to focus on (often isolated) linguistic 'deficits' as signs or symptoms of brain injury or disorder rather than beginning with comprehensive descriptions of discourse.

As the brain is doing a lot at the same time, in whatever way we try to measure its activity, we will find a lot of noise. So, there is no escape from forming precise (and falsifiable) hypotheses, in which a theory becomes our eyes - without it researchers are blind. This simply implies that we have to figure out what the brain does in order to be able to figure out how the brain does it; and we have to figure out how the brain does things in order to figure out how it can do what it does. The main danger is not being precise enough on either side.

2. Aims and methods

This paper explores important and fruitful links between cognitive neuroscience and discourse. By adopting a non-reductive approach to literary and other cultural artifacts as records of high-level cognitive functioning evoking complex responses in their audiences, it seeks to contribute towards a more explicit and candid discussion of the methodologies that employ linguistic insights and analysis procedures in order to address cognitive representations and processes. Particularly, its goal is to eventuate, not in a set of answers, but in a set of pointed and provocative questions for further consideration and research. Our framework aims at three things: completeness, expandability/flexibility, and justifiability.

The specific research questions addressed in this article are the following:

3) How can cognitive processes be accessed and understood sufficiently to enable reliable models to discourse analysis?

4) What practical problems challenge the design of a good discourse-relevant neuro-imaging study, or to develop a theory of discourse comprehension that takes into account what we know about language, about cognition, and about the brain?

People have been analyzing discourses, in some sense, for as long as they have been speaking.

They have done so without the help of linguists, literary critics, or their theories. But a theoretical framework can still perform a service in making explicit what is normally implicit. In this paper, I will attempt to illustrate some frameworks for classifying and cataloguing everything that goes on in the production and comprehension of discourses from a neurocognitive perspective. With minor modifications, the same framework should also be applicable to nonverbal human behavior. It will thus be interest to semioticians as well as literary theorists, though its roots are primarily in linguistics. In this paper, I also intend to outline the mapping of neurophysiology to learning styles as a unification of theory and practice, a synthesis that is essential for effective teaching and learning.

Accordingly, our objectives in the present study are to: (a) Relate Neurocognition and Linguistic Architecture; (b) find links between Linguistic Theory and Neural Activity; (c) map between linguistic operations and neurocognitive processes; (d) Explain how language structure and neurocognitive organization can meet; (e) Provide some background on current approaches ; (f) Present a number of issues on which current discussions focus; and finally (g) Fundamentals of Linguistics against a neurocognitive background.

3. Background: the cognitive neuroscience movement

There has been considerable interest in recent years in whether, and if so to what degree, research in neuroscience can contribute to philosophical studies of mind, epistemology, language, art and discourse. This interest has manifested itself in a range of research in the philosophy of marketing, language, and visual art that draws on results from studies in neuropsychology and cognitive neuroscience.

Cognitive neuroscience is concerned with the scientific study of biological substrates underlying cognition, with a specific focus on the neural substrates of mental processes, and addresses questions of how psychological functions are produced by the brain. It is a branch of both psychology and neuroscience, overlapping with disciplines like physiological psychology, cognitive psychology and neuropsychology. Cognitive neuroscience relies upon theories in cognitive science coupled with evidence from neuropsychology and computational modelling.

Cognitive neuroscience comprises a wide field of investigation, encompassing an array of complementary domains. Among these domains is neuropsychology, which emerged from lesion studies, and its relationship language, first reported in 1861 by the French neurologist Paul Broca. This field has been increasingly developed worldwide. A very important field of research in neuropsychology is neuropsychological assessment. This research domain has a strong interface with neuropsycholinguistics, because of the fact that language is both the vehicle to convey the assessment and the focus of

investigation in verbal instruments, meaning that language is used evaluate language itself.

Despite its importance to cognitive neuroscience and to this subarea of neuropsychological assessment, language appears not to be one of the most studied cognitive processes by neuropsychologists. In the 1970s, relevant psycholinguistic models emerged, including pragmatics and discourse processing theories, which proposed an analysis of language beyond its basic structural facets. For example, speech acts model, proposed by Searle (1969), and the text organization model, proposed by van Dijk and Kintsch (1978), served as the basis for theories on pragmatics and discourse adopted today. Although these models could be an important theoretical basis for the assessment of language production and comprehension, language remains a topic scarcely studied by neuropsychologists compared with other cognitive processes.

Among the sources of knowledge about language processing are experiments, quasi-experiments, and case studies that use healthy samples and neurological or psychiatric subjects that provide behavioral data from standardized general cognitive or language evaluation tools and neuroimaging data from structured discourse contexts.

People use symbolic systems of various kinds as instruments for thought. However, many philosophers and psychologists have believed that thought exists independently of the symbolic forms in which it is clothed and by means of which it is expressed. Language, though of great importance, is not the only medium of cognition. Sometimes a cognitive act, such as deciding which dish to choose from the menu, is achieved by manipulating symbols of other kinds, such as images and mental pictures. Sometimes symbols have a material embodiment in compasses and maps. Language use is not only public, as in conversation, producing an interpersonal realm of meanings. But there is also a private realm of human experience, and private uses of symbolic systems that play a key part in its production.

Discourse analysis emerged as a new transdisciplinary field of study between the mid-1960s and mid-1970s in such disciplines as anthropology, ethnography, microsociology, cognitive and social psychology, poetics, rhetoric, stylistics, linguistics, semiotics, and other disciplines in the humanities and social sciences interested in the systematic study of the structures, functions, and processing of text and talk (for details, see the contributions in van Dijk, 1985b).

In the first half of the twentieth century the main question about the relationship between language and cognition was whether the grammatical structure or vocabulary of our language influenced thought processes. Cognitive science introduced a new question: are language and cognition similar or distinct human abilities? The last 50 years have seen considerable controversy on this question, mirroring the development within cognitive science of two fundamentally different conceptions of the cognitive architecture. The tradition of artificial intelligence emphasized general-purpose problem solving abilities, while the tradition of linguistics and philosophy let to an emphasis on distinctive modules.

There are four different theoretical perspectives on the language –cognition relationship. The view at the beginning of the twentieth century appears to be best captured by the idea that cognition and language have complex similarities and differences, and both develop over the human span from genetic factors constrained by environmental input and cultural learning. It may be possible to set aside the question of whether language is distinct from cognition and whether the brain is composed of distinct mental modules. The theorist Howard Gardner has noted a growing consensus about the importance of a new set of questions about how to divide up the grand areas of mind and brain. Scientists are emphasizing the distinction between areas of human ability that are available to all humans and played a part in the evolution of our species (such as language and basic number use), and areas requiring cultural elaboration (such as algebra and the ability to play musical instruments). The era of simplistic statements about the language-cognition relationship is

drawing to a close, as cognitive scientists begin to deliver on the promise of a truly interdisciplinary approach to understanding the mind-brain.

By 2000, the cognitive linguistics movement had grown into an enduring subfield, but it has remained outside the mainstream of linguistics. While some cognitive linguists have remained focused on specific linguistic questions, others have addressed questions in an interdisciplinary manner, drawing on experimental psychology, brain science, and category induction by artificial neural networks.

The field of cognitive neuroscience emerged from work in neuroscience and cognitive science. Cognitive neuroscience differs from basic neuroscience by having the goal of explaining complex cognitive abilities, but rejects the tradition of artificial intelligence (and much of cognitive science) that one can understand cognition abstractly, without reference to its neural underpinnings. In the 1990s some cognitive neuroscientists argued that basic aspects of the language cognition relationship, such as the autonomy of syntax hypothesis and the innateness and modularity of language, could be evaluated from neuro-scientific point of view.

Neurobiologists noted that developing neural tissue is very plastic. Like other aspects of cognition, language acquisition is heavily dependent on experience. The neurobiological evidence thus may run counter to what would be expected under the autonomy of syntax hypothesis. There is no known way that genes could encode for concepts like subject-and –verb. Cognitive neuroscientist share a view of language that resonates with cognitive linguists: they emphasize the joint-development of language and perceptu-motor processes, with language acquisition understood to be semantically driven and embodied.

Literary studies and the cognitive sciences, pursuing common interests in language, mental acts, and linguistic artifacts, have developed markedly different approaches to similar phenomena of reading, imaginative involvement, and textual patterning. Until quite

recently, the distance between them has drawn more attention than their possible convergence (Franchi and Guzeldere 1994). A number of literary theorists and critics, however, have steadily been producing work that finds its inspiration, its methodology, and its guiding paradigms through a dialogue with one or more fields within cognitive science: artificial intelligence, cognitive psychology, post- Chomskian linguistics, philosophy of mind, neuroscience, and evolutionary biology.

Reuven Tsur (1992) has been developing his ‘‘cognitive poetics’’ since the 1980s; the prominent psychoanalytic critic Norman Holland (1986: 6) demonstrated the advantages of attending to the ‘‘more powerful psychology’’ emerging from cognitive neuroscience in 1988; Mark Turner (1991: viii) advanced his far-reaching project of a ‘‘cognitive rhetoric’’ in 1991_; and Ellen Spolsky (1993: 4) trenchantly brought a theory of ‘‘cognitive instability’’ to bear on literary interpretation in 1993.

While this insight is not new, linguistic knowledge about systematic principles of language structure and use has not yet been integrated sufficiently in cognitive science research. In this field, questions about human concepts and thought processes are often addressed by using various kinds of unconstrained verbalizations. The method Cognitive Discourse Analysis (CODA) provides a framework for utilizing linguistic insights for the analysis of such data, by investigating patterns of language use in relation to the situation in which language is produced. Relevant studies involve situations or tasks that highlight central aspects of *mental representation* and *problem solving processes*. Both of these relate to and enhance well established research traditions in distinct ways.

4. Towards new method of inquiry

One of the greatest fascinations—and most challenging problems—is to know how our brains create and use language (Mildner, 2008). After decades of earnest study in a variety of disciplines e.g., neurology, psychology, psycholinguistics,

neurolinguistics, to name a few, the problem of the brain and language is now addressed especially by the vigorous interdisciplinary specialty of cognitive neuroscience. This specialty seeks to understand the neural systems that underlie cognitive processes, thereby taking into its intellectual grasp the dual complexities of neuroscience and cognition.

Science is a procession of technology, experiment, and theory. From early work that relied on "accidents of nature" (brain damage resulting in language disorders) to modern investigations using sophisticated imaging methods, the path to knowledge has been diligently pursued. As we noted above, in the last thirty years, a profoundly different view of how we compose and understand language has taken shape: the metaphor of the brain as computer has shifted to an embodied and creative brain. An application of the cognitive sciences to discourse studies, then, has much to offer.

Cognitive science has been influential in literature, music, and creativity for some time. There are books recently published or forthcoming that use cognitive theory to rethink the medieval period for example, or that situate the early modern period within a material framework that includes the materiality of the brain. Perhaps the greatest value of this interplay is in the avenues for research it opens up. Some of the avenues of research have already been called for: as discussed elsewhere in this book, F. Elizabeth Hart has called for a materialist linguistics; Bruce McConachie argues for the value of cognitive studies in historiography; Rhonda Blair has called upon cognitive science to inform acting theory. And more work remains.

In large part, the generative theory of language has been replaced by the cognitive linguistic theories applied here. Cognitive linguists broke away from the generative grammar theory because it failed to answer how meaning was made in poetry. The paradigm shift between seeing the brain as a computer, with input undergoing algorithmic processing, and viewing it more as part of an organism, shaping and being shaped by its environment, is beginning to have a profound impact on various fields.

Cognitive science is the term that gets blanketed over various fields that look at the interaction between the mind, brain, body, language, and environment. It includes research from neurology, psychology, computer science, linguistics, and philosophy. Despite an effort to communicate and unify across the disciplines, there are major rifts within cognitive science stemming from different foundational assumptions as well as methodological differences. Of course the neurosciences are focused at the level of neurons while linguists are focusing on behavior, so a lack of connection between such areas might be unsurprising.

By the second decade of the 20th century it has become clear that the nervous system was built of dynamically polarized nerve cells, whose axons and dendrites were organized into groups, and made specific neural connections by means of synapses (Mildner, 2008). In the 1930s the first motor and sensory maps were produced, and it became obvious that each sensory modality has more than one of those maps.

After WorldWar II different methods of imaging and quantifying these connections were designed (more on that in chapter 4, this volume). The obtained results and techniques ensured better understanding of brain physiology and changed the approach to speech and language. However, the key question—does the brain function as a whole or as a set of independent parts—continues to be debated.

According to Kosslyn and Andersen (1992), it seems plausible that simple processes are localized, whereas complex functions such as perception, language and others are more widely distributed (as cited in Gazzaniga et al., 2002).This simple distinction does not solve the problem, of course. Rather, it moves it to a different plane: to the question of the level of complexity at which a process is localized, or at what point it becomes complex enough to warrant wider distribution.

Cook (2010) assures that language does something; it is not just a system of signs and signifiers that we use to narrate and describe

events and actions in the real world. He adds: "It is creative and banal and works to reveal and shape our thought; therefore, a study of language is a study of how we think" (p. 150). The categories we use to organize information can be changed, both linguistically and cognitively, and often have to be, when new information or ideas arrive, which prove them inadequate or inaccurate.

It became clear that the brain is for more than thinking and that it is not a whole discreet organ but an organism with parts. To understand a production/reception of any discourse requires an extraordinary cognitive and biological feat. An obvious example is how theater audiences process extraordinarily complex information without getting lost. Because the seemingly simple ability to watch, understand, appreciate, and be moved by a theatrical production involves elements of our biology, an investigation into these questions will encounter research in science.

The conceptual metaphor theory of George Lakoff (and others) and the conceptual blending theory of Gilles Fauconnier (and others) suggested a rereading of how reading is about manipulating symbols and meaning. If this is not how we make meaning, then we have an obligation to reinvestigate our old assumptions and readings of texts. One of the important consequences of understanding that we create linguistic and conceptual categories is seeing how categories can slip, expand, constrict, and change. In other words, processing the metaphoric sentences required more of the brain to participate. These sentences require a different idea of meaning creation and categorization.

5. Neurocognitive Methodological Prerequisites

There is no single ‘‘perfect’’ method for the examination of psycholinguistic and neurolinguistic questions. Neither are behavioral methods superior to neurocognitive methods because they have been available to the field for a longer period of time, nor do neurocognitive methods provide definitive answers to processing questions simply because they are ‘‘closer’’ to the brain. Rather, all methods are associated with their own particular strengths and

weaknesses. For this reason, investigators believe that true insights into the language processing architecture can only be gained from an integrative perspective, in which a variety of methods are compared and contrasted.

The unveiling of the brain through methods such as functional magnetic resonance imaging and positron emission tomography has satisfied a scientific quest to depict the neural activity associated with specific types of language processing. Today we stand at a remarkable confluence of information, including behavioral experiments on normal language functioning, clinical descriptions of neurogenic speech and language disorders, and neuroimaging of language processes in the intact living brain. But the profound potential of this synthesis is difficult to realize because the knowledge is spread across a huge number of journals and books.

1 Methods with a high temporal resolution
1.1 Electroencephalography (EEG)
1.2 Magnetoencephalography (MEG)
2 Methods with a high spatial resolution
2.1 Functional magnetic resonance imaging (fMRI)
2.2 Positron emission tomography (PET)
2.3 Transcranial magnetic stimulation (TMS)
3 Correlations in neurocognitive data
3.1 Correlations between time and space
3.2 Correlations between neurocognitive patterns and functions: The one-to-one mapping
problem
4 The output: Behavioral methods
4.1 Judgments
4.2 Speed–accuracy trade-off (SAT)
4.3 ‘‘Online’’ methods

1. Clinical Studies
1.1. Studies of Split-Brain Patients
2. Cortical Stimulation
2.1. Transcranial Magnetic Stimulation (TMS)

3. Wada Test
4. Neuroradiological Methods
4.1. Computerized (Axial) Tomography—C(A)T
4.2. Magnetic Resonance Imaging (MRI)
4.3. Functional Magnetic Resonance Imaging (fMRI)
5. Recording of Activity
5.1. Electrophysiological Methods
5.2. Single-Unit or Single-Cell Recording
5.3. Electroencephalography (EEG)
5.4. Event-Related Potentials (ERP)
5.5. Cortical Cartography
5.6. Magnetoencephalography (MEG)
6. Radioisotopic Methods
6.1. Positron Emission Tomography (PET)
6.2. Single-Photon Emission Computed Tomography (SPECT)
7. Ultrasound Methods
7.1. Functional Transcranial Doppler Ultrasonography (fTCD)
8. Behavioral Methods
8.1. Paper-and-Pencil Tests
8.2. Word Association Tests
8.3. Stroop Test
8.4. The Wisconsin Card Sorting Test (WCST)
8.5. Priming and Interference
8.6. Shadowing
8.7. Gating
8.8. Dichotic Listening
8.9. Divided Visual Field
8.10. Dual Tasks
9. Aphasia Test Batteries

Bornkessel-Schlesewsky & Schlesewsky (2009) claim that ascertaining the precise relationship between neurocognitive methods and behavioral methods is essential for several reasons. Firstly, only a more precise understanding of these correspondences will allow for a ‘‘unification’’ of psycholinguistic and neurolinguistic research. This is by no means a trivial matter (see, for example, Sereno and Rayner

2003; Bornkessel and Schlesewsky 2006a, for a discussion of the problems involved in establishing correspondences between ERPs and eyetracking).

Nevertheless, on the basis of the research conducted during the last years, we have come a long way in understanding how different experimental methods work and how they are related to one another. This is also an important step with respect to the question of how different data types might serve to inform linguistic theory. For example, systematic crossmethod comparisons have revealed that linguistic judgments incorporate a range of different influences, thus questioning whether this data type – at least when considered in isolation – is indeed suited to revealing linguistic competence in an ‘‘unadulterated’’ manner (for discussion, see Bornkessel-Schlesewsky and Schlesewsky 2007). However, independently of the type of data under consideration, psycholinguistic and neurolinguistic methods cannot decide which data types are important for linguistic theory-building. This is rather a matter of choice for the developers of each individual theory: if a theory does not seek to be ‘‘psychologically adequate’’ (in the sense of Dik 1991), it needn’t – and shouldn’t – concern itself with processing facts.

The continued evolution of cognitive neuroscience is mainly driven by innovative applications of particular techniques. Many of these new neuroscience approaches clearly require, and have only been made possible in later years by, a dramatic increase in computing power. Senior, Russell, and Gazzaniga (2006) confirm that the many different ways one can now investigate human brain function allow one to take snapshots of structure and function from different perspectives. They explain further the particular snapshot one sees as determined by the temporal and spatial resolution of the technique being used and by whether one is recording activity from the brain or trying to interfere with or stimulate the brain to change stimulus processing or behavioral responses.

The relative spatial and temporal resolutions of various neuroimaging and recording techniques at one’s disposal are vast. The

correct level at which to examine brain function depends on what one wants to know, and what one wants to know depends on what is already believed. Each of these different techniques can best be thought of as inhabiting a distinct problem space. Some known limitations include being aware that 1) faster or smaller spatial sampling isn't always better; 2) brain activations may be misleading; 3) TMS effects may be due to secondary activations; techniques shouldn't necessarily give converging evidence.

6. Principles, Theories and Models of the Nervous System Structure

On the basis of systematic characteristics, the principles of structure, development, and functioning of the nervous system are established. Mildner (2008) detailed in this respect that these principles serve as starting point for the design of theories and models. Empirical and experimental tests and evaluations of theories and models complement existing knowledge. This, in turn, enables us to develop new principles or modify them in such a way that we come to have new models or new versions of the old ones.

Due to this obvious interactivity, it seems reasonable to discuss the principles of structure and functioning of the central nervous system in the same chapter with the theories and models that refer to them. The four principles are:

1) Hierarchical organization, higher levels provide greater precision. Neurons respond to increasingly abstract aspects of complex stimuli as the distance, measured by the number of synapses from the source, increases (reflex arc)

2) Parallel processing, bits of information do not travel along a single pathway. Various aspects of the same sensation are processed in parallel ways (visual stimuli).

3) Plasticity: This is the ability of the central nervous system to adapt or change under the influence of exogenous or endogenous factors.

4) Lateralization of functions: both parts of the brain are anatomically and functionally asymmetrical.

7. Assumptions on language use in context

The primary purpose of language is to communicate with other humans; thus, an accurate understanding of the properties of language requires understanding how language is used to create meaning. In terms of Cognitive Linguistics, the commitment to analyzing extended text is perhaps most apparent in Mental Space Theory and Blending Theory, which attempt to model the complexities inherent in human knowledge representation and linguistic processing, with particular focus on shifts in viewpoint and perspective in naturally occurring discourse. However, many other strands of Cognitive Linguistics have also been driven by observations of contextualized language use.

Another key area of convergence is the shared recognition of the central importance of organized background knowledge in human cognition generally and in creating and interpreting language in particular. Certainly discourse analysts have long recognized schema in relation to interactional routines and scripts. While discourse analysts clearly recognize the centrality of schema in interpretation of the 'ideational,' much of their concern has been on the affective, interpersonal, and actional. In contrast, Cognitive Linguists have focused more on the nature of cognition and how it is reflected in the linguistic code and rather less on the interpersonal and interactional realms. In particular, they have emphasized that language is a reflection of human cognition which stems from a language user who is endowed with a particular physical and neurological architecture that includes rich, complex cognitive capacities, including richly structured memory, as she interacts with the external, social-physical world. Basic to the perspective is the idea that humans do not have direct, objective access to the external world; rather what humans have direct access to their conceptualization of the world.

Cognitive Grammar, Mental Space and Blending Theory, Construction Grammar, ethnomethodology, and interactional sociolinguistics are just some of the frameworks used by the researchers within a usage-based approach to language. There implied a set of shared tenets concerning language as it occurs in natural

contexts include the following: 1) when humans use language, they do so primarily for the purpose of communicating with other human beings; 2) communication always occurs in a context; and 3) language is shaped by its social-cultural nature; and 4) language is inevitably shaped by the nature of human cognition.

8. Benefits of merging disciplines

This study integrates empirical methodology from fields of neuroscience and cognitive psychology into questions of discourse-comprehension previously considered not empirically verifiable and even "non-scientific." The answer to any and all of my questions should do two things: provide new tools for practitioners and open new doors of research and conversation within the academy.

I believe that we have only just begun to understand ramifications of language in other fields, based on the fact that thinking and language attempt to capture and represent. This privileging of imagination, creativity, and the body is part of the reason I find the integration of cognitive science into discourse studies so productive. While I believe that such interdisciplinary travels require rigor and caution, I do also believe that cognitive linguistics operates to open up new horizons of research questions and answers. Until the debate is settled, any application of cognitive science to the humanities should foreground the paradigm in which it operates to explain the aesthetic, emotional, and cognitive experiences that matter the most to us (p. 16).

The separation between the "two fields" is invented and unproductive. Many scholars allude to literature and art as involved in a relationship with the human biology, psychology, or neurology, yet few put pressure on how this might work or what it might mean given historical or contemporary scientific epistemology (Cook 2010, p. 42). This is not to say that the disciplinary walls should come crashing down or that all work is most fruitfully done at or on the wall. We should know whether our idea of how language works (cognitively as well as culturally) matches the evidence collected within cognitive

linguistics that depicts a linguistic system based on profound creativity and instability.

The engagement between the disciplines has already provided exciting work and promises to continue to reshape scholarship in the academy. The movement across disciplines comes from an urge to answer questions unanswered in one's own; the questions being asked at the intersection of literature and cognitive science seem to be: how does a new concept of how language and thinking work alter our understanding of classic plays? What can a study of linguistic processing tell us about a historical period or the brain of the person who wrote the language? Along this interdisciplinary coastline there are different research agendas and questions. What the scientists want to know is how did Shakespeare write a soliloquy that could and would be quoted by all English-speaking high school graduates? How do we remember it and why does it interest us? How is it that a change of brain created a change of mind? How we process and express information could be traced to what was inside and how the parts worked to make up the whole.

9. Some Empirical Evidence

Caplan, Dapretto, and Mazziotta (2000) have shown in fMRI studies of healthy subjects that different neural networks are involved in different aspects of discourse coherence. Logic is controlled by the left hemisphere, primarily by the middle and superior temporal gyrus, but also by the inferior frontal gyrus and anterior cingulate. Aparticularly high activation was recorded when the responses were illogical, whereas in logical ones it was somewhat more evenly distributed in both hemispheres.

On the other hand, maintaining the topic of conversation is controlled by the right hemisphere, primarily by the inferior frontal gyrus, superior temporal gyrus, and the cerebellum. Responses that deviated from the topic increasingly activated precisely these areas. These results confirmed earlier observations of brain-injured patients. Faust, Barak, and Chiarello (2005) also found that the right hemisphere contributes to discourse comprehension by maintaining

widespread meaning activation over an extended period of time, thus monitoring the coherence. Xu, Kemeny, Park, Frattali, and Braun (2005) found the right hemisphere to be increasingly active as contextual complexity increased.

Kuperberg et al. (2000) used fMRI on healthy subjects to study neural activity during listening to correct spoken sentences and compared it with the activity recorded during listening to sentences that were pragmatically, semantically, or syntactically anomalous. All three contrasts revealed robust activation in the left inferior temporal and fusiform gyrus. Studies using PET and fMRI techniques have shown that written language relies on the same neural substrate at its input level as other visual stimuli. In other words, the first steps in visual processing of words will be identical to those in processing any other form; words will be analyzed one feature at a time (curvature and slant of the lines, etc.).

The process of writing proceeds through several stages: planning, sentence generation, and revision (usually in that order). On average, the planning stage takes about 30% of the time, sentence generation about 50%, and the revision stage the remaining 20%. More knowledgeable individuals write with less effort, but not necessarily better than those with less knowledge. Good writers use longer sentences (on average 11.2 words), or longer segments, than average writers (7.3 words). Skillful writers spend more time on text revision than average or poor writers, and their interventions are related to content rather than to individual words or phrases (Hayes & Flower, as cited in Eysenck & Keane, 2000).

Despite the importance of the planning and revision stages, the sentence generation stage has been the most extensively studied. Many authors agree that writing depends on internal speech to a great extent. This means that writers actually produce the words before they write them down. According to this hypothesis, writing would rely on the same neural structures that are involved in speech, in addition to those that are related to the actual motor activity associated with writing.

The restrictions in a poem, on logical or force-dynamic and spatial consistency are not the same as in argumentative or narrative texts. Therefore the possible divergence between results of the construction intended by the author and reconstructed by the reader/hearer does not dramatically endanger the poetic text. On the contrary, Celan cites Pascal, a very geometrically minded French philosopher of the 17th century, who said: "Ne nous reprochez pas le manque de clarté, car nous en faisons profession » (translation: Do not reproach us the lack of clarity, because we intend it). Nevertheless the poet does his best to be precise, to come the nearest he can to his expressive goal. The lack of clarity is just the consequence of the fact that the poetic text is not argumentative and thus does not have to follow the rules of logic; it is not narrative, and thus the spatial/temporal/causal unity is not its primary goal.

Understanding discourse requires the comprehension of individual words and sentences, as well as integration across sentence representations to form a coherent understanding of the discourse as a whole. The processes that achieve this coherence involve a dynamic interplay between mental representations built on the current sentence, the prior discourse context, and the comprehender's background (world) knowledge. In this chapter, we outline the cognitive and linguistic processes that support discourse comprehension and explore the functional neuroanatomy of text and discourse processing.

Many linguistic theories have addressed the relationship between language and thought (e.g., Talmy 2000, 2007; Evans and Green, 2006; Langacker, 2000; Tomasello, 2003). In particular, lexicogrammatical structures in language appear to be systematically related to cognitive structures and processes. This structural fact carries over to principles of language in use: the way we think is related to the way we talk. This is true both generally in terms of what we can do with language, and specifically with respect to what we actually do.

Evidence from the cognitive neuroscience of text and discourse processing generally supports the assumption that areas of the brain

that are active during sentence comprehension also support the comprehension of connected text. When listeners encode sentences, left hemisphere language mechanisms are involved in perceiving words, encoding their meanings, parsing the sentence, and integrating the meanings across sentences. The resulting integration of information is realized at two levels: (1) coherent semantic representations of successive clauses and sentences that are subject to verbatim memory loss at clause and sentence boundaries and (2) a situation model based on the updating of information as the text proceeds.

10. Implications

Investigations of neuropsychological functioning in multiple language users offer much promise in answering questions originating from cognitive as well as biological approaches to language. For example, organizational structure reduces processing load in the prefrontal cortex during discourse processing of written text, which may have implications for high-level reading issues after TBI.

One key challenge for future work will be to reconcile contradictory evidence on the role of the right hemisphere in establishing coherence in discourse comprehension. Another topic that is ripe for future research concerns the nature of syntactic processes, and their interactions with communicative processes. Also, neuroimaging studies of discourse comprehension may add to our understanding of individual differences. We further suggest for future research to tackle any of the following questions:

· How can the ambiguity of such nonce compounds be controlled? Are they able to create a richer field of possible interpretations?

· Will the hearer/reader be able to reconstruct the cognitive pathway of the author or will he at least come to a similar experience?

· How will the space of solutions to the problem of interpretation be coordinated with the interpretation of the words, phrases and sentences which stand in the context of the compound; i.e.

will the compound properly contribute to the global meaning of the text?

· Does a one-to-one mapping of neuro-physiological levels of brain activity to cognitive behavioural levels really enhance educational pedagogy?

· What is the relationship between double-loop learning, reflexive practice, learning styles and neurophysiology?

· Does human cognition rely on structured internal representations?

· How should theories, models and data relate?

· In what ways might embodiment, action and dynamics matter for understanding the mind and the brain?

We can turn to examine ways in which the Person-based discourse, the Organism-based discourse and the Molecule-based discourse are related to one another.

The idea that cognitive tasks often require the use of material tools introduces the metaphor of "brain-as-tool". A certain electronic device is a "calculator" only in relation to the task it is used to perform. Similarly a certain region of the brain is the organ of calculation only in relation to the task we use it to perform. Finally there are cognitive tasks for which we use cognitive or symbolic tools, for instance reasoning carried on with propositions. To produce a statement, expressing a proposition, which is to serve as a tool in the task of solving a problem, is to engage in a task using a material tool, one's brain.

11. Conclusions

The objective in this paper has been to give some indication of the multidisciplinary range of discourse analysis, to identify and describe some of its gradually emerging landmarks (the “ways and means,” the “focusing”. Having shifted focus of our enquiries from the misconceived puzzle about how two wholly disjoint substances could interact, and avoiding the complementary pitfall of the attempt to build a human science on the basis of one or other Crinion and Price (2005) investigated (by means of fMRI) narrative speech

activation in left-hemisphere stroke patients and normal controls. Their results support the role of the right temporal lobe in processing narrative speech and auditory sentence comprehension following left hemisphere aphasic stroke.

There is simply too much evidence to disregard the idea of preexisting conditions in our brain which govern our language abilities. Until we better understand the brain and the neuronal basis of language, however, the debate is still widely open. To borrow Chomsky's very own words, "it remains to be seen in what respects the system that develops is actually shaped by experience, or rather reflects intrinsic processes and structures triggered by experience."

Educational neuroscience is generating valuable new knowledge to inform educational policy and practice. If the scientific community decides not to develop arguments of relationality between neurophysiology, cognitive development and learning within the educational context then it will remain an unmapped area of knowledge.

It is apparent that neurocognitive and analytical approaches to language have different concerns from each other. What I call analytical linguistics is concerned with analyzing linguistic data, utterances, sentences, and the like, and with finding patterns in such data, often guided by theoretical concerns that have little cognitive basis and usually no neurological basis at all. In neurocognitive linguistics, by contrast, while such data is still examined, the object of study is the neurocognitive system of the individual. This difference of focus has a number of consequences, not least of which is the recognition and acceptance that the system of every individual is different from that of every other.

More important for the concerns of this paper is that by taking the natural operation of the human brain into consideration we recognize that linguistic information, like other kinds of information, is often represented redundantly in the neurocognitive system. The tendency of analytical linguists to seek out the most economical

possible means of handling a given body of data is seen to be lacking any neurocognitive motivation.

The human cognitive system represents information as connectivity in a network. It operates by means of widely distributed representations and parallel processing. As a consequence, linguistic forms can be recognized or produced by means of different structures operating in parallel. The brain thrives on redundancy and on multiplicity of strategies.

Many scholars share the belief that the application of cognitive science to the discourse studies will work best in a collaborative spirit—creating not a master theorist but a diverse group of scholars asking different questions using a similar (and rigorous) interdisciplinary methodology. Here at the start of the twenty-first century, the integration of science and the humanities could provide the next century's big bang.

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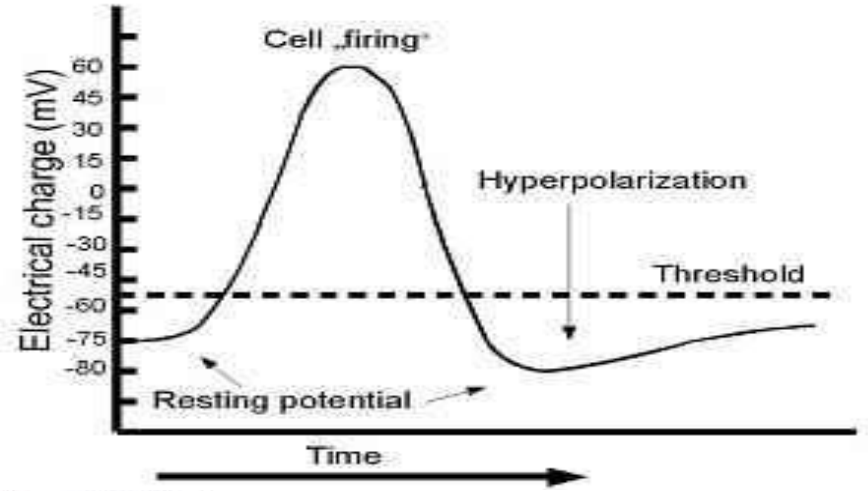
Appendices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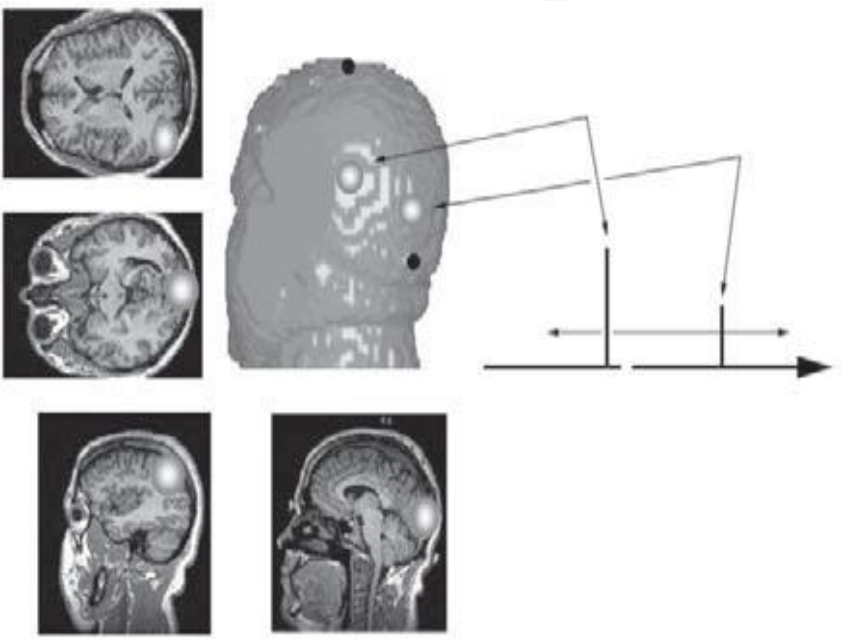
Threshold
Resting potential
Time



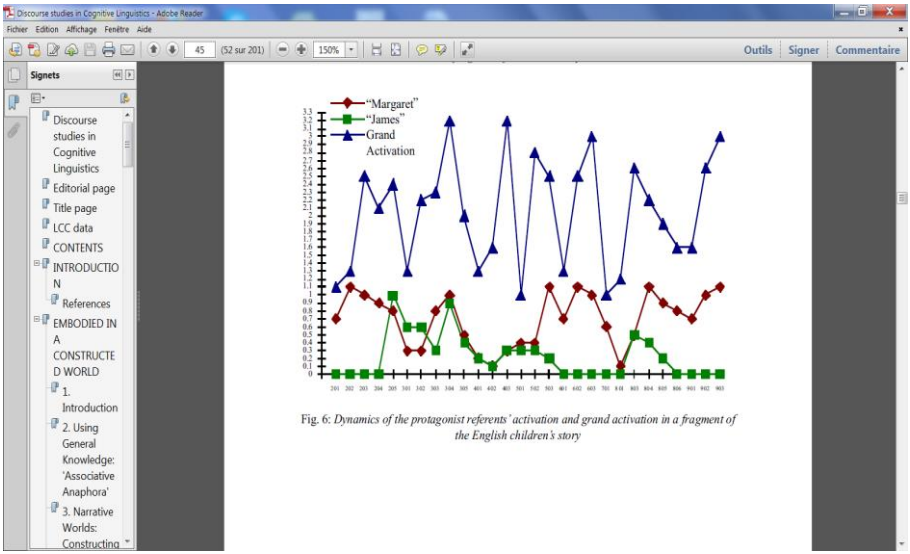


Fig. 6: *Dynamics of the protagonist referents' activation and grand activation in a fragment of the English children's story*