Where Lexicon and Syntax meet

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Where Lexicon and Syntax meet

by
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Contents

Chapter One
Introduction

1.1. The endeavor

> It is common for linguists (myself included) to describe their own analyses as **natural**, reserving the term **unnatural** for the analyses of other investigators. From this one deduces that naturalness is something to be desired in a linguistic description. Yet the term natural is elusive and largely unexplicated, having so little intrinsic content that in practice it easily comes to mean simply "in accordance with my own ideas". (Langacker 1987: 13)

Linguistic models of the present time claim to be more or less explanatory, i.e., they claim to be able to explain how a competent speaker of a language acquires this competence. This also implies – among many other things – statements about the way the linguistic subsystems or -components artificially separated in the descriptions of the language system for methodological reasons actually interact. The validity of such statements can be measured against the facts revealed by the research into language processing, and such an evaluation is exactly what I aim at in the project presented here. It can be roughly described as the search for a "natural" linguistic model, a model which is compatible with findings about language use and which can, apart from defining any "grammatical" (in the sense of grammatically correct) linguistic product as a result of the language user's competence, also explain various performance data, in particular those which seem to be aberrations from "grammatical" or well-formed constructions.

Since in a project like this, it is hardly feasible to discuss the assumptions made with regard to the interrelation/interaction of all the components in linguistic models, I felt the requirement to restrict myself to some representative subgroup of them. Stimulated by the growing linguistic interest in the lexicon, by the increasing importance

attributed to it, and by the centrality of the syntactic component in most current linguistic models, I have focussed on the relationships specified for the lexicon and the syntax and how this is reflected in individual linguistic models. The models I have chosen for an analysis regarding this are the functional ones by Dik (1989) and by Halliday (1985, 1994), the generative ones by Chomsky (1988, 1993, 1995a and b) (Government & Binding and Minimalist Program), by Bresnan (1982) (Lexical Functional Grammar), by Pollard & Sag (1994) (Head-Driven Phrase Structure Grammar) and by Diehl (1981) (Lexical-Generative Grammar), and the assumptions made with respect to the functioning of language by cognitive linguists, such as Deane (1992), Fillmore & Atkins (1992), Fauconnier (1994), Fauconnier & Turner (1996), Goldberg (1995), Lakoff (1987), and Langacker (1987, 1991a and b, 1999).

The hypotheses made with regard to the lexicon-syntax interface vary considerably, with some even being contradictory to one another. In order to assess which of them are more plausible or "natural", which of them are not only elegant and supported by theory-internal facts, but are also in line with the natural procedures involved in speech processing, I compared the claims made in the respective linguistic models with those made in psycholinguistic ones.

If one considers the relationship between lexicon and syntax, linguistic models can basically be divided up into two groups. There are models which give priority to syntax, and there are models which give priority to the lexicon in the total arrangement of language.

This means that either the syntax or the lexicon is considered the central and dominating component of language and the other components are described as being more or less dependent on it or as being secondary to it[1].

For psycholinguistic models of language comprehension, language production, or both (e.g., those developed by Forster (1979), Garrett (1980), Levelt (1989), Kempen & Hoenkamp (1987) Dijkstra & Kempen (1993), Dijkstra & de Smedt (1996b), Bock (1982), Handke (1995) and Frazier (1987, 1989, 1990)), or reflections on the lexicon-

[1] This is not to be equated with the debate about autonomy or modularity as it is going on in the fields of cognition in general and language in particular.

syntax interface as they appear in the research by Shapiro, Zurif & Grimshaw (1989), Trueswell, Tanenhaus & Garnsey (1994), MacDonald (1993), MacDonald, Pearlmutter & Seidenberg (1994), Pearlmutter & MacDonald (1995) and Marslen-Wilson (1989), the situation is more uniform. For language production, there is general agreement on the fact that the lexicon plays a central role in the processing procedures in that the syntactic structure of an utterance is considered to basically, and at least partially, evolve from the syntactic information stored in the lexical entries retrieved for its construction. Models of comprehension, however, differ in the way they assume the parsing process to work, reflecting the polarity found in linguistic models: One group of models describes the lexicon as the driving force in the parsing process, the other attributes priority to syntax in that the parsing process is initiated on the basis of word-category information before any other type of information (pragmatic, semantic, thematic) has been actually accessed.

The present book is meant to trace my search for a natural linguistic model which can give a plausible answer to the question of where and how exactly lexicon and syntax are assumed to meet: I analyse the competence models mentioned above as to what they claim with regard to the lexicon-syntax interface, and I measure the plausibility of their claims against findings from psycholinguistics and a number of performance data.

In particular, I ask and try to answer the following two questions:

1. In what way are the selected linguistic models compatible with psycholinguistic assumptions about the lexicon-syntax interaction in language use?
2. How can the performance data I concentrated on, namely self-repairs, overlaps and lexical patterns, be explained by the linguistic models under analysis?

For that purpose, I first assemble what psycholinguistic models assume with regard to the interaction between syntax and the lexicon, finishing up with a summary of those claims that I strongly support and adding a few aspects that I consider important to my argumentation.

Secondly, I scrutinize the linguistic models mentioned above, focussing on what assumptions about the syntax-lexicon interface they

make or allow for, and considering in what relation that stands to the psycholinguistic claims.

Then I go on to describe the performance data I drew on in order to see how they relate to the claims psycholinguists make with regard to the lexicon-syntax interaction in language processing, and in order to further evaluate the "naturalness" or "plausibility" of linguistic models:

I analysed reformulations or rather self-repairs to find out what the mechanisms of their production are, and whether these mechanisms are provided for by the general design of the linguistic models under discussion. The data were derived from conversations recorded in the London-Lund-Corpus (LLC).

Secondly, I analysed overlaps, i.e., moments in a conversation at which both interlocutors speak simultaneously, as to what they can tell us about language comprehension and whether the procedures involved are explicable by linguistic models. These data were extracted from the British National Corpus (BNC).

A third type of performance data I took from corpus-linguistic research results, in particular from the discovery of not only syntactic, but also an impressive number of lexical patterns in language use.

Drawing on what corpus linguists have revealed about lexical patterning, I once again ask whether the linguistic models under discussion can sufficiently account for this phenomenon, and which psycholinguistic claims it can be taken to support.

Since all three types of performance data can give evidence regarding the lexicon-syntax interaction only via the interpretation by the analyst, I thought it important and necessary to look for more "objective" experimental evidence for the claims I make and support. That is why I designed and carried out an experiment which is meant to reveal information about the cognitive status of lexical patterns, in particular of collocations.

The final step in my argumentation is to check and evaluate the linguistic models discussed in the light of the psycholinguistic findings and generalizations. They will also be evaluated with respect to their capability of covering and explaining the phenomena found in the analyses of performance data, i.e., I will end up discussing which of the numerous models and assumptions presented assigns to lexicon and syntax the appropriate places in the total structure of language.

Chapter Two
Grounding and definitions

2.1. At the core of language: lexicon and syntax

Language is commonly understood as simply consisting of a vocabulary and rules and regularities for the combination of its elements into larger units, i.e., phrases, clauses and sentences.

This general understanding shows, among others, in the description of "language" in the *Cambridge Encyclopedia of Language* (Crystal 1987). Crystal's survey contains a number of definitions, two of which are presented here for illustration.

(Part of) the dictionary definition of language he selected reads as follows: "the words, their pronunciation, and the methods of combining them used and understood by a considerable community and established by long usage." (Gove 1961: 1270)

Chomsky, whose definition (1957: 13) sounds much more technical, though it actually provides less information than the first, is quoted as representing the views of one of the specialists dealing with the subject: "From now on I will consider a language to be a set (finite or infinite) of sentences, each finite in length and constructed out of a finite set of elements."

Thus, the "common" view is not only indicative of what the layman understands a language to be, but also reflects in some very general descriptions and definitions given by linguists. In the latter, the two constituents, the words and the combinatory rules, are usually identified by the terms "lexicon" and "grammar", though there is no general agreement on this. Since "grammar" can be understood in a narrow and a broad sense, with the first referring to what can be more specifically called "morphology" and "syntax" and the latter referring to the language system as a whole, it is just as common, and perhaps more exact, to use the term "syntax" for the combinatory component of language.

The use of "grammar" in the former sense is to be found, e.g., in *The Encyclopedia of Language and Linguistics* (Asher & Simpson 1994), where Humphreys gives the following definition:

> The well-formed utterances or sentences of a language are specified by two components: the grammar, which is a set of general rules for combining and ordering word classes in the language, and the lexicon, which lists everything which is not in itself a general rule. The grammar is about linguistic generalities; the lexicon is about linguistic singularities." (Humphreys 1994: 2192)

With regard to "grammar" in its wider sense, one could take both components, lexicon and syntax, to be at the core of a language, with other components, such as stylistics, pragmatics, sociolinguistics etc. superimposing on them.

Having in mind that the subdivisions just made are artificial, since language functions in its totality and is separated into subparts for the reason of making its analysis and explanation feasible only, I will now start out to analyse what the interrelation between the two core components is.

As a prerequisite for finding this out, I shall first comment on what is generally understood by both the one and the other.

2.1.1. Lexicon

The term "lexicon" will be used here in only one of its common meanings, namely in the sense of "vocabulary" or "word-stock" of a language. In this use it is opposed to the second meaning, which is commonly associated first by the ordinary language user, the sense of "dictionary", or "vocabulary of a language as it is arranged in a dictionary", where the arrangement may follow various criteria. These may be, for example, the alphabet (as in the "typical" dictionaries), the meanings to be expressed (as in a thesaurus or other onomasiologically oriented dictionaries), or topics (as in terminological dictionaries), to name but a few.

The two different, though related, senses of "lexicon" also reflect in the numerous definitions of the term that have been given from a linguistic point of view. Naturally, the survey given here cannot be exhaustive, and, for the sake of brevity, I will have to concentrate on

what can be found in some of the relevant linguistic encyclopedias. Moreover, our selection is also influenced by the perspective adopted here.

The definitions assembled in the following are meant to list important characteristics of the sense under investigation, and I essentially do not disagree with the views represented and the claims made by them.

Bußmann (1990: 456) defines "lexicon" in a most general way, thus also allowing for the second reading: "Lexikon ... Im allgemeinsten Sinn: Beschreibungsebene, die den Wortschatz einer Sprache insoweit kodifiziert, als seine Formen und Bedeutungen nicht aus allgemeinen Regularitäten des Sprachsystems ableitbar sind."

Her definition implies that the lexicon contains only those items of the vocabulary that have idiosyncratic properties with respect to their forms and/or meanings. This understanding of "lexicon" denies the motivated word formations as well as the inflectional forms of a lexical item a place in the lexicon[2]. At the same time, it is not explicit about the particular features that can be taken as specified for each item listed against the background that the information contained enables the speaker to use the item correctly once he has acquired it.

This sort of information is to be found in a separate entry in which Bußmann specifies the term as it is understood in one of the major paradigms of the last 40 years, in generative (transformational) grammar: There the lexicon is defined as part of the basic component of the grammar, and the characteristics that make up a lexical entry consist

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[2] This agrees with early generative assumptions with regard to the character of the lexicon, which were revised by Chomsky's lexicalist hypothesis (Chomsky 1970). With this hypothesis, Chomsky places the establishment of a relationship between a word and its derivatives into the lexicon, implicitly claiming that syntax is blind to morphology (cf. Zwicky 1992: 11): Hence, the lexicon contains also derived words, and the particular form needed for the construction of a sentence is determined by the phrase type the head of which it is meant to become (see also Sproat 1992: 335). In the Government-and-Binding Model (Chomsky 1988), lexical items are assumed to project their syntactic (and semantic) features into the syntax, thus minimizing the importance of phrase-structure rules (see section 4.3.1). The "extreme" position that all morphologically complex words are contained in the lexicon is held by Lexical Functional Grammar (Bresnan 1982) (see also section 4.3.2).

in a list of phonological features to which specific syntactic features are assigned (cf. Bußmann 1990: 456).

Chomsky (1988: 5) is more specific with regard to the features that go into each entry: "The lexicon specifies the abstract morpho-phonological structure of each lexical item and its syntactic features, including its categorial features and its contextual features."

A similar definition, being as theory-specific as the latter two, is given by Lyons:

> The lexicon lists, in principle, all the lexical items of the language and associates with each the syntactic, semantic and phonological information required for the correct operation of the (phrase-structure) rules. (Lyons 1970: 125)

Also Humphreys's definition (1994: 2193) reflects main-stream linguistics of the last 40 years when he classifies for "Formal Grammar" that: "...the lexicon is the repository of basic items on which grammar rules operate (words) together with word-related constraints on the free operation of those rules (see X-bar syntax...)".

Lewandowski's definition (1976: 674) is meant to be more theory-neutral and reads as follows:

> Lexikon...
> Die Gesamtheit der Wörter bzw. der Wortschatz einer (natürlichen) Sprache im Sinne des internalisierten Wissens des Sprachteilhabers von den lexikalischen Eigenschaften der Wörter/Lexeme (phonologisch-phonetische, orthographisch-graphematische, syntaktische und semantische Informationen).

The definitions just quoted attribute quite an amount of information to a lexical entry, which a speaker is supposed to know as soon as he has acquired this particular item of the lexicon. The information contained in a lexical entry covers (almost) every aspect of knowledge needed by the language user for the verbalization of his intentions and for the translation of sound into meaning. This is information about:

- the meaning (concept(s) designated by the particular item),
- its syntactic category (word class),
- its grammatical features (e.g., number, person, tense, etc.),
- its morphological classification (morpheme structure),
- its derivational morphology (i.e., assignment of the compatible affixes),
- its subcategorization (i.e., configurational information),
- its predicate-argument structure (i.e., thematic information),

- the cases (of its possible arguments), and
- register (style).

Thus, due to the fact that knowing a word also implies knowing about its use, the speaker/hearer will be heavily constrained as to the structures and forms he may choose or expect when constructing or comprehending an utterance.

Certainly, in the course of language acquisition, the native speaker of a language will also have to find out how all this information of a lexical entry is "disguised" in this particular language and how it is used. That means that he will have to generalize and abstract from experienced particular instances of word usage, almost exclusively from speech input, what the concept(s) named by a word is/are and what the combinatory or the appropriateness rules of his native language are.

So, at a certain age, the native speaker will naturally have semantic, structural (syntactic), stylistic, pragmatic knowledge as such, perhaps also in the form of "autonomous" rules, but he does not normally use this knowledge separately and, what is more, all this knowledge is present in his mind as soon as a lexical entry is activated from his mental lexicon.

This amounts to recognizing that it is extremely difficult to draw a dividing line between lexicon and syntax, and it implies that, for determining the relationship between the two, it will not be sufficient to analyse and interpret linguistic models of the language system ("langue") or of the language user's competence ("competence", "I-language"), but that one will have to consider the assumptions and the data provided by the research into language processing and language acquisition as well.

In these areas of psycholinguistics, the lexicon and its component parts have been a constant object of enquiry, be it with regard to their acquisition, storage, access, or retrieval, or their processing.

The inclusion of these aspects in the concept of "lexicon" is made explicit by a more specific term used for the designation of the lexicon, namely the use of "mental/internal lexicon" instead. The term is also given separate entries in most linguistic dictionaries. Generally speaking, the "mental lexicon" can be considered to be the internalized knowledge of the properties of words.

Bußmann's definition (1990: 480) reads as follows:

> Teilkomponente der Grammatik, in der Informationen über einzelne Wörter/Morpheme gespeichert sind, die bei Sprachproduktion und Sprachverstehen abrufbar sind. Zu diesen Informationen zählt das Sprecher-/Hörerwissen über phonetisch-phonologische Form, morphologische Struktur, semantische Repräsentation und syntaktische Regularitäten...

This formulation already indicates currently open questions as to the form in which the lexicon is stored[3]. Is it words, or is it morphemes, or, from a perspective of parallel distributed processing (for details see section 3.2.1, pp. 27-30), does the lexicon, at a microstructural level, exist "merely" in the form of activation patterns distributed over particular units at the levels of orthographic, phonetic, and semantic knowledge about the words (for a discussion of the "standard" views as against the assumptions of parallel distributed processing see Neumann 1990: 174-176, for example).

Lewandowski uses the term "internal lexicon" and defines it as a model that has been constructed about the internal representation of lexical items in the semantic memory. The latter he claims to contain the language user's subjective knowledge of the meaning(s) and the use(s) of a linguistic sign, and about the way language users gain access to lexical information in speech production and perception. (cf. Lewandowski 1976: 482).

In the psycholinguistic literature, the term is ubiquitous and so basic that it is not always defined explicitly. I will illustrate its reading by a few examples.

Handke, who sets out to analyse and describe the lexicon as the central component of natural-language processing, defines the (mental) lexicon as follows:

> A lexicon ... is the central module of a natural language processing system ... It closely interacts with the other components of the language processor and provides detailed information about the words to be produced or comprehended. (Handke 1995: 50)

The items contained in the lexicon, the lexical entries, he assumes to be specified with regard to phonological/graphological, morphological,

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[3] Other definitions also show this indeterminacy: For the lexicon in Formal Grammar, Sproat summarizes that: "[t]he inventory of words or morphemes of a language is the LEXICON." (Sproat 1989: 335). For a discussion of what is listed in the mental lexicon see Hankamer 1989: 392-408.

syntactic and semantic aspects, which – depending on the mode of language use, viz., production or comprehension – are made available in different ways (cf. Handke 1995: 68).

Schreuder & Flores d'Arcais (1989: 409) describe the "mental lexicon" to stand for

> the store of all our knowledge related to words. We will assume here the current view of the mental lexicon as the important relay station connecting certain specific sensory events or motor (output) patterns with mentally represented knowledge structures.

From the point of view of language production, Levelt defines the mental lexicon as a language user's store of information about the words in his language. As such it contains information about all the lexical items he knows. When a lexical item is retrieved from the mental lexicon (in the productive mode), this is done on the basis of its meaning, but in addition to the meaning, it contains syntactic, morphological, and phonological information (cf Levelt 1989: 6)

Roelofs, basically drawing on Levelt's description, elaborates that a lexical entry's lemma, which does not contain form-related information, is a representation of the meaning and the syntactic properties of a word. In addition, it also contains functional information, i.e., information on the mapping of thematic arguments on syntactic functions. Via the access of an entry's lemma, also morphological and phonological information contained in the "form lexicon" becomes available. (cf. Roelofs 1996: 310)

Another aspect, which is implicitly contained in the meaning information specified in the previous definitions, is made explicit in Kess's definition (1992: 80-81), namely the assumption that also information about the relationships to other lexical entries is available with any entry. Moreover, it also contains hints at possible mechanisms involved in the recognition of items of the lexicon:

> The **mental lexicon** is your mental dictionary, that vast compendium of information about words and their relationships that you carry about in your head (...). Like the dictionary on your bookshelf, it too is organized along principles which reflect the phonological, orthographic, and semantic characteristics that words share. But in searching through the mental lexicon as we attempt to place a word, we note that the process of word recognition is sensitive to other characteristics as well, characteristics like word frequency and the effects of context.

This rather comprehensive understanding of "mental lexicon" will be the basis for further considerations in chapter 3, where the point at issue is how the information contained in the lexicon interacts with our general knowledge of syntax in language use.

2.1.2. Syntax

It is even more difficult to find a theory-neutral definition of syntax than one of the lexicon. Syntax, traditionally determined as the theory of sentence construction, is generally defined along the same lines even now. What has sometimes been added are explications of probable mechanisms involved and criteria effective in it.

Crystal's encyclopedia contains one such very general definition of syntax:

> Syntax is the way in which words are arranged to show relationships of meaning within (and sometimes between) sentences. The term comes from *syntaxis*, the Greek word for 'arrangement'. Most syntactic studies have focused on sentence structure, for this is where the most important grammatical relationships are expressed. (Crystal 1987: 94)

Bußmann (1990: 766) is more explicit about the elements and procedures that play a part in the construction of sentences when she defines one sense of syntax as:

> Teilbereich der Grammatik natürlicher Sprachen (auch: Satzlehre): System von Regeln, die beschreiben, wie aus einem Inventar von Grundelementen (Morphemen, Wörtern, Satzgliedern) durch spezifische syntaktische Mittel (Morphologische Markierung, Wort- und Satzgliedstellung, Intonation u.a.) alle wohlgeformten Sätze einer Sprache abgeleitet werden können...

Abraham (1988: 855) adds the fact that by "syntax" we do not only understand the rules for combining words into phrases and sentences, but also some principles for describing these rules.

In the subsequent sections, he speaks of "autonomous syntax" and "generative syntax", which is indicative of particular linguistic assumptions and thus no longer theory-neutral. However, we know that every attempt to define a more or less theoretical term will necessarily reflect the assumptions made by the model whose beliefs the "definer" shares. That is why I will – just as it is intended for the understanding of "lexicon" – take into consideration the definitions offered by the linguistic models under discussion in chapter 4.

In the psycholinguistic literature, one encounters definitions of "syntax" only very occasionally. In descriptions of syntactic processing, terms such as "parsing", "syntactic analysis", "syntactic frame", "syntactic ambiguity resolution" etc., will be met, but they all presuppose a general understanding of what "syntactic" or "syntax" is. And this seems to be exactly that one which a particular linguist has.

Handke (1995: 5) uses the term syntax to denote the study of sentence structure.

From the point of view of language acquisition, Clark (1995: 318) explains what knowledge of syntactic structures implies, namely the recognition of the systematicity of word combinations, of their contributions to meaning, and of the means by which they are marked, such as the order of constituents, morphological marking, intonation, etc.

I take all these definitions to agree in what is important to our understanding of the term under investigation: Syntax describes the rules by which words combine in a verbal utterance, what their contribution to the utterance meaning is, and the means by which the intended combinations are signalled or expressed.

Whether the knowledge of these rules is separate from the knowledge we have about words and, what is more, whether the former can be considered autonomous is one of the questions that is still under general discussion, and I will take it up occasionally within the course of my argument.

On the basis of these general readings of the terms "syntax" and "lexicon" and of the psycholinguistic readings of "mental lexicon" and "syntax" in particular, I can now set out to collect information on what psycholinguistic findings and generalizations predict with regard to the interaction of lexicon and syntax in language use.

Chapter Three
Theories of language processing

3.1. The lexicon-syntax interface in performance models

Interest in the procedures involved in language processing has been vivid for quite some time: with psychologists investigating – among other things – the relationship between language and cognition, and linguists constructing language models which they claim to be psychologically real.

The intersection of psychological and linguistic research interests resulted in a new interdisciplinary science, that of "psycholinguistics", a field which is mainly concerned with the discovery of the procedures that are involved in language acquisition, language loss, language comprehension and production, and – as Kess (1992: 14) put it – "a field which depends in some crucial way on the theories and intellectual interchange of both psychology AND linguistics".

Thus, both linguistics and psycholinguistics are centrally interested in the phenomenon of human language, but they analyse their common research object from different perspectives and with different aims in mind.

Linguistic models (as they are described below) are meant to describe what human language is like, what elements it consists of, and what the principles are for combining these elements into larger units. In structuralist terms, this is what makes up the language system ("langue"), in generative terms, this aspect of language is referred to by the term "competence", which is to be understood as the native speaker's internal knowledge of his language (the "steady state", cf. also section 4.4).

Psycholinguistic models, on the other hand, aim at describing how this knowledge of one's native language is put to use. The association with such concepts as language use ("parole") or "performance" respectively becomes obvious right here. Moreover, from the psycholinguist's point of view, speech/language use is considered to be

informative regarding the character of cognition in general, it is considered as a window to the nature and structure of the human mind (cf. Scovel 1998: 4).

Most psycholinguistic enterprises try to find out what is going on when language is used in communication, that is, when it is produced, or when it is comprehended. These two main activities involved in language use are commonly summarized under the term of "language processing". Analysing language processing, psycholinguists also consider whether the processes and the representations assumed are compatible with the inventory of elements and principles suggested by the various linguistic theories, they may even start out from the latter to develop their own models, as is done by, e.g., Frazier (1995). Apart from that, they also take a vivid interest in how language is acquired, i.e., how a child finally manages to master the language into the speaker community of which it is born, and what the individual stages in this process are. Last, but not least, there is also considerable interest in language loss, that is, in the phenomena of language decay in an individual due to illness, accident and/or old age.

In my search for cues for the relationship between the lexicon and syntax of a language I will concentrate on what psycholinguists have found out about language use. I will neglect what the findings about their interaction(s) in language acquisition are and what might be concluded from phenomena related to language decay.

As to models of language use, there are some general surveys or overall sketches available, which try to incorporate everything that is possibly involved in the translation of thought into verbal utterance and vice versa. These are complemented by more detailed elaborations of individual facets of the whole process (in the one or the other direction), such as speech perception, especially segmentation and perception of auditory units (cf., e.g., Cutler 1989; Nygaard & Pisoni 1995), lexical access (cf., e.g., Forster 1976, 1989, 1990; Seidenberg 1990; Roelofs 1996), phonological encoding (cf., e.g., Dell & Juliano 1996), or articulation (cf., e.g., Fowler 1995), to name but a few.

As the topics already indicate, these partial processes involved in language processing are analysed and described either for the comprehensive mode or for the productive one. This is due to the fact

that profound differences are assumed and have been recognized to exist between the two.

Apart from that, assumptions about the functioning of language also differ with regard to the question of whether the ability to understand and speak is just one specification of, or can be derived from, general cognitive abilities, or whether language is a particular module of the mind with its own specific structure, representations, and procedures, that is, whether language is self-contained and independent of other parts of the cognitive system (cf. also footnote 4).

All in all that means that there is a rich diversity of models, and I do by no means aim at a comprehensive survey of the state of the art.

However, for a better understanding of how the procedures involved in language processing can be assumed to interact, I think it helpful to present two suggestions about "the language-user framework" and "the architecture of a natural processing system". These were made by Dijkstra & de Smedt (1996) and Handke (1995) respectively, who, on their part, draw also on ideas proposed by Bock, Levelt and Kempen:

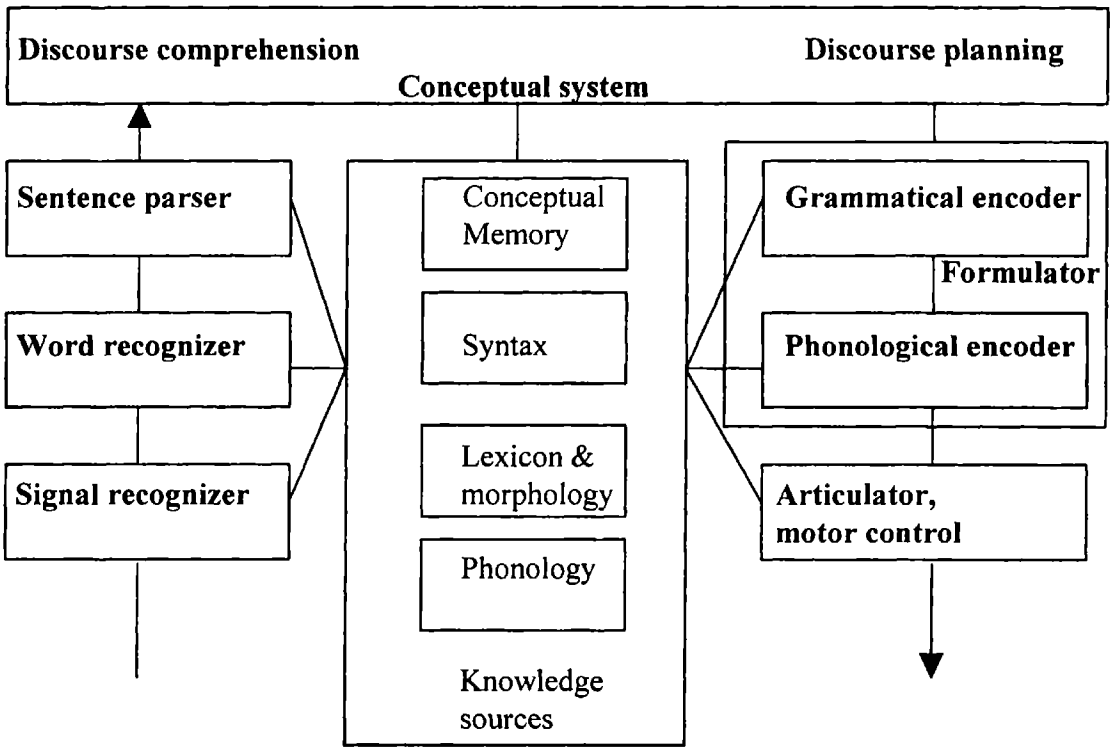

Fig. 1. The language-user framework (source: Dijkstra & de Smedt 1996: 16)

This framework allows for the description of the production as well as of the comprehension of an utterance, with the arrows indicating the directions.

When producing an utterance, the speaker starts out from his intention, i.e., he conceptualizes what he wants to express. In order to grammatically and phonologically encode and articulate his message (cf. the right column), he then draws on his linguistic knowledge and on his knowledge of the world (cf. the middle column). The framework does, however, not spell out the details of the exact procedures involved in the encoding of a message. Thus, for the field of our special interest, the grammatical encoding of a message, it remains undecided in what particular way the speaker uses his "conceptual system", his knowledge about, say, the lexicon, syntax, or phonology. The framework merely specifies that the "encoder" does make use of it.

As for the comprehension of an utterance (cf. the left column), the framework informs us about the general algorithm from signal recognition, via word recognition and sentence parsing to the extraction of the meaning, which commonly corresponds, or rather should do so, to the speaker's intended message. Once again, the details are left unspecified.

The reasons for which this framework is not expressive with regard to these details may be that it would simply be less clear if all the possible connections and interactions between the stipulated elements and procedures had been indicated and, what is more, that there is no general agreement on some of those.

Handke's illustration of the architecture of the natural-language processing system (shown in figure 2 below) contains some more detailed information about how the individually listed parts probably act in combination.

It makes explicit a number of assumptions about the course of the individual processes and procedures involved in producing and comprehending language: The "hollow" arrows indicate the sequence of procedures in language processing, the others – the assumed interactions between parts (elements and procedures) of the system. Moreover, this view of language processing also projects some compartmentalization onto the overall processing mechanism, resulting

in the three segments of "conceptualizing", "linguistic processing" and "low-level processing".

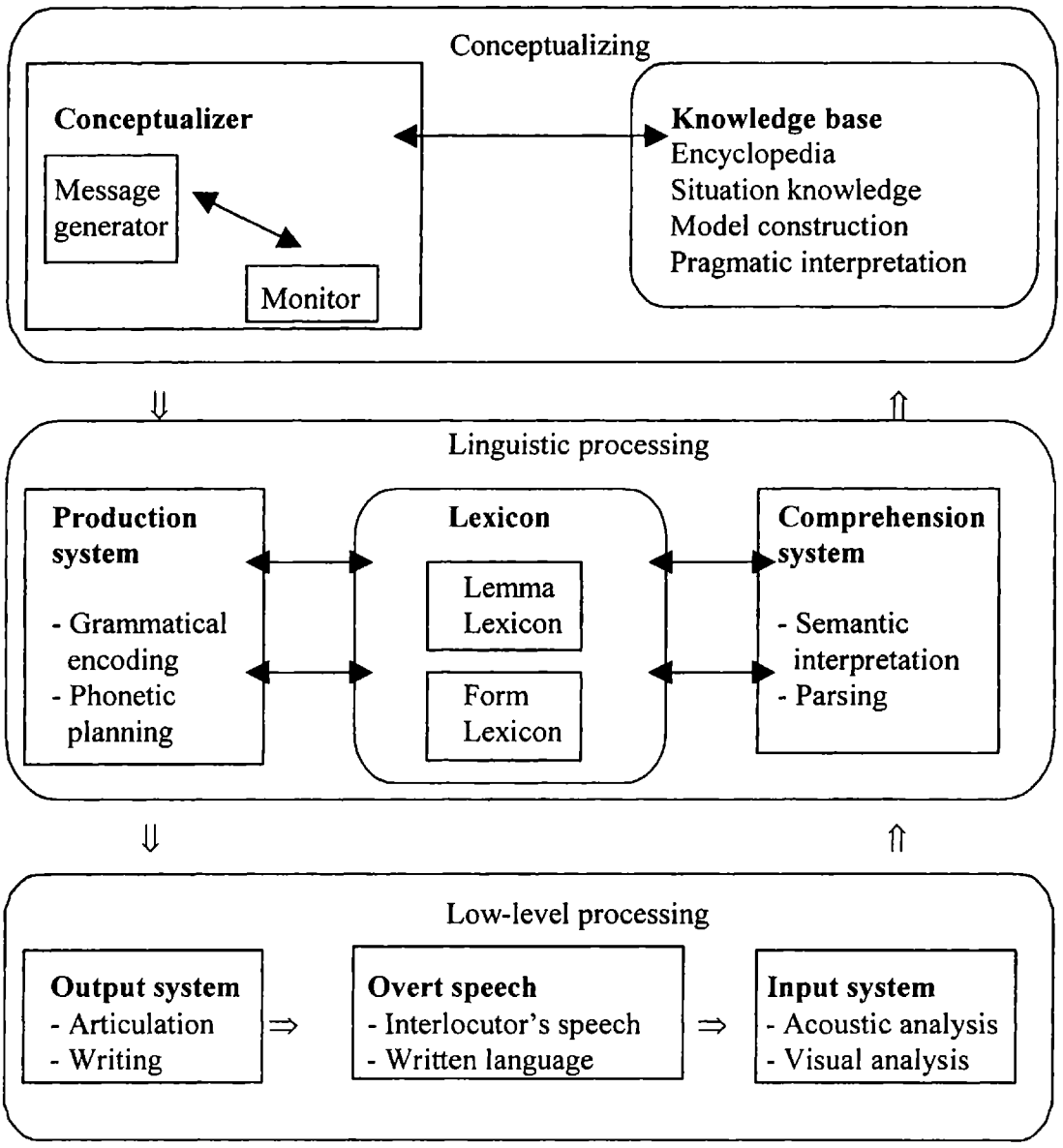

Fig. 2. The architecture of a natural-language processing system (source: Handke 1995: 35)

It also commits itself on a more or less modular view of processing language in that it posits subparts which operate on one particular type of input only, thus also allowing for the flow of information in only one direction, whereas the framework proposed in the first illustration

(Figure 1) deliberately leaves this issue open (cf Dijkstra & de Smedt 1996: 16).

In the following, I will separately consider the mechanisms assumed for language production and comprehension, also touching upon the general question of the modular or non-modular architecture of the respective models.

3.2. Models of language production

3.2.1. An overall survey

Language production has been analysed less comprehensively than language perception, one reason being that it is very complicated to exactly know or find out what a speaker's intended message of an utterance is and to test or influence this experimentally, whereas speech comprehension allows for manipulation of an utterance and for experimentally testing the consequences for the understanding of the message (cf Keller & Leuninger 1993: 208; Dell 1986: 283; Garrett 1980: 177-178; Bock 1995: 206).

Nevertheless, there have been developed quite a number of language production models, all of which are derived from the analysis of performance data, predominantly speech errors of all kinds. They basically fall into two groups: models which consider the production process to be a serial procedure of individual steps (e.g., Fromkin 1971; Garrett 1975, 1980; Cooper 1980; Levelt 1989; Keller & Leuninger 1993; Pechmann 1994), and those considering production to be a procedure of interactive processes (e.g., Dell & Reich 1981; Stemberger 1982, 1985; Dell 1986).

A short survey of the essential features of both kinds of models follows:

Serial models commonly assume three or five levels of processing: The three-level models comprise the levels of:

1. conceptualization, i.e., the combination of thoughts/concepts and intentions into the (preverbal) message to be transferred,

2. formulation, i.e., the grammatical and phonological encoding or the transfer of the message into a lexico-syntactically and morpho-phonologically specified form, which results in a phonetic/articulatory plan,
3. articulation, i.e., the conversion of the latter form into a sound form, which is controlled by the muscles of the speech organs and results in overt speech (cf. Levelt 1989: 9-14).

For the five-level models, the following levels are specified:

1. conceptualization,
2. encoding on a functional level, i.e., the specification of a sentence frame with regard to the semantically relevant constituents (such as the theta-roles/deep cases/transitivity structure (cf. chapter 4)), their word categories, and their grammatical functions.
3. encoding on a positional level, i.e., the specification with regard to the positions of the constituents and their attendant grammatical formatives,
4. encoding on the phonological level, i.e., determination of phonetic details, and
5. articulation (cf., Garrett: 1975: 176, 1988: 78; Keller & Leuninger 1993: 218).

As can easily be seen, the differences merely follow from a more detailed description of what the assumed procedures of "translating" the preverbal message into an articulatory plan are.

Thus, for all the serial models, the first stage of speech production is the conceptual level, at which concepts, ideas/thoughts, intentions are arranged so that they result in a message.

At the next level, the formulation/encoding, the individual models differ: does the message first initiate a syntactic frame (specifying syntactic functions, the predicate-argument-structure) or the selection of lexical items or both at the same time, in other words is the formulation process driven by phrase structure or by the lexical entries needed for the expression of the intended message or by both in cooperation? These distinctions show in how exactly the formulation processes are spelled out, that is, they are directly depicted in the general claims of a five-level model, or they need to be further elaborated for the "formulation" in a three-level model.

Garrett and Keller & Leuninger, for example, postulate a functional level ("prädikative Ebene") at which both the selection of the lemmas of lexical items and the construction of a functional structure is localized, whereas Fromkin and Cooper locate lexical selection/insertion at stage 3, after the specification of syntactic structure at stage 2. At the third level of the former models, which is called the positional level ("positionale Ebene"), the morpho-phonological forms of the lemmas and the positional frame of the sentence to be produced become available.

The final level in the production process is the sound level, where phonetic details are specified and commands are sent to the muscles of the vocal apparatus, which on their part initiate articulation.

For the point in dispute, i.e., the places at which the lexical entries needed and the syntactic structure of the utterance come into play, Cutler (1995:119) reports the situation to be as follows: "It has been argued that syntactic formulation precedes lexical selection (Fromkin 1971), follows it (Bierwisch & Schreuder 1992) or operates in parallel to it (Bock 1982)."

This crystallization of views is also reported by Garman (1990: 414). Allowing for both serial and parallel positions, he specifies:

> ...given that the message level controls both lexical access and syntactic structuring, it could be that either the one is dependent upon the other, or that the two processing hierarchies interact, with lexical decisions affecting syntactic choices, and vice versa.

The assumption of parallel action of processes or that of mutual influence between several processes was not made from the very first days of research into language comprehension and production. On the contrary, most of the serial models considered speech production as a strict top-down process, where there is feed forward only and no feedback to previous levels or stages of the procedure. Models which postulate components that operate in a strictly serial way (that is, in a top-down manner in language production and in a bottom-up manner in language comprehension, where lower level representations are the only input for the construction of higher level representations) and do so independently of one another are known by the terms of "non-interactive" or "autonomy" models (cf. Garnham 1985: 186). An even more important assumption of strictly autonomous models is that – specified here for comprehension models –

> high-level decisions cannot be used to influence the computations that take place at low levels of representation. Thus, the incoming waveform is translated into an acoustic-phonetic representation at the first stage of processing (...) [in language comprehension D.S.]. This representation is used to access the mental lexicon. Lexical information drives processing within a syntactic module. Finally, the output of the syntactic processor is used to begin message-level computations (...) (Lively et al. 1994: 280)

But the further analysis of, and the quest for, the explanation of speech errors, such as alternative and competing plan errors, have led to changes in these conceptions, especially with regard to assumptions about parallelism of processing procedures. These modifications are reflected, for example, in Butterworth's, Garrett's, and Levelt's models: Butterworth (1982: 102-103) assumes parallel operation of the processes of the selection of syntactic structures, intonation contours and lexical items, whose outputs then merge again in what he calls the "phonological assembly system".

Garrett (1988: 90) allows for "some form of parallelism in the processing scheme" as well, specifying this possibility for the level of message representation. The evidence he draws on is the occurrence of competing plan errors, such as *Please turn off the flower*, uttered while looking at a flower pot on top of the TV set with the intention to say *Please turn off the TV* (cf. Garrett 1988: 92).

Levelt (1989: 235) assumes the processes of accessing lemmas and building syntactic structures, which he calls "Grammatical Encoding", to be lexically driven and incremental in their operation, thus basically following Kempen and Hoenkamp's (1987) model of an "Incremental Production (or Procedural) Grammar". This sort of "parallelism of action" allows for the simultaneous operation of all the processes involved in the formulation of an utterance, with the proviso that they "manipulate" different parts of it.

The assumption of parallel or incremental operations in the production of speech in the above-mentioned models does, however, not deviate from the "modularity hypothesis"[4], which claims cognitive

[4] The "modularity hypothesis" follows from a modular conception of the mind, where the mind is conceived of as a complex system of subcomponents or modules with specific tasks and abilities, which work on particular input. This conception is closely associated with Fodor (1983) and is broadly discussed in Garfield (1987: 1), who summarizes the essential claims of the so-called modularity hypothesis: "The mind is

(thus also linguistic) processing to be divided among autonomous subsystems[5] (cf. Tanenhaus, Dell & Carlson 1987: 83). The subcomponents involved in language processing are assumed to be "blind to each other's internal states and operations and ... [to] communicate only at their input and output stages." (Tanenhaus, Dell & Carlson 1987: 84)

This assumed blindness or encapsulation of information in the distinct linguistic subcomponents, such as syntax, semantics, lexicon,

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not a seamless, unitary whole whose functions merge continuously into one another; rather, it comprises – perhaps in addition to some relative seamless, general-purpose structures – a number of distinct, specialized, structurally idiosyncratic modules that communicate with other cognitive structures in only very limited ways. According to this hypothesis, these modules include, roughly, input systems (including certain components of the perceptual systems and of the language-understanding system) and certain components of the output systems (including processes involved in motor control and language production). The hypothesis contrasts these modules with the presumably nonmodular structure of, for example, long-term memory, or the cognitive structures underlying general knowledge." Fanselow & Felix (1987: 173) formulate: "Die Modularitätsthese besagt, daß das menschliche Kognitionssystem modular aufgebaut, d.h. aus einer (finiten) Anzahl von eigenständigen und unabhängigen Subsystemen (=Module) besteht. Jedes dieser Module hat seine spezifische Struktur und seinen spezifischen Aufgabenbereich." Hence, language is considered as a particular module of the mind and it is claimed to be modular in itself.

[5] It becomes obvious here, that the autonomy hypothesis is an ally of the modularity hypothesis. The former implies claims as to both the overall architecture of the mind and the language module in particular. It is generally assumed that the modules involved in cognition are independent of one another, or rather autonomous. This means: "... die interne Struktur eines Moduls ist nicht auf die interne Struktur irgendeines anderen Moduls reduzierbar. Ebensowenig gibt es ein „Supermodul", aus dessen Prinzipien wiederum die internen Strukturen der einzelnen Module ableitbar sind. Kognitive Leistungen entstehen in der Regel aus der Interaktion zwischen verschiedenen Modulen, wobei diese Interaktion jedoch nicht die interne Struktur der Module verändert oder beeinflußt. Mit anderen Worten, Interaktion vollzieht sich auf der Ebene des Input/Output der verschiedenen Module, nicht jedoch auf der Ebene der modularinternen Verarbeitung (...)." (Fanselow & Felix 1987: 173)
As for the language module in particular, it is one such module. Consequently, linguistic structures are understood as "autonomous from more general conceptual structures with the language faculty being its own special mental organ or module." (Gibbs 1995: 31) It is, above all, two of its subcomponents which have been found to be autonomous, namely syntax and phonology. As postulated by Fanselow & Felix (1987: 67), these components show regularities that cannot be detected in other knowledge systems and hence cannot be attributed to general cognitive abilities.

amounts to the claim that the processes in one component do their processing without drawing on information being processed in the other components.

The acceptance of parallelism and mutual influence of processes in linguistic processing can, however, be made compatible with the modular conception of the mind in that one postulates informational encapsulation for the language module as a whole and makes no claims about the processing conditions within this module (cf. also Marslen-Wilson & Tyler 1987: 41).

Another way is to postulate an "editing device" outside the production system (editing theories) or internal to the system (connectionist theories), which checks the output of one component against that of (higher-level) components that did their work prior to it (cf. Levelt 1989: 498). These checks may probably lead to an overruling or even revision of the original output of these higher-level components (in language production), thus also providing for feedback, or bottom-up effects.

The contraposition to the modular conception of the mind is taken by the proponents of a holistic view of the mind (cf. section 4.4). The latter allows for massively parallel and interactive cognitive processes, which, with regard to language, means that the language processor can be understood "s a highly interactive system in which different sources of knowledge communicate freely." (Tanenhaus, Dell & Carlson 1987: 84).

This conception has led to the development of models of language processing, i.e., both comprehension and production, which are based on interactive accounts, that is, they assume a high degree of parallelism and interaction. Models of this type are the so-called interactive, connectionist, or spreading activation models. Because of their similarity to the neural networks in the brain they are also known by the term "neural networks".

The basic elements or primitives of such models are thought to be units or nodes representing some sort of linguistic notion, such as sound features, sounds, words, etc., and links or connections between them. The nodes form levels and there are activation values associated with them, which result from the input and from the activation of other nodes they are connected to. The connections represent paths via which

activation can spread from one unit to all the other units it is linked to. They are either excitatory or inhibitory, depending on what nodes they link: the connections between incompatible nodes (which are predominantly those between the nodes of one level) are inhibitory, those between mutually consistent nodes (of different levels) – excitatory.

The flow of activation is assumed to spread in either a parallel or an interactive way. The former assumption results in models in which the activation of simultaneously activated units or nodes spreads unidirectionally to the linked nodes until one node (the most plausible one) exceeds the threshold level, fires, inhibiting the competing nodes, and is thus chosen for the representation under construction. The exemplification of a procedure like this can be found in Morton's "logogen model" (1969) of word recognition. The latter assumption is incorporated into models in which activation spreads multidirectionally, so that all the nodes simultaneously activated pass on their activation to both lower and higher levels, that is, forwards and backwards. Activations between different levels exert a facilitatory effect, activations within one level – an inhibitory one, and finally the most plausible node, the best match, will be the one with the strongest activation, because this one was activated strongly enough to inhibit the competing nodes and drive their activations down. Forster explains the differences between the two procedures metaphorically as "first past the post" and "survival of the fittest" (Forster, personal communication). For concise surveys of the mechanisms assumed to apply here see, e.g., McClelland & Rumelhart 1981: 378-379; Stemberger 1985: 145-147 Forster 1994: 1307; Handke 1995: 44-45; Murre & Goebel 1996: 50-51.

Examples of models based on interactive activation are Stemberger's "interactive activation model of language production" (1985), or Dell's "spreading-activation theory of retrieval in sentence production" (1986).

For the production process in general they postulate

> a network of linguistic rules and units in which decisions about what unit or rule to choose are based on the activation levels of the nodes representing those rules or units (...). (Dell 1986: 283).

That means that language processing, here language production, is no longer considered to operate serially, where the output of a higher level

operation becomes the input of the next lower level operation with no feedback.

> Rather it is a cascading system; information is passed on to higher or lower levels as soon as it becomes available. All subunits of a higher unit are partially activated at he same time, so that they coexist during production. Different levels are interactive, so that they can mutually influence each other. (Stemberger 1982: 54)

The two models mentioned are indebted to McClelland & Rumelhart's "interactive activation model of context effects in letter perception" (1981), who developed their model to account for the interaction between knowledge and perception in visual and auditory word recognition. Since this model can be considered the classical forerunner of all the interactive models, I think it helpful to summarize here some of its basic tenets, especially those which might prove influential regarding our key question, the relationship between syntax and the lexicon. These are (specified for word recognition):

1. the assumption of levels within the processing system,
2. the assumption of parallel processing, namely the parallel processing of more than one unit at a time (called "spatially parallel") and parallel processing at several levels, and
3. the assumption of perception as an interactive process (cf.McClelland & Rumelhart 1981: 377).

Although these assumptions are specified for word perception, they, nevertheless, are and have been attributed to production procedures as well.

The third assumption seems to us the most important one, since it represents the one which most distinctly differentiates interactive from serial conceptions of (linguistic) processing:

> ... we assume that "op-down" or "conceptually driven" processing works simultaneously and in conjunction with "bottom-up" or "data driven" processing to provide a sort of multiplicity of constraints that jointly determine what we perceive. (McClelland & Rumelhart 1981: 378).

A particular variant of interactive models is represented by parallel distributed processing (or PDP) models. In such a model, linguistic notions of various complexity are represented as patterns of a number of activated nodes. That means that there is no direct correspondence between a linguistic unit (e.g., letter, phoneme, or word) and a particular node, as is assumed for the localist representations in the interactive activation models mentioned above, but that the unit's

representation consists of an activation pattern or rather is distributed over several nodes, hence the name "parallel distributed processing" (PDP).

Moreover, such models are capable of learning by being trained on input-output patterns in that – on the basis of the output errors – the weights of the involved connections are adjusted so that input presentations finally produce the "correct" output.

The majority of PDP-models designed have been implemented not for the total process of language processing, but for partial procedures only, one reason being that simulations of this kind would need very extensive nets of nodes which can, if at all, only be modelled by extremely powerful computers.

Well-known examples of simulating linguistic processing by PDP-models are Seidenberg & McClelland's "model of word recognition and naming" (1989) or Dell, Juliano & Govindjee's "model of phonological encoding" (1993). Though the first models comprehension phenomena and the latter those of production, they do not differ that much: the mappings implemented are from letters to sounds and from lemmas to sounds respectively. So for illustrating the mechanism, either one will do.

We will draw on Seidenberg & McClelland's model, where orthographic representations are to be transformed into phonological ones. This is realized via the interaction among the units that are part of the distributed activation patterns. The units of the two types of representation are not directly connected, but an additional layer of hidden units is included, in order to enlarge the processing capacities of the network. The mapping process itself can be described as follows:

> In processing an input, units interact until the network as a whole settles into a stable pattern of activity - termed an *attractor* - corresponding to its interpretation of the input. Unit interactions are governed by weighted connections between them, which collectively encode the system's knowledge about how the different types of information are related. Weights that give rise to the appropriate transformations are learned on the basis of the system's exposure to written words, spoken words and their meanings. (Plaut 1997: 767-768)

At the initial state, the model has no weighted connections yet, that is, it does not know about the relations between letters and sounds. As a consequence of being repeatedly exposed to the orthographic