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## The acquisition of interlanguage morphology

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## Chapter 2

# Morphology and the lexicon

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### 2.1 Introduction

It is a universally accepted fact that the lexicon is the most essential element in language processing. Without knowledge of words, no language can be understood. If the words in the language are examined more closely, many words appear to have an internal structure. It is this internal structure, the morphology of words that is the main issue in this and the following chapters. Morphology can be seen as an important component of the lexicon, and morphological information about words is essentially lexical information. This chapter will elaborate on the role morphology plays in the comprehension and production of words.

All speakers of a language have the capacity to analyse words into their components. This capacity is evident from the observation that people can perfectly understand morphologically complex words that they have never seen before. Consider the word *unmumbleable*. If native speakers of English were to come across this word, they would definitely be able to attribute meaning to it, although this is not an “existing” word in English. To deduce the meaning of the word *unmumbleable*, the reader or listener must first decompose the word into its morphological constituents to arrive at its root, *mumble*. The meaning of the entire word can be interpreted on the basis of the meaning of the root together with the meaning of the prefix *un-* and de suffix *-able*. From these three elements the reader or listener will be able to interpret this word as an adjective with the meaning “that cannot be mumbled”. The reader or listener will even be aware of the inherited subcategorisation properties of the verbal root, and expect this adjective to take an external argument as its complement (for instance a word with many open vowels, which may be difficult to *mumble*). Apparently, (native) readers or listeners are able to deduce syntactic, semantic/pragmatic properties of words purely because of morphological analysis. All this seems very clear. At the same time, many questions can still be raised about morphology and the lexicon. What, for instance, will happen if the native speaker comes across a morphologically complex word that is not possible or questionable, like *\*bookity* or *?sleepable*? And if decomposition of affixes is assumed, where do we stop decomposing? For instance, why, in the example above, don’t we continue stripping off affixes until we arrive at *mum* as the root of *unmumbleable*? After all, *mum* is an existing English word; it does occur in the speaker’s lexicon. Do we also apply morphological knowledge in producing morphologically complex words, and, if so, what stops us from forming words like *\*arrivation* for *arrival*? What are the conditions that should be met before a newly formed word is stored in the lexicon?

Two strategies can be distinguished for the processing of morphologically complex words. We can either assume that all words are stored in a "mental lexicon" regardless of their morphological complexity, or that only roots are stored. The latter strategy would involve the application of devices to analyse or generate words during speech or comprehension. Arguments have been presented in favour and against both approaches. An argument that is frequently used in favour of storing only the roots in the mental lexicon is that it would not seem to be economical to store all words of a language separately, since this would involve storing a great deal of redundant information. For example, storage of the root *cat*, together with a general rule of plural formation would be more economical than storing both *cat* and *cats*. If efficiency of lexical storage is indeed a decisive factor, an approach that tries to minimise the number of entries in the lexicon is to be preferred. There is some evidence that one should be economical with the mental storage available. For purely agglutinative languages (like Turkish), as was argued in the previous chapter, Hankamer (1989) has argued that full storage of all words would require more storage capacity of the brain than people have at their disposal. On the other hand, there are two familiar arguments against root storage and in favour of a full-listing approach. These arguments point to the extreme complexity of storage and processing that has to be assumed in the case of root storage. Firstly, the combination of root storage and a system of morphological rules is less attractive for affixed words which have a bound root (*prefer*) or those which are highly complex (*un-re-mit-ting-ly*), as this would logically require the storage of bound roots like *fer* and *mit*. Storage of bound roots is usually rejected for reasons of psychological reality. Secondly, morphological decomposition complicates mechanisms for perceiving and producing morphologically complex words. For the comprehension of complex words it would require a complex perceptual system to distinguish between real derivatives (*un-true*) and pseudo-derived words (*uncle*). For the production of a complex word (e.g. *drawing*) it is not only necessary to know the rules to refer to the correct syntactic category and sub-category ( $V_{\text{trans}} + \text{ing} = N$ ), but also the correct corresponding semantic relation ( $N_{\text{ing}} = \text{the result of } V$ ). Moreover, a number of spelling rules, phonological rules and sometimes even prosodic rules must be applied. This is even more complicated by anomalies in morphology: in English one morpheme can have several orthographic representations (*un-*, *in-*, *ab-*, etc. for negation) and one orthographic representation may represent more than one morpheme (the suffix *-s* can be plural, third person singular and possessive). Apart from the question whether such a notion of efficiency is at all psychologically real, it cannot account for a large number of irregularities and idiosyncrasies in the lexicon.

In the past few decades numerous studies of the language user's production and reception of morphology have been conducted, from two points of view. First, by linguists, who, starting from Chomsky's *Remarks on Nominalizations* (1970) and following Halle (1973), Jackendoff (1975) and Aronoff (1976), have produced a variety of theories and models of morphological (ir)regularities in the lexicon. Second, by psychologists who have investigated the language user's "mental lexicon". In the wake of Taft & Forster (1975), the theories of these researchers are mostly based on experimental studies of lexical access to morphologically complex words. Current

models of morphological processing show that the situation proves to be more complex than a simple choice between the two strategies exemplified above. Most linguists as well as psychologists will now agree that instead of a choice between listing and active rule-based word formation both strategies are likely to interact in a complete model of producing and processing morphologically complex words.

The aim of this chapter is twofold. Firstly, to evaluate some representative models of morphology. Secondly, to select a suitable model of morphological processing that can be adopted as the basis for a model of morphological processing by second language learners. I will review a variety of linguistic theories and psycholinguistic models determining the role of morphology in the lexicon. After this review of the prevailing theories and concepts, some of the most relevant and controversial issues will be elaborated on. Based on this discussion, a set of requirements will be established that the preferred model should comply with. These requirements will lead to the selection of one particular model, for which some alterations and extensions will be proposed.

## 2.2 Terminological conventions

To avoid confusion about the terminology used, I will briefly touch upon some terms for which no firm conventions have yet been established, and make explicit which choices have been made for the current work.

A first source of confusion is the use of the terms *base*, *stem* and *root*; all referring to the part of the word that remains after affixes have been removed. Following Matthews (1974), Lyons (1977) and Bauer (1983), the following distinction will be made when relevant: the term *root* will be used for any form that cannot be further analysed morphologically, either in terms of inflection or in terms of derivation. The *base* of a word is that part of a word to which affixes can be added. The term *base* refers to a more general concept than *root*: a base can be a root, but also any (derivationally complex) form to which (other) affixes can be added. Bauer (1983) makes the additional distinction between *root* and *stem*, where *root* is used to refer to derivation and *stem* to refer to inflection. However, as a principled distinction between inflection and derivation is difficult to make (see 2.5.5), I will not distinguish between *stem* and *root* and use the latter term to refer to any form from which inflectional or derivational affixes have been stripped.

### 2.2.1 Morphemes and words

A recurring issue in discussions about morphological theories is the definition of morphemes and word. Obviously, these definitions are essential to any theory of morphology, as they constitute the primitives of the theory. Halle (1973), for instance, uses a definition of morphemes that allows him to analyse words like *brother* as consisting of two morphemes, *bro-* and *-ther*, in which the latter is seen as the affix attaching to the root *bro-* and to similar roots like *fa-* and *mo-*. Not everyone will agree with this definition, not in the least because it seems very counter-intuitive and artificial, as it will be hard to attribute semantic content to these morphemes.

Traditionally, a morpheme has been defined as the smallest, indivisible unit of meaning. Moreover, it was generally assumed that there is a strict one-to-one relation between form and function: one morpheme should essentially have one function and meaning. But, although it may be more appealing than Halle's definition, this definition is not flawless either. It is, for instance, not always possible to attribute meaning to a morpheme. This is exemplified by English words like *cranberry*: in this word, two morphemes can be distinguished (*cran* and *berry*). The second morpheme clearly carries meaning (classifying it as a type of *berry* and contrasting it with, for instance, *strawberry* and *blackberry*), but the grammatical function and meaning of the first morpheme are not clear. The same holds true for the meaning of *-fer* in words like *prefer*, *infer*, *confer*, *transfer* and *refer*: although the meaning of the first element may be obvious, it will be hard to identify a consistent meaning for the second. The solution to this problem will have to be sought in the definition of morpheme. Instead of defining morphemes in terms of meaning or function, it could be defined as relating to distribution. Recently, Katamba (1993) suggested the following definition:

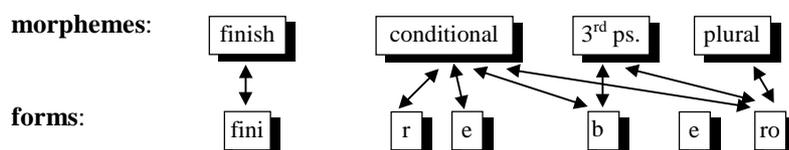
The morpheme is the smallest difference in the shape of a word that correlates with the smallest difference in word or sentence meaning or in grammatical structure.  
Katamba (1993: 24)

This definition may solve the "cranberry problem", but the result is that Katamba's concept of morphemes is very similar to Halle's and will allow morphemes like *bro-* and *-ther*. What is obviously lacking in this definition is some way of referring to the productivity of affixes to form words. This point will be addressed in 2.4 and in 2.5.1.

Another problem that remains is the assumed one-to-one correspondence between meaning and form. This assumption is a result of using English as a source language for morphological theory. The morphology of English, and other agglutinative languages for that matter, is very limited and problems arise when these theories are generalised to non-agglutinative languages. The lack of a one-to-one correspondence between meaning and form is illustrated by cases where several morphemes are realised by a single portmanteau morph<sup>3</sup> or where a single morpheme is realised by several morphs. In all these cases, a complex relation exists between morphemes and forms. An example of a word that contains both one-to-many and many-to-one relationships is the following analysis of the Latin word *finerebbero* based on Matthews (1970: 108):

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<sup>3</sup> A morph is defined as the physical realisation of a morpheme ("it is a recurrent distinctive sound (phoneme) or a sequence of sounds (phonemes). (Katamba:1993: 24). The lack of a one-to-one correspondence between meaning and form can thus also be defined as the lack of a one-to-one relation between morpheme and morph.



This example also illustrates the necessity of assuming additional “empty morphs”: no obvious function or meaning is attributed to the second *e*-formative. Whether or not meaning and form should be separated has been subject to intense debate and forms a source of disagreement among morphologists. This issue is elaborated on in section 2.5.2 below.

Another notion that seems obvious, but that is actually very difficult to define, is the nature of the *word*. As all theories of morphology and the lexicon are inherently dealing with words, the definition of a word is quite relevant for the current discussion. Generally, most people will agree about what is a word and what is not. Even speakers of languages that do not exist in writing are able to identify words in a sentence (Sapir, 1921: 34). This would suggest that words can be defined syntactically as the smallest unit that can exist on its own, or “minimal free form” (Spencer, 1991: 43). But this will not hold for all words. Speakers of English, for example, may argue whether *all right* should be considered as one word or as two. Most of the borderline cases can be found among compounds; especially phrasal compounds, like *sister-in-law*, *lady-in-waiting*, *pain-in-the-stomach gesture*<sup>4</sup> are examples of phrases that may also be seen as words. Syntactic criteria for words are even harder to determine when languages other than English are taken into account. In Turkish, for instance, affixes can be added to words to create meanings for which English would need a phrase or a sentence: *ev-ler-in-de* means “in their house” (Lyons, 1968:130) and *çalış-tır-il-ma-malıy-mış* means “they say that he ought not to be made to work” (Spencer, 1991: 189). These examples show that syntactic criteria of wordhood, regarding the word as the minimal free form, are not reliable.

Semantic criteria for words are also hard to define, for two reasons. First, because words are usually not semantically transparent. If words are supposed to constitute a unit of semantic content, idiomatic expressions like *pass away* will have to be considered as one word, rather than as a phrase. If this is accepted, one is faced with longer and syntactically more complex expressions like *kick the bucket*, which do have a lexicalised meaning. This view, however, will run counter to all accepted linguistic analyses. Second, because of the existence of “bracketing paradoxes”, like *transformational grammarian*. If this is seen as a phrase consisting of two words [[transformational] [grammarian]], this leads to an (in most cases) incorrect semantic interpretation: “a grammarian that is transformational”. If, on the other hand, the semantically correct bracketing is presumed ([[transformational grammar]ian], the phrase *transformational grammar* will have to be regarded as a word, which, again, is not in line with the conventional concept of words.

<sup>4</sup> These examples are mentioned in Bauer (1983:207).

As yet, morphological theory has not solved the problem of wordhood. Attempts have been made to disambiguate the concept “word” by introducing terminology that is supposed to be less confusing. The term “word” is mostly used to refer to “word forms”, which are seen as realisations of more or less abstract underlying forms, called “lexemes” (normally printed in capitals). The lexeme GIRL, for instance, is realised by “girl” and “girls” as its word forms. With regard to the traditional distinction between inflection and derivation (see 2.5.5), inflectional paradigms are seen as word forms of the same lexeme, while derivation creates new lexemes. When referring to the items listed in the lexicon, usually the term “lexical items” is used (though Di Sciullo & Williams (1987) prefer the term “listemes”), but when the lexical item is meant including the (subcategorisation) information it includes, normally the term “lexical entry” is utilised. In psycholinguistically oriented theories, moreover, the term “lemma” is sometimes used to refer to the abstract representation of words (e.g. Levelt, 1989). Whether the continuous introduction of disambiguating terminology really contributes to more clarity is doubtful, but the variety of terms is evidence of the general tendency to avoid the term “word”. This is not surprising in view of the discussion above, but the conceptual problems of, for instance, compounds and bracketing paradoxes have not been solved by the introduction of new terms.

Further terminological variability is found for *compounds*. In the literature, the term *compound* is variably used to refer to any word that is morphologically complex (Butterworth, 1983) or to “a lexeme containing two or more potential stems that has not subsequently been subjected to a derivational process” (Bauer, 1983: 29). I will use this term in the latter sense only, referring to combinations of at least two roots (usually free morphemes), as in *lead-free*, *ready-made*, *language laboratory*; but not *player*, *remorseful*, *unbelievable*). For the other words, I will use the more neutral term “morphologically complex word”.

Finally, there is some confusion in the use of the terms “non-words” and “pseudo-words”. If a distinction is made, pseudo-words are words that do not exist as such, but are not phonologically illegal either (like *\*debrile* in English), while non-words are words that are not “possible” (a word like *\*rlopm* in English). A further distinction is sometimes made between “possible” and “existing” words (e.g. by Meijs, 1981a), where “possible” words are referred to as words that may not readily exist but can be formed by applying productive morphology, leading to transparent new forms (e.g. *uncaressable* in English).

### 2.3 Theories of morphology and the lexicon

In this section some of the most influential linguistic theories of morphology will be discussed, as these theories have shaped all subsequent thinking about morphology and the lexicon, and also form the basis of many psycholinguistic theories that were later developed. Although the model presented later in this study can be categorised as a psycholinguistic model, it shows traces of linguistic theory that cannot be properly discussed without any elaboration of its origins. First, a brief historical overview of the ideas about morphology and the lexicon is given, starting with

Bloomfield (1933), and gradually working through history to more modern linguistic approaches dealing with this issue (for instance Lieber, 1981). Then some issues are discussed that are relevant to many basic assumptions about morphology and the lexicon, the form and function word formation rules and the common ground of morphology, phonology and syntax. It should be noted that the purpose of this discussion is not to give a full and balanced account of all major linguistic theories (see Spencer, 1991), but to provide a framework for models presented later in this study.

### **2.3.1 A historical perspective**

In the tradition of American structuralist linguistics, the lexicon was seen as only containing completely idiosyncratic information. Bloomfield (1933: 274) called it “an appendix of the grammar, a list of basic irregularities”. He assumed that all words that can regularly be analysed on the basis of phonology or syntax are not listed in the lexicon. The basic unit of analysis in these theories is the morpheme. Morphemes were assumed to have an underlying form to which arrangement—in the Item-and-arrangement (IA) approach—or a process—in the item-and-process (IP) theory—applied to create derived forms. One problem of such approaches is their limited applicability. First, because the aim of these theories was to account for an analysis of the internal structure of words rather than to develop a general theoretical framework to account for productive language use. Secondly, because the analyses are limited to agglutinative languages by assuming a strict one-to-one relation between morpheme and meaning.

One of the earliest generative linguistic theories, the Standard Theory (Chomsky, 1965), did not accommodate morphology as such. In this theory most aspects of morphology (inflection, derivation, compounding) were accounted for by syntactic transformations; the role of the lexicon was limited to providing the items for (syntactic) lexical insertion transformations. Also, allomorphic variation was not regarded as the result of independent morphological operations, but as the result of the operation of phonological rules. Early lexicalist theories of morphology, starting with Chomsky’s “Remarks on nominalization” (Chomsky, 1970), abandon the idea that all regular morphology is to be accounted for by phonology and syntax and emphasise the need for a separate theory of (derivational) morphology.

An influential article on morphology and the lexicon was Halle’s “Prolegomena to a theory of word formation” (Halle, 1973). This paper initiated the discussion of many aspects of morphology. It raised questions that have been answered in many different ways, both within and outside linguistic theory. For some of these questions no satisfactory answer has yet been found, with regard to the nature of the entities listed in the lexicon, the internal structure of words (and the order in which morphemes appear in words), and the idiosyncratic features of individual words. Many aspects of the model that Halle proposed in this article are reflected in later models of morphology and the lexicon. Therefore, Halle’s model will be briefly outlined here.

Halle’s model (see Figure 1) is morpheme-based: its starting point is that the lexicon contains a list of morphemes that form the input of Word Formation Rules

(WFRs) to create words. As these WFRs can in principle generate any legitimate combination of roots and affixes<sup>5</sup>, they also create words that do not actually occur in the language, like *\*arrivation*, *\*retribute*, *?halation* and *\*fiss*. To account for these “lexical gaps”, Halle postulates a filter that contains all exceptions to possible outcomes of the WFRs. The filtered output of the WFRs enters the Dictionary, which is a list of all actually occurring words that includes information necessary for the correct application of lexical insertion transformation of all words. After the application of lexical insertion transformations, the surface form of the word appears. To account for the fact that affixes can not only be added to morphemes, but also to morphologically complex words (for instance to derive *readability* from *readable*), Halle postulates a loop from the dictionary to the word formation rules. As all phonological rules apply after syntactic rules in the overall generative theory this model is part of, the loop has to run through the phonological component to enable phonologically defined constraints on surface forms.

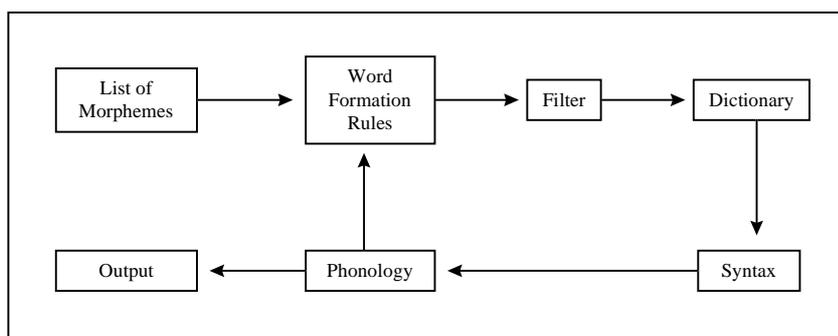


Figure 1. Halle's (1973) model

Halle's model has widely been criticised. Especially the idea of a powerful filter has generally been rejected, as this leads to the postulation of what Carstairs-McCarthy (1992:25) called an “anti-dictionary”, which is not only rather counter-intuitive, but also seems an unnecessary duplication. After all, the dictionary and the filter are largely complementary. But the merit of Halle's model is that it is one of the first attempts to make explicit what the most pertinent problems are resulting from postulating an independent position of morphology in the lexicon. Many issues raised in Halle's article have been addressed by later theories of morphology and the lexicon, both within linguistic theory and in psycholinguistic and computational approaches, and for many of the problems mentioned no adequate or universally accepted solution has yet been found. The very basis of this model, the list of morphemes has been questioned by many linguists, particularly those taking a list of words as a starting point (e.g. Aronoff, 1976). This fundamental question is still current in morphological theory. A similar discussion has taken place among different groups of

<sup>5</sup> The legitimacy of Halle's words is determined by morphosyntactic features with which root morphemes are marked.

psychologists, taking either the morpheme or the word as the starting point of their models of access to the mental lexicon. Another issue of interest is the exact nature and function of the word formation rules, which is discussed in section 2.3.2 below. Also, the problem of lexical gaps, or the (over-)productivity of morphological rules, for which many different solutions have been suggested is further discussed in that section.

Two more “classical” models have been very influential, the model of Aronoff (1976) and that of Jackendoff (1975). These two models have in common that they take the word, and not the morpheme as the basic unit of their theory. The difference between these models is that Jackendoff’s model can be categorised as a “full-listing” model, and that Aronoff’s cannot.

Jackendoff posits a model in which all possible words in the language, both morphologically simple and complex, are listed in the lexicon. To account for the redundant information that the lexicon would contain (e.g. both *cat* and *cats* will be in the lexicon) he postulates “redundancy rules” that constitute links between the constituents of morphologically complex lexical entries. By separating morphological and semantic redundancy rules, form-based relations can be distinguished from semantic overlap. The advantage of Jackendoff’s model is that the meaning of separate morphemes can be represented without having to be listed in the lexicon, and without having to be derived by means of word formation rules. The occurrence of links between words with identical patterns (*untrue* - *true*, *unhappy* - *happy*) will reduce the cost of referring to other words with the same pattern (*unsound*). Traces of Jackendoff’s early model can still be found in current theories of the lexicon. The idea of lexical connections, for example, is reflected in the work of Bybee (1985, 1995) and the notion of the cost of referring to a redundancy rule provides a challenging explanation for different degrees of productivity (see 2.5.1).

Aronoff’s (1976) model, which unlike Halle’s is restricted to derivational morphology, takes the word as its starting point. Affixes are attached to words by productive word formation rules, and all morphologically complex words that cannot be regularly formed on the basis of productive word formation rules are assumed to be listed in the lexicon. However, the lexicon does not contain any words that can productively be formed by applying WFRs. Aronoff’s model is centred around the application of productive word formation rules, which are similar but not identical to Halle’s. The different notions of WFRs and their criticism are discussed in 2.3.2. Also, Aronoff’s ideas are reflected both in later morphological theory and in psycholinguistic models of language processing. Spencer even claims that: “The model of word formation proposed by Aronoff (1976) marks a watershed in the development of morphological theory within generative grammar. A good deal of work done subsequently is an extension of, or reaction to, Aronoff’s theory” (Spencer, 1991: 82).

Thus far, some models have been described that deal with the overall picture of the lexicon. Another relevant point that was raised by Halle (1973) is how the internal constituent structure of morphologically complex words should be determined. If a morphologically complex word is represented by a tree, how can the branching of that tree be accounted for? This problem can be illustrated by the example of *revitalisation*:

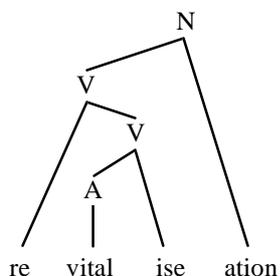


Figure 2. Example of bracketing problems for the word "revitalisation".

The bracketing in Figure 2 is one of several possible ways of bracketing. The “correct” way of labelling trees depends on the theory one adheres to. One solution is to shift this problem to the level of word formation rules. The word formation rules can be formulated in such a fashion that, for instance, the prefix *re-* cannot attach to adjectives to avoid  $[_N[_V[_{re}[_A[vital]]]ise]ation]$ . The internal constituent structure of words can thus be accounted for by a series of word formation rules, each operating on the output of the previous. But many other interesting ideas have been developed with regard to this issue.

One of these is the idea of “level ordering”. This idea originates from theories of traditional generative grammar (the SPE model), where the order of application of transformational rules is essential. For the same reason that Halle’s model needs a loop through phonology (phonological rules apply after the application of syntactic transformations), Siegel (1979) divides affixes into different classes (Class I and Class II). She hypothesises that Class I affixes apply before stress rules and Class II affixes apply after stress rules (the “Level Ordering Hypothesis”). Class II affixes are stress-neutral (among others #ness, #less, #hood, #ise, #ful), but Class I affixes are not (among others +ity, +y, +al, +ate, +ion, +ous). Therefore, Class II affixes will always be external to Class I affixes. Moreover, Class I affixes may attach to bound roots (*callus*), but Class II affix only attach to words (*wordhood*). The idea of level ordering turned out not to be satisfactory. Class II affixes do, for instance, apply before Class I affixes in words like *organisation*; also in the example in Figure 2 the Class I affix *-ation* is outside Class II affix *-ise*. Yet, the idea of differential behaviour for different types of affix has been proposed in many other studies.

Another intriguing idea to account for the internal constituent structure of words is suggested by Lieber (1981). Lieber posits a morpheme-based lexicon that contains (bound and free) roots and affixes. At the very basis of Lieber’s model are subcategorisation frames of all affixes listed in the lexicon. These subcategorisation frames state which syntactic (sub-)categories an affix may attach to. The subcategorisation frame of *-ation* will look something like:

(1) ation:  $\{ \{ [V], [N] \} \text{ _____} \} [N, +\text{abstract}]$

An affix can only be inserted if its subcategorisation restriction is met. For the actual insertion of the morphemes, Lieber postulates three steps. First, she proposes unla-

belled binary branching trees that can be applied to account for the internal structure of any word, resulting in two possibilities for words consisting of three morphemes: left and right branching trees. The subcategorisation frame of the affix determines which of the two possible trees is used. After the insertion of the morphemes, the next stage is that the features of the morphemes will percolate up to the nodes in higher positions in the tree. By means of these “Feature Percolation Conventions”, the labelling of the tree is accounted for<sup>6</sup> (see Figure 3). Lieber’s model is not flawless. Especially its limited use to account for allomorphy other than English has been criticised. But the central role of subcategorisation frames is very appealing and can be applied to account for selection restrictions of affixes and for the interface of morphology with syntax in many other models of morphology and the lexicon, both inside and outside linguistic theory.

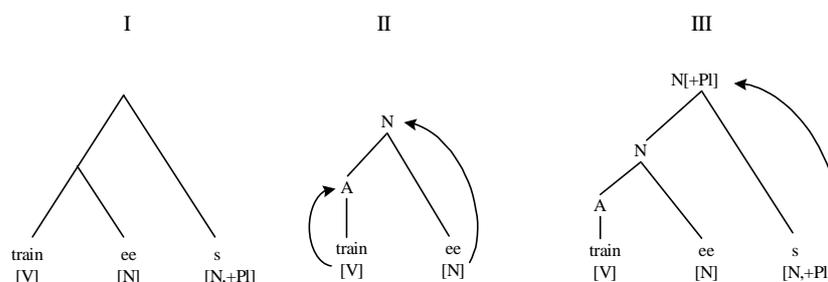


Figure 3. Three stages of morpheme insertion (Lieber, 1981)

### 2.3.2 Word formation rules

In spite of the unclear status of the term “word”, most of the influential early generative morphological theories postulate word formation rules that create new words by the application of morphology. Many of the proposals involving morphological rules, for instance by Marchand (1969); Halle (1973); Siegel (1979); Jackendoff (1975); Aronoff (1976); Allen (1978); Selkirk (1981) and Meijs (1975, 1979, 1981b) include some sort of word formation rules. Of all the different proposals that have been suggested, two of the most influential types of rule will be discussed in this section, those of Halle (1973) and those of Aronoff (1976). The main purpose of this discussion is to show that word formation rules (WFRs), though intellectually appealing, are not likely to provide a powerful explanation for the actual role of morphology in language.

Halle’s (1973) postulates two types of WFRs. As the lexicon in Halle’s model consists of morphemes, the first type of WFRs combines these morphemes to make

<sup>6</sup> The Feature Percolation Conventions that have applied in this example are FPC I: “The features of a stem are passed to the first dominating non-branching node” and FPC II: “The features of an affix are passed to the first node which branches. FPC II has applied twice.

words. This type of WFR is described as: [STEM + ther]<sub>N</sub>, to create words like *bro+ther*, *mo+ther*, *fa+ther* (Halle, 1973:10). The second type of WFRs accounts for morphologically complex words that take words as their basis, for instance [ADJ+ness]<sub>N</sub>, to create words like *blackness*, *blindness*, *shortness*. Halle's model further implies that some WFRs supply syntactic information to the resulting words, as is the case in the latter example quoted: the input of this word formation rule is an adjective; the output a noun. Some WFRs will also comprise semantic information. In the case of the WFR used to create words with the affix *-hood*, for example, it is stated that this rule applies to nouns designating human beings (*boyhood*, *brotherhood*<sup>7</sup>), and that the result of the rule is a noun marked with the feature [+abstract]. The result of a WFR can be subject to further word formation (as is obvious from the loop in Figure 1), to account for words that contain more than two morphemes. The word *totality*, for instance, is the result of the subsequent application of [STEM+al]<sub>A</sub> (accounting for *total*) and [ADJ(+i)+ty]<sub>N</sub>.

As one of the first models in the lexicalist tradition, it is only natural that Halle's model raises more questions than it answers. One of the weaknesses of this model is the order in which WFRs are assumed to apply. The derivation of *totality*, for example, requires that for the correct sequence of WFRs the system should "know" what the internal constituent structure of words looks like. However, as the discussion in 2.3.1 shows, this is problematic. A further problem for Halle's WFRs is that they are extremely powerful. For example, to account for the word *serendipity*, Halle needs the rule [STEM+i+ity]<sub>N</sub>. But if this rule applies to the morpheme *tot*, the result, *\*totity*, is not a valid word. This word, like all other over-generated "words" will have to be marked "[lexical insertion]" in the Filter. Seen from the perspective of generative grammar in those days, the disadvantages of Halle's WFRs are that they are substantially different from the contemporary syntactic and phonological rules. They are also much too powerful, leading to an extreme extent of over-generation, arbitrarily solved by postulating an all-powerful filter. From the point of view of psychological reality, this type of WFR must in any case be rejected for reasons of economy: a rule-based system that mostly generates non-existing words that have to be stored in an "anti-dictionary" is psychologically unlikely.

Aronoff (1976) worked within the same theory of generative grammar as Halle, and he too assumes word formation rules to be an essential part of the grammar related to lexicon. Aronoff's WFRs, however, are different from (many of) Halle's in that Aronoff takes the word and not the (bound) morpheme as the basis of WFRs. Aronoff's word formation rules are further restricted in that they are only used to account for regular productive derivations that take single words as their input: "a new word is formed by applying a regular rule to a single already existing word" (p. 21). All morphologically complex words that are irregular and unproductive are assumed to be listed in the lexicon, while inflection and compounding are taken care of by syntactic transformations. Like Halle's rules, Aronoff's WFRs define the syntactic

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<sup>7</sup> The fact that *brotherhood* is not transparent, as it does not refer to a male sibling, is of no importance to the application of the WFR; all idiosyncratic meaning is accounted for by the Filter.

and semantic properties of their output. An example of the kind of WFR that Aronoff's advances is:

[[X]<sub>v</sub>#er]<sub>N</sub> 'one who Xs habitually, professionally, ...' (Aronoff, 1976: 50).

Due to Aronoff's restrictive assumptions, many of the problems that were noticed for Halle's WFRs present no problem for Aronoff's. The cranberry problem, for instance, is avoided by assuming a word-based morphology, in which there is no place for (bound) morphemes. The disadvantage of this position is that one loses the possibility to refer to some semantic generalisations for forms containing similar bound morphemes like *reduce*, *deduce*, *induce*, *conduce* and *adduce*. Limiting the application of WFRs to existing words and limiting WFRs to living, productive formations minimises the chance of rules to over-generate and create words that are not possible. However, even productive morphological types can generate non-existing words. As *curiosity* can be formed on the basis of *curious*, it will be difficult to stop *\*gloriosity* from being formed on the basis of *glorious*. To account for this apparent inconsistency, Aronoff introduces the notion of "blocking", based on the non-occurrence of synonymy in the lexicon: *\*gloriosity* will not be formed, as its semantic slot in the lexicon has already been taken by the already existing noun *glory*. Words formed by fully productive WFRs cannot be blocked, because these words will never be entered in the lexicon. This explains the possible co-existence of *gloriousness* and *glory*. Aronoff has a point in claiming that pure lexical synonymy does not exist: even for seemingly synonymous words pairs like *buy* and *purchase*, and *bucket* and *pail*, some semantic/pragmatic (e.g. register) difference can always be found. This position is further supported by acquisition data (see Chapter 3). However, an obvious problem for this approach is how to determine the exact productivity of a WFR, especially since productivity does not seem to be an all-or-nothing affair. This issue will be addressed in section 2.5.1 below.

Assuming a word-based system, Aronoff avoids many problems that morpheme-based approaches are being faced with. However, this is at the expense of some possible semantic regularity of bound morphemes. Limiting the application of WFRs to single words only leaves us with the problem of the status of compounds. Especially root compounds tend to be rather unpredictable in their meaning (compare, for instance the meaning of *poison* in the words (or phrases) *rat poison* and *snake poison*) suggesting that these words should be part of the lexicon. Disregarding compounds in word formation is a serious flaw, especially when bracketing paradoxes, like *transformational grammarian* are taken into account. The same can be said about other types of affixation in which the word cannot be considered the basis, like the affixation added to phrases: *a far outer* (a nonconformist) and *I feel particularly sit-around-and-do-nothing-ish today*<sup>8</sup>. In addition, the exclusion of inflection from the lexicon may not be justified, as the basis for a distinction between derivation and inflection is unsound (see 2.5.5) and because some (inflectional) allomorphy is lexi-

<sup>8</sup> These examples are taken from Bauer (1983). For a detailed critique on Aronoff's word-based WFRs, see Bauer (1980).

cally conditioned and must be accounted for by the lexicon. Finally, the limitation with regard to the productivity of WFRs is appealing, as a model that generates words that are not possible in a language is too far from linguistic reality. Yet, this raises questions about the degree of productivity that Aronoff's model is unable to answer. So, apparently, all of Aronoff's assumptions can be challenged, either on theory-internal grounds or on grounds of psychological reality.

In fact all WFRs (both Halle's and Aronoff's) are very much like redundancy rules in that they apply only once and cannot be undone once they have applied. They are what Spencer (1991: 84) calls "once only" rules. Their function is therefore predominantly to be used in the analysis of words rather than in word production. In this respect both Halle's and Aronoff's models are quite different from psycholinguistic models of language processing. Their function is to describe a static situation in language, not to provide a diachronic explanation of word processing. But although neither Aronoff's nor Halle's model is geared towards the explanation of actual language processing, the psychological reality of any model must be accounted for. Moreover, it has been argued (e.g. by Walsh, 1983) that the classical type of word formation rules cannot be accounted for in terms of language acquisition: these rules are claimed to be "unlearnable". The issue of the "learnability" of morphological rules is elaborated on in Chapter 3 (3.2.3.1). Despite the rich source of inspiration that the classical model of morphology and the lexicon has been in the past twenty odd years, the conclusion must be that a theory of language that is not in agreement with the actual linguistic behaviour of language users must be considered of little value.

## **2.4 Modelling morphological processing**

Besides theoretical linguistic approaches to morphology, several psycholinguistic models of morphology and the lexicon have evolved. In search of a model that can be adopted (and adapted) to account for the acquisition and use of L2 morphology, a wide range of proposals made over the past twenty years will be examined in this section. Similar to the overview of the linguistic theories in the previous section, the main aim of this survey is to provide a framework for the model proposed later in this book, and does not pretend to be an all-embracing overview of the field. This discussion is organised according to the main streams of theories modelling storage and retrieval of morphologically complex words: models postulating that morphologically complex words are always divided into their constituent morphemes before lexical access takes place, models postulating that morphologically complex words are stored as whole words in the lexicon and are never or hardly ever analysed into morphemes, and models taking a compromise position between these two extremes. The two main approaches run parallel to linguistic theories of the lexicon that posit a morpheme-base lexicon and a full-listing lexicon respectively. Not surprisingly, psycholinguistic models and linguistic theories share the issues that are essential to any theory involving morphology and the lexicon: the role of productivity, the distinction between meaning and form, the nature of lexical representations and the distinction between inflection and derivation. These issues may occasionally arise in

this section (as they did in the previous section), but will be elaborated on in a separate section later in this chapter (2.5).

Contrary to linguistic theories, psycholinguistic models have primarily been based on experimental evidence. Most of the experiments investigating word access in the mental lexicon involve reaction time measurement in lexical decision tasks, and priming tasks. The basic assumption underlying lexical decision tasks (LDTs) is that the processing time for the recognition of words can be measured and that the difference in reaction time to respond to different forms (e.g. morphologically complex vs. morphologically simple) provides information about the structure of, and the access to the lexicon. The same principle is used in priming tasks, in which the effect of a prime (e.g. the root of a morphologically complex word) on a target (the whole word) is measured and expressed in terms of facilitation or inhibition (in milliseconds). Although the focus of attention will be on visual word recognition, I will also include some models of and experiments involving auditory comprehension whenever these appear to be relevant for the discussion. Furthermore, as it will be argued later in this study that the core of the lexicon is neutral between comprehension and production, production studies are equally relevant for this discussion and are therefore referred to.

The discussion in this section will show that models accounting for the processing of morphologically complex words should ideally combine the two extreme positions: neither a full-listing approach (2.4.2) nor an approach exclusively assuming decomposition (2.4.1) is tenable or adequate. The many compromise positions that have been proposed (discussed in 2.4.3) vary widely with regard to both the access procedure that is considered the default and the factors that determine when and how each procedure is applied. Based on the examination of the models in this section, I will express a preference for a compromise position that has great explanatory power. This preference will be further supported in section 2.5.

### 2.4.1 Affix stripping

Similar to morphological theories assuming a morpheme-based lexicon in combination with word formation rules, psycholinguistic models of the mental lexicon have been proposed that posit lexical storage of morphemes combined with access procedures in which all affixes of a morphologically complex word are always “stripped off” prior to lexical access. One of the first and most influential papers taking this stand was written by Taft and Forster (1975). They view lexical access for the visual recognition of prefixed words as a serial process consisting of a number of steps to be taken in a fixed sequence (see Figure 4). They make this claim on the basis of empirical research involving reaction time measurement: it takes longer for readers to decide that a non-word containing a real prefix is not a word than to decide on matched unprefixed controls. One of their assumptions is that affixed words are stored in their base form in the lexicon: *unlucky*; *cats*. The target of lexical search, they claim, is the root and not the word as a whole. Bound roots are also stored separately and words containing these roots (like *preferability*) must be decomposed before lexical can occur. This view was supported by further studies by the same

authors, though with some substantial alterations. Taft & Forster (1976) conducted five experiments examining the storage and retrieval of polysyllabic words. In this paper, the authors argue that polysyllabic words are accessed via their *first* syllable, regardless of whether the words are polymorphemic or monomorphemic. Polysyllabic single morphemes (*platform*), they claim, "are recognized by the same procedure as are polysyllabic words containing two morphemes" (p. 611/612), as non-morphemic syllables and morphemic syllables are functionally equivalent. To determine the first syllable of the word, left to right processing is postulated until a matching lexical entry is found. One of the effects found in lexical decision tasks was that words beginning with letters that could signal a prefix (*regatta*, *disciple*) take longer to recognise than words that do not begin similar to a prefix: *graffiti*, *Tabasco*). Taft & Forster take this as evidence that an attempt is made to strip off prefixes whenever possible.

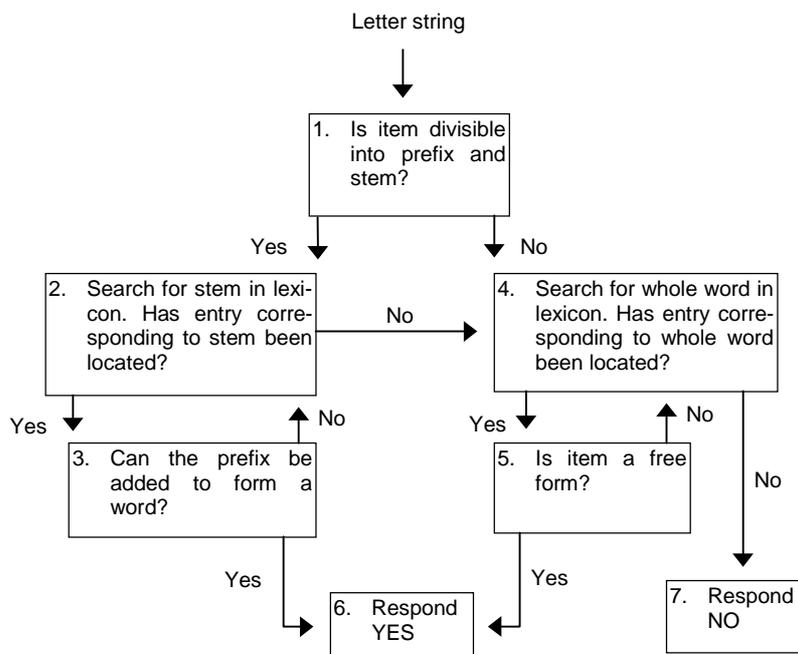


Figure 4. Model of word recognition as proposed by Taft & Forster (1975).

Taft & Forster's articles have initiated a lively discussion between advocates and opponents of the affix stripping position, addressing both the methodology they used (especially the criteria set for the distinction between affixed and pseudo-affixed words, see 2.5.6), their basic assumptions and the motivation for their model. Henderson (1985) elaborates on the problems of this model of lexical access. One of his objections is that stage 1 in Taft & Forster's (1975) flow chart (see Figure 4) is problematic, because "English words are likely to be subject to several decomposi-

tional solutions” (p.43) out of which only one can be chosen. Henderson’s critique can be generalised to all other theories postulating serial processing: this problem will hold for any serial model of morphological processing and can only be overcome by assuming a parallel model of lexical access. Taft & Forster’s rationale for assuming morphological decomposition is economy of storage: it is more economical to store one root for a number of different words. If efficiency of lexical storage is indeed a decisive factor in the choice of the strategy to be employed, it is likely that a minimal number of lexemes are stored to reduce redundant information in the lexicon. However, for similar reasons of efficiency it can be argued that it is unlikely to assume exclusive reliance on word formation rules in producing and processing morphologically complex words. Firstly, morphological decomposition is less attractive for affixed words which have a bound root (*prefer*) or those which are highly complex (*unremittingly*). Secondly, as MacKay (1978) points out, it complicates mechanisms for learning, perceiving and producing morphologically complex words. It requires, for instance, a complex perceptual system for distinguishing real derivatives (*untrue*) and pseudo-derived words (*uncle*), and this would complicate connections that have to be made to the semantic system. Taft & Forster’s second argument in favour of decomposition is that this allows for the clustered storage of morphologically related roots, which would increase processing efficiency: by stripping off the prefix, words can be stored alphabetically. In this way, the entry for, for instance, (*re*)*juvenate* could be located without having to search through all the words beginning with *re-*. But this assumption bears some problems as well: although clustering may economise storage in transparent cases, (*work, works, worked, etc.*) it would pose a semantic problem for opaque word formations: (*in*)*vent* and (*pre*)*vent*; (*im*)*plore* and (*ex*)*plore*. A related problem is the assumed access via the root of the word: a pure model of decomposition cannot accommodate the large number of irregularities and idiosyncrasies in the lexicon. For strongly lexicalised and opaque complex words like *sweetbread*, *runner* (in the interpretation of table covering)<sup>9</sup> and *drawer* (in the interpretation of part of a *dresser*) access via the root will lead to incorrect semantic interpretation. Finally, as Taft & Forster assume storage of morphemes, utilising a very broad definition of morpheme, their model faces the same problems as Halle’s (1973) model of the lexicon: no mechanism is incorporated to check the legality of concatenations of root and affixes, and thus fails to solve the problem of lexical gaps.

Taft (1979) attempts to solve some of these problems by assuming a different way of storing stems in the “access bin”, the stage at which words are decomposed before entering the lexicon. Taft introduces the BOSS unit: basic orthographic syllable structure for the visual recognition and storage of stems. The BOSS unit is the string that starts with the first consonant after the (stripped) real prefix and contains as many consonants past the first vowel as possible, but without violating orthographic rules and without crossing morpheme boundaries. This means that *fin, final, finance, fine, finish, finite, define* and *confine* all share the same BOSS unit and as Taft (1987) puts it are “listed together in some way” (p. 266). Although this may

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<sup>9</sup> Example from Meijs (1985b).

speed up access procedures for some words, there are some obvious disadvantages to it as well. As Sandra (1994) points out, moving away from the morpheme as a basic unit implies that words sharing an access code need not be morphologically or semantically related. This means that at the level of the access bin speed may be gained that is lost again once the structure enters the mental lexicon.

In reaction to Taft & Forster's articles, Stanners et al. (1979) argue that affix stripping will not always take place. Contrary to Taft & Forster, they propose a model that assumes separate memory representations for roots that are bound morphemes and roots that are free morphemes. For affixed words both the root and the whole word is represented in the mental lexicon; words with free morphemes (*untrue*) as their root access both the unitary representation (*untrue*) and that for the root (*true*). As lexical processing is assumed to combine information about the whole word and the root, they argue, parallel processing is required. To investigate the representation of words in the lexicon they tested three types of prefixed words in a series of priming experiments: one with free morphemes as roots (*untrue*), and two with bound morphemes as roots: with a unique roots (*rejuvenate*) and with a roots that are shared with other words (*progress*). Their results show that prefixed words may access memory representations of word constituents, but (in addition) always access unitary representation of the whole word. Partial representations of the word with free morpheme roots (*untrue*) access both the representation for the whole word and that for the root (*true*). Words with bound morpheme roots (like *progress*) access memory representations for both the whole word and for words with which they share a prefix (like *regress* and *ingress*). This position is heavily opposed to by Taft (1981), who claims that the experimental data of Stanners et al. could also be accounted for by the Taft & Forster (1975) model. Taft's conclusion is that "the notion that whole words as well as stems are stored in the lexicon is an unnecessary elaboration of the model on the basis of these experiments" (p.290).

As two essentially different models can explain the same experimental data, the conclusion must be that these early models are too general to make specific claims that can be tested in reaction time experiments. Taft's (1981) attempt to silence the opposition by producing new experimental results supporting the Taft & Forster model was not very successful due to many methodological uncertainties in these experiments (see 2.5.6). Due to the lack of sound empirical support and the ambiguous motivation of the affix stripping model, models leaving open the possibility of both decomposition and (simultaneous) unitary access appear to be more realistic: there is quite some evidence that decomposition does occur, but there is no evidence that decomposition always takes place. Nor, as Henderson (1985) points out, is it evident that decomposition necessarily takes place before lexical access. Henderson supports the latter remark by pointing to the observation that the initial letters of a word, whether they constitute a prefix or not, do activate semantic information, independent of the root of the word. In the word *introvert*, for instance, both *in* and *intro* may contribute some semantic activation, even though *\*vert* is not a free morpheme. This kind of semantic activation does definitely not involve prelexical morphological decomposition.

Also on the basis of *production* studies, claims have been made for decomposition of morphologically complex words as the default processing strategy. MacKay

(1978) compares the same two basic hypotheses as had been studied in word recognition tasks so far: derivation (the Derivational Hypothesis, DH) and direct access (the Independent Unit Hypothesis, IH). In his study, subjects were asked to nominalise orally presented verbs as quickly as possible. If, for instance, *defend* was provided, subjects were expected to rapidly produce *defence*. Four complexity levels were determined and tested: pairs like *decide / decision* were expected to require more complex processing than pairs like *conclude / conclusion*, because of the additional vowel alteration rule, and it would consequently take the subjects longer to respond to the former. The results indeed showed longer response latencies (and a higher error probability) for higher levels of phonological complexity, which leads MacKay to conclude that the subjects must have applied morpho(phono)logical rules: this could only be accounted for by DH. Based on these findings, MacKay pronounces a clear preference for derivation over direct retrieval; he concludes that the derivational hypothesis is more likely for “everyday production”, but stresses that his study does not rule out the possibility that “words may be stored in some memory system” (p.70). Criticism of MacKay’s study has concentrated on the limited set of English derivations and on the fact that although MacKay’s findings did confirm the DH, no evidence is given against IH. Henderson (1985) points to the absence of a control condition, and remarks that without that, the effect noticed is not necessarily attributable to the phonological complexity of the process of nominalisation. Instead, Henderson assumes that the effect is “one of interference between independent units”(p.26): partial activation of the phonological output for one of the forms may interfere with the production of the other. Although MacKay’s study does not in itself give evidence for this view, the lack of a control condition indeed gives rise to speculations like Henderson’s. A final criticism could be that in MacKay’s test the frequency of the items is only marginally taken into account, though this appears to be an important factor. However, in spite of all criticism, MacKay’s study has provided some useful evidence for the DH, without excluding the possibility of direct access. This was an important next step towards the recognition that the two hypotheses are not mutually exclusive.

In the latest generation of psycholinguistic models, Taft & Forster’s 1975 position of obligatory decomposition prior to lexical access is hardly adhered to. In most contemporary theories of the mental lexicon (Caramazza, Laudanna & Romani, 1988, Schreuder & Baayen, 1995), the compositionality of morphologically complex lexical items is certainly taken into account, but it is not obligatory, nor does it necessarily take the form of morphological decomposition. And it does not usually take place before lexical access. But the discussion on this issue is still very much alive. Taft’s (1981) defence of the Taft & Forster (1975) model, has even very recently prompted a reply by Schreuder & Baayen (1995) in which new insights from computational linguistics are utilised to demonstrate flaws in the prefix stripping assumption. The main issue in their argumentation is that in a serial model involving decomposition prior to lexical access, pseudo-prefixed words leads to “backtracking”: if the stem of a pseudo-prefixed word (*de-corum*) enters the lexicon, no match will be found and the system requires a second cycle, in which the lexicon is searched for an entry of the whole word. If backtracking is incidental, it will not strongly affect the overall processing efficiency of the system. However, by means

of a computer corpus investigation Schreuder & Baayen demonstrate that in more than 80 per cent of all prefixed words in English backtracking is required<sup>10</sup>. They further calculated that the average number of search steps required for the prefix stripping model is almost eight times higher than the search steps that are necessary in a base-line model. The obvious conclusion must be that the addition of a prefix-stripping module to a serial search model does not contribute to greater processing efficiency, but rather impairs processing efficiency.

As the models of lexical processing have mushroomed since the early Eighties, a full account of all models currently available is not feasible within the scope of this study. But to illustrate the evolution of thinking about affix stripping over the past 20 years, the current position of Taft (1991, 1994) is interesting. In his most recent “interactive activation framework”, based on, among others, McClelland (1987), Taft postulates that prefixed words are represented in a decomposed form, without the necessity of prelexical prefix stripping: in this model no separate storage of prefixes is assumed, but prefixes are treated separately from their roots, because morphemes constitute independent activation units. So, although Taft retains the position of a separate role for prefixes in a serial model of lexical access, he has given up the idea of obligatory prefix stripping prior to lexical access.

### 2.4.2 Full listing

The opposite position is that the lexicon does not contain any morphological information that is stored separately, be it affix or root, and that lexical access always takes place through an independent lexical representation for each word in the language. In linguistic theory, this “full-listing” position is taken by Jackendoff (1975). In psycholinguistic models of the lexicon an upsurge of the full listing model was initiated as a reaction to Taft & Forster’s (1975) prefix stripping position. All models advocating this position, however, will have to account for people’s observed ability to understand and create (pseudo-)words on the basis of roots and affixes: all speakers of English will be able to derive the form “wugger” for “someone who wugs” (Berko, 1958). To account for productivity, approaches supporting full listing usually incorporate the possibility of decomposition.

Advocates of the full-listing hypothesis usually point to the idiosyncrasy of affixation: the meaning of affixed words is often not predictable from the meaning of their constituents, and it may be hard to find regularity in the combinations of affixes and roots. In English, for example, the verb *induce* has the derived forms *induction* and *inducement*, whereas *produce* has *production* and *produce* (N), excluding *\*producement* (Butterworth, 1983: 264). In addition, Butterworth (1983) shows that there is little semantic regularity for suffixed forms (*induce-* + *-ment* / *-ive* / *-tion* / *-ible*). After an elaborate discussion pointing to evidence from speech production, speech perception and reading, Butterworth concludes that it is not likely for the mental lexicon to contain morphological rules, and that, due to the idiosyn-

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<sup>10</sup> The definition of pseudo-prefixation used by Schreuder & Baayen is strict, giving the prefix stripping system the benefit of the doubt (if any).

crasy of semantic relations, a full-listing model is the only model possible. However, despite many convincing examples, doing away with morphological regularity altogether seems to be a rash decision that overlooks many morpho-semantic relations that are regular and productive<sup>11</sup>. Moreover, any conclusion regarding the structure and processing of lexical items should be based on sound empirical data instead of exemplary evidence.

Access procedures in full-listing models are generally assumed to take place through spelling patterns and syllables, rather than through affixes. Seidenberg (1987) and Rumelhart & McClelland (1986), for instance, try to account for the recognition or production of words by orthographic patterning without the use of morphological cues. In terms of reaction times, this would mean that there are no differences in access times between morphologically complex words and similar monomorphemic words of comparable length. This was indeed what Manelis & Tharp (1977) found when they conducted a reading experiment to compare the reaction times for unsuffixed words (like *fancy*) to suffixed words (like *dusty*). In their experiment, they included regular and productive derivations, like *-y*, *-est* and *-er*, to create a context that is most likely to elicit differences between the conditions in the test. However, no significant differences in response times were found for affixed words as compared to nonaffixed words. These results, they claim, show that word recognition does not involve decomposition, neither before, nor after lexical access. But this is a hasty conclusion that presents a gross oversimplification of the problem and that is not motivated by their results. The fact that they found no differences in reaction times for these items is not to say that lexical access never relies on morphological decomposition. In view of the productivity problem, this position cannot be maintained.

A compromise position would be to say that it is only in very specific contexts that morphological complexity plays a role. Evidence for this was found by Rubin, Becker & Freeman (1979). The results of a lexical decision task they conducted indicate that morphological structure affects word recognition (longer latencies) only in contexts where all words, including the filler-nonwords, were prefixed (*deview*, *enpose*). In a neutral context, where the words and nonwords other than the targets were unprefixes (*danger*, *custom*, *demple*, *curden*), the overall reaction times were faster, even for the pseudo-prefixed words (*uncle*). On these grounds, Rubin et al. conclude that a decomposition strategy may be available, but is only used in very specific contexts.

The relevance of morphological information in word processing is further supported by several studies showing that morphological features do affect word recognition and that these effects cannot only be accounted for in terms of orthography and phonology (Fowler et al., 1985; Feldman & Moskovljević, 1987; Hanson & Wilkenfeld, 1985; Napps & Fowler, 1987), nor by semantics alone (Bentin & Feldman, 1990; Feldman, 1992). Stolz & Feldman (1995) conducted five (priming) experiments to investigate this further. In a long-lag priming task, prime-target pairs

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<sup>11</sup> These regularities point to at least some consistency in the relation between form and meaning. This issue is further discussed in section 2.5.2.

were compared that were either identical (*mark-mark*), morphologically related (*mark-marked*) or orthographically related (*market/arked*). The results show significant facilitation for the identical prime-target pairs and the morphologically related pairs, whereas the facilitation obtained for orthographically related prime-target pairs was not significant. In the second experiment, orthographically related prime-target pairs with and without a shared base morpheme were compared (*arked - mark* and *market - mark*). The results of this experiment show that orthographically related but morphologically unrelated primes tend to inhibit rather than facilitate recognition of the target, indicating that morphological information in words is relevant, as the orthography was kept constant. The third experiment shows that the component structure of pseudowords does affect recognition, supporting the authors' claim that besides semantic information, also morphological information is important in the recognition of morphologically complex words. The fifth experiment conducted was a "segment shifting task", in which subjects were instructed to separate a segment from a source word, to shift the segment to a target word, and then to name the newly coined word as rapidly as possible. For instance, the form *arden* was provided with the target form *brigt*; the subjects were required to shift the affix *-en* to the target and name the newly formed word *brighten*. This line of experimentation is very interesting as it seeks to combine production and perception strategies. In this experiment the results for morphologically complex source forms, like *arden*, were compared to morphologically simple source forms, like *arden*, involving both inflectional and derivational suffixes. The outcome of this experiment shows that shifting latencies are significantly faster for morphologically complex forms, even when these have a lower overall frequency than the morphologically simple words. Stolz & Feldman conclude that based on previous studies in combination with their own experiments, "similarity based on orthography and phonology or on associative semantics alone cannot account for morphological effects" (p. 126). This is a very reassuring conclusion for anyone who is eager to hold on to the meaningfulness of morphological information for word recognition, but it is also a conclusion that should be tentative. After all, as the authors themselves acknowledge, drawing a single conclusion about different dimensions of language based on a series of experiments involving different variables and different sets of words, cannot possibly take into account the interconnection of all variables. Moreover, some variables, like the distinction between inflection and derivation, may turn out to be more important than appears from this article. But in spite of this, their paper shows that morphological cues in word processing are not to be underestimated.

As morphological (de-)composition during lexical access is not a major issue for full-listing models, these models emphasise the role and organisation of the lexical entries in the lexicon. Butterworth (1983) proposes modality specific Lexical Representations consisting of words of which the internal structure marks the morpheme boundaries. All morphologically related forms (*walk, walks, walked*) are grouped together in one "unit type" (or "name", in Bradley's (1980) terms). To solve the productivity problem, Butterworth assumes "fall-back procedures" that can be used to produce new words or to analyse unfamiliar words. The idea of fall-back procedures is also used by Aitchison (1994), who postulates a full-listing model consisting of a "main lexicon" including all existing words, a "back-up store" in which the

morphological boundaries of words are stored and a “lexical toolkit” to generate and analyse new or unfamiliar words. The main body of evidence Aitchison uses for her assumptions consists of speech error data. The fact that prefixed words often interchange with non-prefixed words (*porcubines* instead of *concupines*; *concupines* instead of *columbines*) is interpreted as evidence that prefixed words should not be regarded as a special category. In addition, malapropisms of words containing suffixes (as in *provisional* for *provincial*), are said to show that the suffix is “tightly attached” (p.115). But this evidence is not very convincing: all these words will be opaque for most speakers of English, and these examples cannot make any claims about the degree to which transparent, fully productive affixes are attached to their roots. Besides, Aitchison does not clearly distinguish between semantically motivated morpheme selection and the eventual selection of syllables. Speech errors can usually be attributed to the latter stage, and do not necessarily make claims about the storage of items in the mental lexicon. Although the idea of word boundaries included in lexical entries, linked by some mechanism of word formation may be appealing, its foundations in Aitchison's model are questionable. Moreover, this model does not satisfactorily resolve the question how it should be determined when unitary access takes place and when (de-) composition is used.

In sum, the evidence in favour of the full-listing hypothesis clearly suggests that a pure decomposition position cannot hold. This has been demonstrated by many examples of lexical irregularities that cannot be accounted for by decomposition alone. This view is supported by empirical evidence indicating that there is no difference in access time between some morphologically complex words and orthographically similar, morphologically simplex polysyllabic words. The counter-evidence against a pure affix-stripping position should, however, not be over-generalised by stating that morphology plays no role whatsoever in word processing. Recent studies have convincingly shown the relevance of morphology in lexical access. Moreover, the logical problem of productivity requires full-listing models to accommodate the possibility of morphological decomposition. The conclusion must therefore be that neither a pure affix stripping position, nor a pure full-listing hypothesis is tenable and that a compromise position will have to be adopted. This conclusion, however, raises more questions than it answers. For instance, are the different methods of access applied simultaneously or successively? If simultaneously, what determines the eventual success of one procedure over the other. If successively, how is it determined which access procedure applies in which situation or with which words? Different proposals with regard to these questions are discussed in the next section.

### 2.4.3 Compromise positions

Two streams of compromise positions can be distinguished. First, there are models that use one of the “extreme” positions as a starting point and (are obliged to) incorporate parts of the opposite school to account for effects otherwise left unexplained. Secondly, there are models that use a mixed approach as a starting point and argue that some words or word groups are accessed directly whereas others are analysed,

or that both types of access take place simultaneously in a model of parallel processing. Most of the models of the first type have been discussed in the previous sections. This section will therefore concentrate on the second type.

An early model combining the direct access and decomposition was posited by Meijs (1975, 1979, 1981b, 1985), graphically represented in Figure 5. His proposal is one of the few that seek to fit a psycholinguistic model of the mental lexicon into (transformational generative) linguistic theory. Like Aronoff's and Halle's, Meijs's model contains word formation rules, and aims at lexical insertion into syntax rules at deep structure. However, the model could best be compared to Jackendoff's (1975) theory of the lexicon, as it assumes full listing rather than morpheme or word listing. The WFRs that Meijs refers to are more similar to Jackendoff's redundancy rules than to Aronoff's or Halle's word formation rules in that they form projections of the patterns of morphologically complex words the speaker knows. An essential distinction in this model is that between *possible* and *existing* words. Existing words are listed in the full-entry lexicon, but possible words (that are always regular) are not: the speaker "knows" these words "projectively" by referring to a WFR. Meijs refers to this distinction by speaking of the Item Familiar Lexicon (IFL) and the "Type Familiar Lexicon" (TFL).

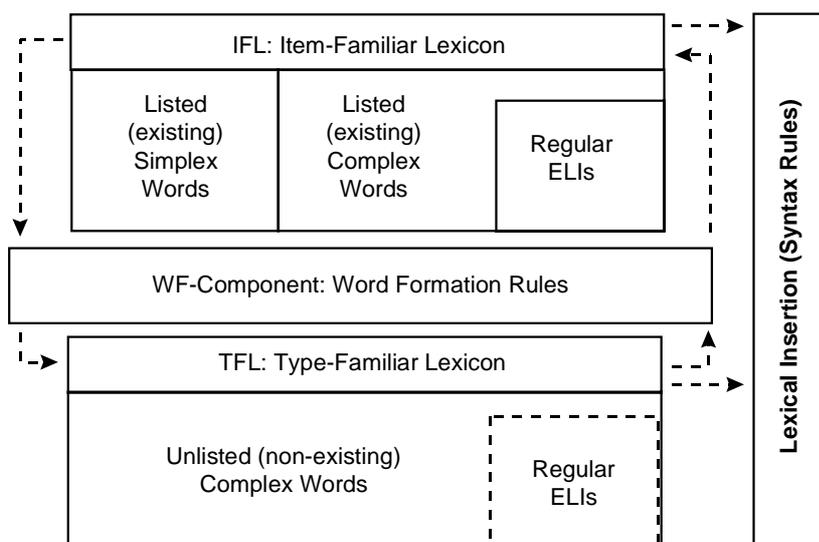


Figure 5. The structure of the mental lexicon according to Meijs (1981b) The item-familiar lexicon (IFL) comprises all existing lexical items, complex and simplex; the type-familiar lexicon refers to all words that can be derived from word formation rules. The regular existing lexical items (ELIs) are represented in both the IFL and the TFL: these items may be listed, but can also be derived on the basis of WFRs.

The IFL is a finite list of all existing words; the TFL is the indefinitely large set of words that can be formed or interpreted at a particular moment by the application of word formation rules. In this model, productive word formation rules can be applied to coin regular lexical items but need not be, since frequently used complex morphological items are assumed also to be stored in the Item-Familiar lexicon. In this way, all of the existing regular morphological complex words are accessible in two ways: via words formation rules in the ITL and directly as existing items in the TFL. The default strategy, however, will be direct access, Meijs argues, because this is faster.

In an experiment involving reaction time measurement, Meijs (1985) compared access times for complex and simplex lexical items and found that the results of his test confirmed the main predictions about the model. Access times for idiosyncratic complex items were equal to access times for simplex items (direct access is always used for full entries); existing regular complex lexical items (CLIs) were accessed as quickly as the idiosyncratic items if accessed directly (=default), but more slowly if not; non-existing, possible CLIs will have to be decomposed, and indeed turned out to have slower access times.

The power of Meijs's model is that it can account for newly formed complex words while maintaining a full-entry lexicon. But in spite of this asset, the model leaves many questions unanswered as it contains a number of "black boxes". How can the speaker have access to WFRs if these are not stored? What exact information do the WFRs comprise? What information is stored in the lexical entries? Moreover, the model is clearly inspired on the central position of syntax in the language ("lexical insertion") that was common in early generative models of morphology and that has generally been abandoned in modern morphological theory.

The distinction between possible (unlisted) and existing (listed) words is appealing, because it provides an explanation for the many contradictory findings in earlier psycholinguistic experiments. At the same time, however, this distinction is problematic, as a clear-cut two-way distinction cannot be made with regard to these concepts. For instance, Meijs allocates the word *vulbaar* ("fillable") to the possible, but non-existing group and *slechtheid* ("badness") to the existing, listed group. Choices like these are rather arbitrary and may vary from speaker to speaker and from context to context. Therefore Meijs specifies that the model is to be seen as "a strictly-synchronic reflection of the idealised language-user's lexical store, as well as his complex-word potential at an arbitrary, fixed point in time, M" (Meijs, 1985: 77). However, the disadvantage of this solution is that it explicitly creates a static model that is inherently unable to account for language processing as a dynamic process. In a footnote, Meijs mentions a tentative solution to this problem by introducing "a kind of threshold level associated with mental traces left by productive/interpretive occurrences, beyond which it becomes economical to create a new full entry in the IFL for some possible combination, which is thereby promoted to the status of listed complex word" (Meijs, 1985: 77). But in this way the problem is shifted rather than solved, because it remains unclear how and by which factors such a threshold level should be determined.

This last question has been central to many other studies investigating the mental lexicon. When assuming a serial model of language processing, one of the most im-

portant questions is whether different types of morphological knowledge undergo differential processing. White et al. (1989), for instance, first make a distinction according to the type of affix: they claim that in the case of suffixes the context is used to guess their meaning, whereas in the case of prefixes the meaning is looked up in memory. Then they assume that familiar words are always retrieved directly, whereas unfamiliar words are “stripped”. Their first distinction is motivated by their observation that suffixes change the syntactic category of their base, while prefixes do not. But the validity of this criterion is doubtful, as not all suffixes are class changing. Their second criterion is also problematic: it is hard to define familiarity and it is not clear from their argumentation whether the distinction works in two directions (does it leave the possibility of familiar words to be stripped?). Another distinction could be drawn between inflection and derivation: derivational processes might only be used when we are forced to apply them, while inflectional processes could be assumed to be used whenever we have to understand or produce a sentence or word (Miceli & Caramazza, 1988). In Aitchison’s (1994) model the distinction between inflection and derivation is used as the main criterion for the way words are processed: words containing inflectional affixes are assumed to be decomposed, whereas words containing derivational affixes are accessed and produced as whole words. But since the distinction between inflection and derivation is not always obvious, especially when it concerns languages other than English, it is difficult to maintain this position (see 2.5.5 for a discussion of this issue). Stemberger & MacWhinney (1988) propose a model of spoken production processes in which the criteria are regularity and frequency: all irregular forms are stored, whereas regular forms are generated by rule, except for regular forms that are very frequent. Here, as in the model proposed by Meijs, the problem is to account for the (individual) threshold: at which frequency will words start to be stored?

To solve this apparent problem, Bybee (1985, 1995) introduces the notions of “lexical strength” and “lexical connection”. When the meaning and phonology of an input form is successfully matched to a lexical representation, this representation is strengthened. Hence, lexical strength varies as a function of frequency. Partial mappings, on the other hand, will create lexical connections between the (partially) mapped forms. The lexical connections, reminiscent of Jackendoff’s (1975) redundancy rules, ensure that information about morphological complexity is accounted for by the internal structure of the lexical representations, without having to postulate the separate storage of morphemes, and thus evading the problem of storage or non-storage of bound morphemes. The real solution to the problem of when to store and when to analyse lies in the interaction of lexical strength and the lexical connections. Frequently occurring regular morphologically complex forms will have a high lexical strength and will therefore be less dependent on lexical connections, while low frequency forms will be more dependent on lexical connections and will therefore create stronger lexical connections. Bybee uses diachronic facts to support her model. For instance, frequent derived forms will have the tendency to show semantic drift, whereas infrequent derived forms tend to maintain a close (semantic and form-based) relation with their base. In this way, a continuum can be presumed in which productivity, frequency and transparency interact. On one extreme end of the scale we find forms with the strongest lexical connections (between phonologically

and semantically transparent pairs such as *clever* and *cleverness*); on the other extreme end we find opaque pairs like *awe* and *awful*, which have weak lexical connections and high lexical strength. The position on the scale is affected by the token frequency of the derived form (higher frequency weakens connection and increases lexical strength of the derived form), the type frequency of the morphological relation (high type frequency will strengthen the connection) and phonological and semantic similarity (transparency strengthens the connection). What is particularly attractive about this model is that it principally treats regular, irregular, transparent, opaque, inflectional, derivational, productive and unproductive formations in the same way. Moreover, the model is not limited to a particular language module. A possible problem for this model is that it may be hard to make accurate predictions in terms of processing time for the various procedures, as it is not clear how (new) words are being processed. A more serious problem for this model, however, is the validity of the link between connection in processing and diachronic change: although Bybee more or less takes this link for granted, the two types of language development are not inherently linked. Nevertheless, Bybee's model is a valuable attempt to incorporate all relevant variables into a single system.

The lexical models of Meijs and Bybee contain elements and concepts, like Item-familiarity, Type-familiarity (Meijs), lexical strength and especially the role of frequency and transparency (Bybee) that are very valuable and that will be adopted in the model proposed later in this book. Moreover, Meijs's representation of the mental lexicon provides an accurate picture of the role of morphology in the mental lexicon and is in line with some of the psycholinguistic models that will be discussed below. However, neither of these models is geared towards explaining the (development of) acquisition of L2 morphology, which requires a model that can account for dynamic language processing. In the rest of this section, I will therefore discuss some models in which the processing time is the primary concern. These are models assuming parallel processing, postulating that both direct access and decomposition is attempted simultaneously, and that the search ends as soon as one of the processes manage to retrieve the desired form.

One of the first proposals for parallel processing was that of Stanners et al. (1979), formulated as a response to Taft & Forster (1975) and mentioned in 2.4.1. Essential to their model is that some words (those with free morphemes) will access both the unitary representation and the representation of their root: *untrue* will access both *untrue* and *true*. Words with bound roots, however, will access both the unitary representation and the words they share a prefix with: *progress* will activate *progress*, but also *regress* and *ingress*. In this way, it is not necessary to assume storage of bound roots (*-gress*), while the possibility of "affix stripping" is maintained. Although the idea of parallel processing is very appealing, by concentrating on the roots this model does not say anything about the exact function, storage and retrieval of productive affixes, and is therefore unable to account for the productivity problem. This problem is largely evaded by concentrating on prefixes only, which appears to be the least productive of morphological types.

Focusing on productivity in language production, Anshen & Aronoff (1988) stipulate that three processes are at work simultaneously: speakers search their lexicons for words needed, attempt to build the words by rule and construct them from

analogy. The authors suggest that the success of the strategy be determined by the productivity of the combination. The model can be seen as a “rat race” with the different processing routes as competitors: as soon as one of the processes has been successful, the other processes will be blocked. A variety of types of evidence, experimental, historical and statistical, the authors claim, support these hypotheses. To determine which strategies of lexical access are used in production, they conducted an experiment in which subjects wrote down all words they could think of ending in a particular sequence of letters (e.g. *-ment*, *-ness*, *-ity*). In the results, attention was paid to only to *-ibility* vs. *-ibleness*, and *-ivity* vs. *-iveness*, as these would represent a difference in productivity (see 2.5.1 for discussion). The results show that for forms ending in *-ness* more nonce forms were used and less often the same word was used, indicating more forms being created constructively. This leads the authors to conclude that, based on a difference in productivity, *-ity* forms are stored separately from their bases (and picked from a fixed set), while *-ness* forms are not stored with their bases, but constructed by rule as they are needed. The experiment is of extreme simplicity and one may wonder whether a test like this can at all be related to real-life production; focusing attention on a particular form can have (and in fact will have) many disadvantages. An alternative explanation for the large number of nonce forms for *-ness* produced by the subjects in the test, for instance, could be that the subjects felt that they had to produce an equal number of forms for each affix. Since *-ness* is not as frequent as *-ity*, more nonce forms were likely to be produced.

The “threshold” that Meijs refers to and the “lexical strength” mentioned by Bybee are represented in most modern psycholinguistic models of the lexicon in terms of “activation”, a term borrowed from neuropsychology. In itself, activation does not solve the problem of determining which strategy is used for which words and under which circumstances. But it offers a tool to express and to quantify the chance that a particular strategy is used. The problem can thus be rephrased into finding the factors that affect activation of either the whole word or the constituents of words. Of these factors, transparency, frequency and productivity are frequently mentioned. To close off this section, three models are discussed that try to account for the choice between decomposition and direct access in terms of activation. Based on this discussion, a tentative preference will be expressed for the last of these models, Schreuder & Baayen’s “Meta model” to be used as the foundation for a model of morphological processing in L2.

Productivity plays an essential role in the Augmented Addressed Morphology (AAM) Model of word recognition (Chialant & Caramazza, 1995; Caramazza et al., 1988; Burani & Caramazza, 1987; Laudanna & Burani, 1985). This model postulates that processing is guided by an orthographic surface form. The lexicon is accessed through “access units”, which comprise whole words and morphemes, and which are activated by the input strings. The degree of activation of access units depends on the graphemic similarity between the input string and the stored representation: the input string activates all “similar” access units: whole words, morphemes and orthographically similar forms. For instance, the input string *walked* will activate the access units of the whole word, *walked*, the morphemes it comprises, *walk+ed*, and orthographically similar forms like *talked* and *balked*. An important

assumption of the AAM model is that for “known” words whole-word access units will always be activated, whereas novel and unfamiliar morphologically regular words will activate morphemic access units. Hence, transparency and frequency play a crucial role in the activation of the access units: for all orthographically transparent forms both access units for whole-word and morphemes will be activated “to an extent which is directly proportional to the frequency of the access unit” (Chialant & Caramazza, 1995:63). Indirectly, this means that the independence of roots and affixes varies according to their productivity; regularly inflected forms will thus be stored in a morphologically decomposed format.

The AAM model is able to explain the most important empirical findings. The model is in line with the observed effect of root frequency (Taft, 1979): reaction times for morphologically complex words are affected not only by the frequency of the entire word, but also by the cumulative frequency of the forms that share the same root. This effect can be explained by morphological decomposition as in Taft & Forster (1975), but also by assuming the existence of decomposed access units. Also the observed effect of morphological priming (by, for instance, Stanners et al., 1979), showing facilitation for morphologically related words, points to the likelihood of the existence of decomposed access units.

A point of dispute remains, though, concerning the predictions about pseudo-prefixed words. Taft (1994), defending his serial “interactive activation model”, argues that since the AAM model does not allow for morphological decomposition of pseudo-prefixed words (there is no access unit for non-existing roots), these words will have to be processed in the same way as non-prefixed words. This, however, would be incompatible with the observed delay in responding to pseudo-prefixed words. Chialant & Caramazza (1995) refute this alleged weak spot in the AAM model by pointing to methodological weaknesses of the experiment involving pseudo-prefixed words in Taft & Forster (1975) (see below, in 2.5.6), ignoring the fact that Taft’s later and improved experiments (Taft 1981) showed the same effect. Another potential problem for the AAM model is that it takes the orthographic representation of a word as a starting point for lexical access, disregarding the central position of word meaning. Although transparency is crucial to the model, the exact role of semantic aspects at the level of access units has yet remained unclear. This also leads to problems concerning the activation of semantically related forms that are not orthographically regular, like irregular past tenses of verbs and regular spelling features: it is not quite clear how *blurred* should activate the access units *blur-* and *-ed*, or how *deluded* should activate *delude-* and *-ed*. Finally, it is not unambiguously clear whether the AAM model should really be considered as a parallel model, as the lexical search is completed when the access unit that first reaches a pre-set threshold activates its corresponding lexical representation. Frauenfelder & Schreuder (1992) point out that since whole-word representations will always be activated faster than the morphemic constituents of a word, and since this model does not allow an overlap in the temporal distribution of the processing times, the access of morphologically decomposed representations must be seen as a back-up procedure for the processing of new words rather than a route that is actually “competing” with direct access.

A model that is more distinctly parallel is Frauenfelder & Schreuder's (1992) Morphological Race Model (MRM), which was based on Baayen's (1992, 1993) Race Model. The guiding principle in Baayen's Race model is productivity'; the basic assumption is that all morphologically complex words have a full listing entry and a "decomposed" entry. In that sense this model can be compared to the model of Meijs (1975, 1981b) outlined above. An important difference, however, is that Meijs has limited the words that can be accessed "item-familiarly" to "regular" items, which is a concept that is hard to define. Baayen's (1992) starting point is that morphologically productive forms are parsed, whereas unproductive forms are processed through direct access. The processing procedure is assumed parallel; the two routes start simultaneously, and the one that first reaches completion yields the output. The difference with the AAM model is that the two routes may overlap and that, as a consequence, low frequency forms can be recognised by either route. The inclusion of productivity is very appealing, yet the obvious problem with this approach is the difficulty to express the degree of productivity in terms of a processing mechanism. Baayen has attempted to solve this by linking productivity to frequency: words with unproductive affixes tend to be more frequent than words with productive affixes. However, this solution is not satisfactory, as not all low frequency words are productive and parsable.

Frauenfelder & Schreuder (1992) extend Baayen's Race Model by considering the factors that influence the parsing route. They determine the time that is necessary for a word to be recognised for both routes, in which the "resting activation" of a word is crucial. For the direct route, the recognition time depends on the token frequency of the word: the resting activation depends on how often a word is encountered. Words that are more frequent will thus be recognised faster, which is in accordance with empirical findings of whole-word frequency effects. The recognition time for the parsing route is affected by the phonological transparency of the word, its semantic coherence, and the resting activation level of its root and affixes. The model further postulates a unique one-to-one relation between access representations and meaning representations, enabling direct recognition of surface forms and parsing based on meaning representations of roots and affixes. For morphologically simple or opaque words the parsing route will fail, and these forms will be stored and accessed directly. For morphologically complex words, the situation is different. Once such a word has been parsed successfully, the resting activation of the morphemes it comprises will increase, while the resting activation of the whole word will increase even more. In this way it can be explained that the more often a word has been encountered, the higher the resting activation level of the whole word will become and gradually the direct route will be faster than the parsing route. For words with a high surface frequency, the direct route will usually win the race, as these words will have a high whole-word activation level, irrespective of their internal structure. For morphologically complex low-frequency words the fastest route will depend on the activation levels of the root and affixes relative to the activation level of the whole word, which in turn is determined by the number of successful parses and therefore dependent on the degree of transparency of the word. In this way, Frauenfelder & Schreuder have managed to incorporate productivity into the model. After all, productivity coincides with low frequency, and by introducing

transparency as a necessary condition for productivity, the problem of low frequency word forms with unproductive affixes has been solved: as the success of parsing is dependent on the transparency of the word, parsing will not be successful for these words and the direct route will win the race.

The MR model is appealing in that it gives insight into the way morphological parsing may actually take place and in the way some essential variables (frequency, productivity, transparency) may interact in determining which route is faster in a parallel model of word recognition. However, it is yet not much more than a rough sketch of this complex system, with many assumptions that will have to be tested and some properties that will have to be refined. Especially the idea that after a successful parse the whole-word entry is activated more than the constituents of the word seems an arbitrary solution to fit the model to a generally observed phenomenon. Moreover, the problem of determining the degree of productivity has been shifted to determining the degree of transparency rather than solved.

The MR model has recently been refined, culminating in Schreuder & Baayen's (1995) "Meta Model". A logical next move after making transparency central to a model is to concentrate on the meaning of the word, and this is indeed what Schreuder and his colleagues have done: the Meta Model focuses on calculating meaning. Unlike the AAM model, it is not limited to visual word recognition. It postulates that morphological processing takes place in three stages: segmentation, licensing and combination (see Figure 6). Further assumptions are that morphologically complex words that are not transparent and very frequent transparent morphologically complex words will have their own lexical representations. The first stage, segmentation, links intermediate access representations to normalised access representations. The assumption of an extra intermediate access representation solves the problem of spelling rules and phonological rules mentioned in the discussion of the AAM model: *blurred* and *deluded* will at this stage be mapped to the access representations *blur*, *delude*, and *-ed*. The access representations will activate one or more concept nodes, which represent abstract concepts with no particular form. In the licensing stage, the activated concept nodes are linked to separate semantic and syntactic representations, which check the possibility to combine concepts in case more than one concept has been activated. In the combination stage, the lexical representation of a complex word, if licensed, is calculated as a function of the semantic and syntactic representations of its constituents. As mentioned above, transparent morphologically complex words can have their own lexical representation. Whether they actually do acquire their own representation is determined by a trade-off of computational complexity and frequency. Following Pinker (1991), Schreuder & Baayen argue that when computation is very simple, even the most frequent complex words will always be coined rather than given their own representation. Regular plural formations, for instance, will be computed, since the only computation that has to be done is to unite the lexical representation of the noun and the plural. When more computations have to be applied, however, a new concept node will always be created. The retention of the new concept will depend on frequency: very frequent forms will retain their own representation, whereas infrequent forms will decay.

The power of this model lies in the mechanism of activation feedback, indicated by the bi-directional arrows in Figure 6. In fact, this system is an elaboration of the

ad hoc solution Frauenfelder & Schreuder (1992) used to create a possibility for transparent morphologically complex forms to have their own lexical representations. Activation feedback allows for activation at all levels of the processing mechanism to be affected by all other levels. Access representations not only activate concept nodes, but activation will also flow back to the access representations, affecting the way this access representation will be processed when encountered again. For a transparent morphologically complex word for which a new concept node has been created, this means that the whole word will receive more activation than its constituents. The same occurs at the level of concept nodes: after a successful licensing stage, activation will flow back from the semantic and syntactic representations to (the concept nodes of) the constituents of a transparent morphologically complex word. This, then, is where productivity comes in: “the activation level of the concept node of an affix is a function of the number of semantically transparent formations in which that affix occurs and of the frequencies of those formations” (Schreuder & Baayen, 1995:142).

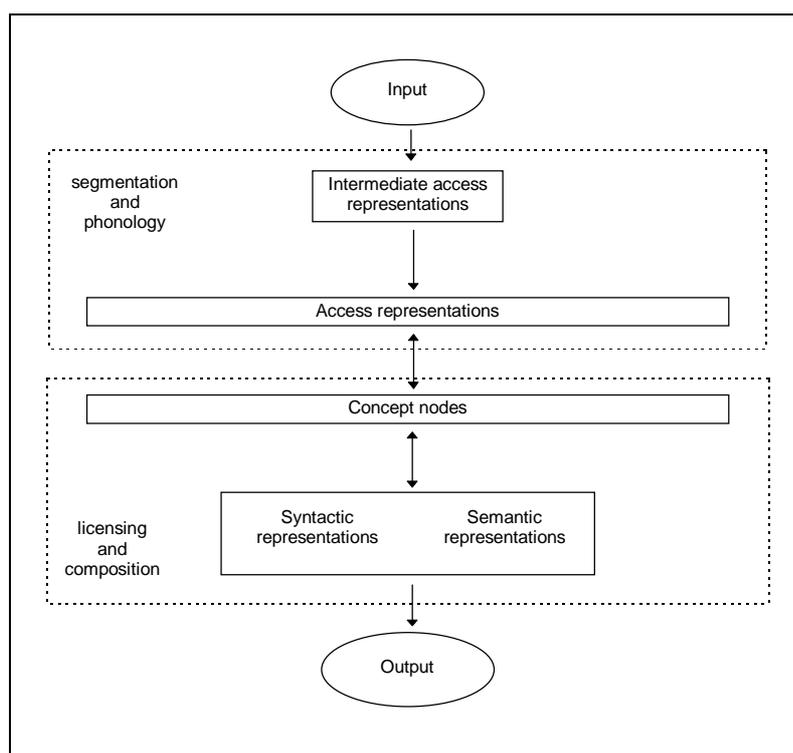


Figure 6. The Meta model as proposed by Schreuder & Baayen (1995)

The Meta model combines aspects from several other models, like the MRM, the AAM, Pinker’s (1991) linguistic rules, and McClelland’s (1987) and Taft’s (1991, 1994) interactive activation model. Also, traces of linguistic theory can be recog-

nised, like the incorporation of syntactic subcategorisation frames in the syntactic representations, which enables the model to account for, among others, bracketing paradoxes. Due to its generalistic principles, it can account for the most substantial observations from psycholinguistic experiments, like the root-frequency effect, the whole-word frequency effect, pseudo-affixation and the productivity problem. Moreover, the model is applicable to word recognition in all language modalities, can explain morphological processes in a variety of languages, and holds for inflection as well as derivation<sup>12</sup>.

The obvious disadvantage is that it needs further development in many aspects. For instance, this model positions both the syntactic representations and the semantic representations under the concept nodes, which is not in line with widely asserted views of the lexicon in language production models. In Levelt's model (Levelt 1989, 1993), for instance, the syntactic information referring a lexical representation plays a role at a different moment in language processing than semantic information (see 2.5.3). Other specification is required concerning the precise nature of the semantic representation and the exact procedures taking place between the intermediate access representation and the access representations proper. It is, for instance, not clear how the intermediate access representations are specified for the different language modules. As the access procedures will be quite different for each module and between production and comprehension, major adjustments will be required. In sum, the model must be further specified to enable predictions that can be empirically verified. Yet, it is well motivated by taking productivity as its starting point and can therefore provide a sound foundation future research.

The discussion thus far shows that a model exploring the role of morphology in the lexicon must account for unitary access as well as decomposition. Moreover, producing and understanding (morphologically complex) words is a dynamic process that cannot be captured by static theories lacking the time dimension. Therefore, we need a dynamic model of language processing. Dynamic models postulating parallel processing have as a major advantage over serial models that no principled choice is required that determines in advance which route is to be taken. The relative success of either route will be individually determined for a particular word at a particular moment by the resting activation of its root and its affixes. Resting activation should reflect the productivity, the frequency and the transparency of both morphologically complex words and the constituents it contains. The interrelation of these variables and some other issues relevant to morphology and the lexicon will be elaborated on in the next section.

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<sup>12</sup> It should be noted, though, that this model has primarily been designed to account for Germanic languages. It is, for instance, not obvious how phenomena like Arabic broken plurals can be explained in terms of this model. This need not be problematic, because the model does not purport to be universal: it is not necessarily true that the structure and access of the mental lexicon is independent of language typology.

## 2.5 Issues in morphology and the lexicon

After a review of the most important models proposed in the literature, this section will revisit the most relevant issues that briefly came up in the previous sections. These issues will be discussed in view of their role in a model of morphological processing. Based on this discussion, I will express my preference for one particular model that is most suitable to serve as the foundation for modelling the role of morphology in the L2 lexicon. First, frequency, productivity and transparency are reviewed. The discussion will focus on the interaction of these three factors. Second, the controversial linguistic relation between meaning and form is discussed and applied to psycholinguistic models. Third, a comparison is made of the nature of the lexical representations as they are proposed in different models, from which a set of requirements is established that should be met by a model of morphology. Fourth, it will be determined to what extent the models that have been focused on comprehension can be applied to production. It will be argued that the core of the lexicon is neutral between comprehension and production, and that the activation-spreading model introduced in the previous section can be applied to production too. Fifth, the pros and cons of distinguishing inflection and derivation are discussed, again with regard to the application of this distinction to a model of morphology. Finally, some methodological issues are discussed that have affected psycholinguistic research in the past.

### 2.5.1 Frequency, productivity and transparency

Morphological productivity, frequency and transparency are concepts that are clearly interrelated. All three have played a major role in modelling the role of morphology in the lexicon. Opinions differ, however, about how they are related and what their respective role is in morphological processing.

Reaction time experiments have provided compelling evidence that words that are more frequent are recognised faster. Whaley (1978), for instance, found an extremely powerful effect of word frequency in many reading tasks. This is generally interpreted as evidence that frequent forms require less processing and are stored by their full form. Besides this surface frequency effect, it is widely accepted that access time is positively affected by “root frequency”, which is defined as the cumulative frequency of all the words that share a root. Taft (1979) found a difference in response time between, for instance, *sized* (faster) and *raked* (slower): as both have a low surface frequency, the difference in reaction times can only be explained by the higher root frequency of *sized*. Although Taft (1979) interprets this observation as evidence of prelexical decomposition, this effect is not necessarily a result of lexical search, and might as well arise as a result of postlexical processing. At any rate, the root frequency effect is evidence of morphological decomposition at some stage of lexical processing<sup>13</sup>.

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<sup>13</sup> The concept of root frequency could be refined by not only considering the cumulative number of occurrences of the root, but by also taking into account in how many different

Frequency effects have also been found in L1 acquisition. Children are sensitive to frequency and show better knowledge of words presented to them more frequently than of less frequent words (Schwartz & Terrell, 1983). Children are also sensitive to type frequency: in the order of acquisition of affixes, children acquire the most frequent affixes first (see Chapter 3 for a more elaborate discussion of this issue). This observation confirms findings from reaction time experiments that both root frequency and type frequency play an important role in our perception and use of morphologically complex words. This points to the necessity to presuppose separate storage of roots and affixes, in combination with the storage of whole words. Of the models discussed in the previous section, especially the Meta model appears to have great explanatory power in this respect. Roots, affixes and whole words are stored in this model, and the relative activation of these elements depends on their individual frequency.

Besides frequency, productivity is a major variable affecting morphological processing. Since productivity is a crucial factor in the model that will be adopted for the current study, some elaboration is required with regard to the definition of productivity and the instruments to quantify it.

The productivity of affixes may range from highly productive to totally unproductive, and anything in between. Attempts to categorise affixes of different degrees of productivity into classes, or "levels" as proposed in more recent approaches to level ordering, are not satisfactorily motivated for productivity, as no differentiation within the categories is possible. In a division of affixes into three levels (Kiparsky, 1983), the affixes at level one (e.g. *-ity*, *-ize*, *-al*, *-ic*) are claimed to be less productive than those at level two (e.g. *-er*, *-ness*, *-able*), while level 3 contains the most productive ones (including all regular inflection). But, as Clark (1993:128) rightly points out, affixes that are marginally productive in general may be more productive within specific domains (Clark mentions the productivity of *-ic* in technical domains). Productivity must therefore be seen as a cline with, for instance, regular plural formation at one extreme end and unproductive affixes like nominalisation by adding *-th* at the other. The position of an affix in the continuum may vary along different domains.

Much debate has been going on about how the exact position of an affix on this continuum can be determined. A first characteristic of morphological productivity is that the meaning of a word coined by a productive morphological type can be predicted on the basis of the meanings of its constituents. In other words, transparency is a necessary condition for productivity. To illustrate this, consider the affixes *-ful* and *-ness*: although transparent words may be created with *-ful*, many derivations with *-ful* will not be fully transparent (*grateful*, *songful*<sup>14</sup>, *lawful*, *awful*); derivations formed with *-ness*, on the other hand, will usually be transparent (*abstractness*, *brightness*). *-ness* could therefore be considered more productive than *-ful*. How-

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words the root occurs. This measure, the *relative root frequency* can be calculated by dividing the number of different roots by the cumulative root frequency.

<sup>14</sup> *Songful* is a common term in American English, meaning "given to or suggestive of singing: MELODIOUS". (Webster's Ninth Collegiate Dictionary)

ever, transparency alone is not enough to define productivity; although transparency is a condition for productivity, the reverse is not true: transparent forms are not necessarily productive. The nominalising suffix *-th*, for instance, may be transparent (*width*, *length*), but cannot generally be applied to form acceptable nouns from adjective (*\*poorth*). In other words, productivity is essentially related to production. Moreover, production is always related to a particular moment in time. After all, at the time when *length* was first coined, *-th* nominalisation might have been a (more) productive process<sup>15</sup>. Morphological productivity can thus be defined as the probability that the combination of a root plus an affix will lead to an acceptable and transparent word at a certain moment in time. The acceptability of a newly formed word will depend on the judgement of the language community. From this it can be deduced that the productivity of an affix is a reflection of its actual use by a language community at a particular moment in time, or, in other words, the frequency of actual use in that language.

Since productivity, reflecting the collective preferences of a speech community, is inherently dynamic, it is difficult to measure. Several approaches have been undertaken to measure productivity in a consistent and reliable manner. These attempts range from theoretical views to experiments involving production and assessment by judges and to frequency counts from dictionaries and corpora.

The lack of a clear definition of productivity has been shown to provide insurmountable problems for theoretical approaches using word formation rules. To account for the productivity problem (the fact that word formation rules cannot be stopped from over-generate non-existent forms like *\*arrivation*), Aronoff (1976) advances the concept of “blocking”. But to allow legal over-generated forms like *aggressiveness*, which is not blocked by *aggression*, he argues that blocking cannot occur for WFRs that are fully productive. As productivity must be regarded as a continuum, this line of reasoning will not wash. Working in the different framework of redundancy rules, Jackendoff (1975) attempts to account for the productivity continuum by calculating the productivity as a function of the cost of referring to a redundancy rule:

The cost of referring to redundancy rule R in evaluating a lexical entry W is  $I_{R,W} \times P_{R,W}$ , where  $I_{R,W}$  is the amount of information predicted by R, and  $P_{R,W}$  is a number between 0 and 1 measuring the regularity of R in applying to the derivation of W.

Jackendoff (1975: 666)

The obvious disadvantage of this definition, however, is that it shifts the real problem to determining the “regularity” of the redundancy rule in applying to the derivation of the word. But if this regularity can be measured objectively, it can contribute to the solution of quantifying productivity.

Anshen & Aronoff (1981) attempt to measure productivity. They determine productivity by taking the ratio of actual words of a given pattern to possible words of that pattern: the more productive a pattern is, the greater the ratio of actual to possi-

<sup>15</sup> This is not very certain; *-th* is probably a loan from old Norse or Dutch, as the Old English form was rare.

ble words. They conducted two experiments to investigate the role of productivity by testing the acceptability of affixes by native speaker judgement. In their first experiment, they compared the acceptability of words ending in *-ness* (generally regarded to be very productive) to words ending in *-ity* (regarded less productive) in an Xive environment: Xivity vs. Xiveness. The results showed that the *-ness* words were more often accepted. They conclude, however, that this might be due to phonological transparency, as the *-ity* forms affects the stress pattern of the word and *-ness* does not. Therefore, a second experiment was set up, testing the same affixes in a Xible environment: *-ity* is very productive with *-ible*, although phonological transparency would predict that *-ness* is more productive with *-ible* (no stress change). The results indeed showed a preference for Xibility forms over Xiveness. Anshen & Aronoff interpret this as evidence that the productivity of an affix is dependent on the combination with the base. However, these results may be largely due to a difference in processing of the two words and on word-internal frequency: because of the high frequency of the combination, the occurrence of *-able* will activate *-ity*. This goes to show that the degree of productivity should reflect the subtle interrelation between frequency and transparency.

Schultink (1961) has defined morphological productivity as the chance that language users unintentionally coin a new word of a particular type. The number of formations of that type is, in principle, infinite. Baayen (1989, 1992, 1993) has quantified this concept of morphological productivity in terms of frequency by expressing it in an objective statistical measure, comprising the total number of types of a particular affix (all words in a large corpus containing that affix:  $N$ ) and the number of “hapaxes” (types that contain that affix and occur exactly once:  $n_1$ )

$$P = \frac{n_1}{N}$$

$P$  is an estimate of the conditional probability that a new type with a particular affix will be encountered when the size of the corpus increases. Using Baayen’s formula, productivity is defined in terms of frequency with transparency as an inherent condition: a hapax will always be transparent. The relevance of productivity for models of morphological processing is obvious from the discussion in 2.4 above: an integrated notion of morphological productivity enables us to make a clear distinction between, to use Meijs’s (1975, etc.) terms, type-familiar access and item-familiar access. Calculations using this measure of morphological productivity with a large corpora of English (the CELEX database) carried out by Baayen & Lieber (1991) confirm Anshen & Aronoff’s (1981, 1988) empirical findings about productivity. The  $P$ -value of *-ity* (405 types, 29 hapaxes = 0.0007) is indeed much smaller than that of *-ness* (497 types, 77 hapaxes = 0.044). Although this measure may be limited by its emphasis on structural conditions of productivity only, it provides a very objective and accurate prediction of morphological productivity.

### 2.5.2 Meaning discrepancies

The relation between the form of an affix on the one hand and its syntactic functions and semantic properties on the other, has been a source of disagreement among (psycho-)linguists. However, the apparent discrepancy between surface form and meaning<sup>16</sup> must be accounted for in a model of morphological processing. The discussion of this issue becomes particularly relevant if it is extended to second language acquisition (in Chapter 3) and the factors that are important for the bilingual mental lexicon. As this issue will be referred to extensively in later chapters, it is worthwhile reviewing the main positions taken and to determine which of the models discussed in 1.2 and 1.3 can most adequately explain the facts observed.

(Generative) grammars of derivational morphology usually take the form as the basis of description (Halle, 1973; Jackendoff, 1975; Aronoff, 1976; Booij, 1977; Lieber, 1981), and emphasise the regularity of combinations of words plus affixes by postulating rules generalising these combinations (see 2.3). Logically, the advocates of a full-listing hypothesis usually adhere to the view that form and meaning must be separated because the connection between the two is inconsistent and possibly even coincidental. Bloomfield (1933), who regards the lexicon as “a basic list of irregularities” is very clear about this: “the meaning of each morpheme belongs to it by an arbitrary tradition”. (274). Essentially the same position is expressed by Butterworth (1983:266): “Derivational compounds where the major category is changed by the derivational process in general have unpredictable semantics and thus constitute a problem for a model of LR (lexical representation) which rejects to FLH (full listing hypothesis).” Butterworth illustrates the idiosyncrasy of derivation by referring to Latinate forms that have *-duce* as their roots, as discussed in 2.4.2. Also the affixes with which *-duce* can combine indeed seem entirely random, as illustrated in Table 1.

Table 1 derivatives of *-duce* words

	?	-ion	-ment
educer	*		
adducer	*		
conducer	*		
producer		*	
reducer		*	
deducer		*	
introducer		*	
traducer			*
seducer		*	*
inducer		*	*

<sup>16</sup> For a detailed discussion of the lack of isomorphism, see Matthews (1972).

Likewise, Meijs (1981a), argues that there is "a lack of parallelism between morphological and semantic relations" (Meijs, 1981a: 134), and that it is more adequate to adopt a semantic/syntactic base along which morphological forms may vary. Meijs illustrates the lack of consistency in the relation between form and meaning as represented in Table 2 and Table 3:

Table 2. Meijs (1981a) illustrates the fact that one form may have several different meanings.

form	meaning	example
-ment	abstract result of V	agreement
	body of people who V	government
	act of V-ing	establishment
	concrete result of V	settlement

Table 3. Meijs's (1981a) illustration that one meaning can be represented by several different forms.

form	meaning	example
-ation	abstract result of	expectation
-ment		resentment
-ion		appreciation
-al		approval
0		regret

These examples show that both polysemy and synonymy occur at affix level. Beard (1984) refers to this phenomenon as "morphological asymmetry": "The ability of a single suffix to reflect several meanings while several such suffixes convey any one such meaning" (Beard, 1984:50). To solve this problem, Beard postulates a (generative lexicalistic) model that distinguishes Lexical Extension Rules (L-rules) and Morphological Rules (M-rules). The deep-level L-rules operate completely independently of the surface-level M-rules that mark it with affixation. Affixation (M-rules, which assign the affixes to the output of the L-rules), Beard argues, is an extremely simple process. Its only complexity lies in the choice of the affix, since M-theory is obliged to posit only one suffix insertion rule. In cases where constraints such as the transitive-intransitive condition cannot be discovered, the root must "carry some 'diacritic' feature to trigger proper morphological insertion" (Beard, 1984: 57). Other linguists also insist on a distinction between form and meaning. Matthews (1984), for example, argues that affixes may be considered each other's rivals for the same meaning: "The rules of word formation, if they are properly called rules, are not stated of morphemes, but of formations (...) directly. These are in general neither contrastive nor non-contrastive. Instead they can, and widely do, compete." (Matthews, 1984: 91/92).

Others maintain that form and meaning in morphology should not be separated and introduce solutions to account for morphological asymmetry that consist of constraints to limit the number of cases to be properly considered as derivations. Zwanenburg (1984a, 1984b), for instance, argues that "it is only correct to speak of word formation when a possible derived word has a form-based as well as a semantic relation to the word serving as its base" (Zwanenburg, 1984a:131). Instead of regarding apparently similar affixes as rivals, Zwanenburg claims that the different meanings a complex word can have must be seen as a core meaning plus a set of derived meanings, and that form and meaning of a complex word, though inseparable, must be described in different components of the grammar. Likewise, Booij (1986) argues that there is no basis for a systematic distinction between form and meaning of affixes. With regard to synonymous affixes Booij adheres to Aronoff's one-affix-a-rule hypothesis: purely synonymous, competing affixes do not exist as such, since they differ at least with respect to productivity and distribution: "The poly-interpretability of certain affixes also shows a certain systematicity, once we distinguish between productive and unproductive interpretations." (Booij, 1986:515). Booij accounts for polysemy in derived words by assuming there is one prototypical meaning for a certain word formation process and that other meanings are derived by extension rules. As an example he mentions *-er* agentive and argues that "Agents" should be extended to "personal agents", "impersonal agents" and "instruments". Of these three, the personal agents are prototypical. By structuring "agent" in this way, Booij argues, an important part of the polysemy of *-er* deverbal nouns can be accounted for. He considers all other interpretations of *-er* as marginal, unproductive and/or idiosyncratic (e.g. *doordenker*, *bijsluiter*, *misser*, *afknapper*, *dijenkletser*), and argues that these cases cannot be used as arguments for a principled separation of form and meaning in morphology.

The pros and cons of a principled distinction between form and meaning for affixation will have to be weighed carefully, as it concerns an essential underlying assumption for theories of morphology. A decisive factor in this must be how the relation between form and meaning can be mapped onto an acceptable model of morphological processing.

The concept of rival affixes for a particular function or meaning is often overrated. Booij certainly has a point in claiming that a detailed analysis of seemingly rival affixes may reveal that much of the rivalry can simply be accounted for by a difference in properties of the base and the affix, especially regarding distribution and productivity. The famous rivalry between *-ity* and *-ness*, for instance, can partly be attributed to properties of the root: *-ity* usually attaches to Latinate roots, while *-ness* preferably attaches to native roots (*acidity*, *adversity*, *affinity*; versus *deafness*, *fatness*, *coldness*). Moreover, the use of the affix is also restricted by its morphological context or sub-domain: Baayen & Lieber (1991) have convincingly shown that *-ity* is more productive than *-ness* after *-able* / *-ible*, whereas *-ness* is more productive after *-ed*, *-ful*, *-less*, *-some* and *-ish*. Also when we closely consider the rival affixes mentioned by Meijs (1981a) (see Table 3), differences in the productivity of the affixes are revealed: *-al*, for example, is barely productive; Baayen & Lieber,

1991) and is strongly restricted as to the bases it can combine with<sup>17</sup>. *-ation*, on the other hand, is much more productive and has only few restrictions. The marginal productivity of *-ment* is very clear from Table 2. *Document* and *settlement* are opaque, *government* and *establishment* are also barely transparent, and almost all *-ment* forms are very frequent: 44,419 tokens at 184 types and only 9 hapaxes (data from Baayen & Lieber, 1991).

On the other hand, however, the assumption of prototypical meanings for homonymous affixes cannot hold. Although this may account for agentive and instrumental *-er*, it will not hold for all homonymous affixes. For instance, it will be very difficult, if not impossible, to find a common core for the diminutive and the agentive use of *-ee*, for the two types of *-ful* (as referring to quantity —*spoonful*, *mouthful*— and referring to a characteristic —*tasteful*, *fearful*—), and for the deverbial and the denominal types of *-al* (*arrival* versus *nominal*). These forms rather seem to represent different “types”, appropriately labelled “derivation type” (Beard, 1981, 1984; Baayen, 1989).

Advocating the full listing hypothesis, Henderson (1985) argues that the relation between meaning and form is very inconsistent in derivation. He uses a very productive word formation device (*un-*) in an attempt to demonstrate the unpredictability of derivation, by mentioning several examples of derivations with *un-*. He points to the ambiguity of *doable*, meaning either “able to be undone” or “not able to be done”, and further points to the different meanings of the *un-* affix in *unarmed* and *unfrocked*. However, Henderson’s example of the ambiguity in the bracketing paradox *undoable* ([[undo]able] or [[un]doable]) and the variable meaning of the other two examples, can easily be explained by considering the two meanings of *un-* as different but homonymous derivation types with different subcategorisation frames. One of the types that takes *un-* as its form attaches to verbs, and has the meaning of *de-*: “make undone whatever is done by the verb” (e.g. *to unscrew*). The other type taking *un-* as its form attaches to adjectives, and serves as a negation: it reverses the meaning of the adjective (NOT doable).

Further evidence for the position that purely synonymous derivation types do not exist is found in the acquisition of L1. The fact that children refuse to accept pure synonymy in language is an essential principle in the explanation of language acquisition. It is because of perceived synonymy that children are motivated to drop their own coinages in favour of more productive adult morphological types (see Chapter 3).

In view of the evidence, a one-to-one relation between type (including phonological, syntactic, and semantic/pragmatic cues) and form must be adopted for productive derivation types. Linking this to the models of morphological processing discussed in 2.4, most present-day models will be able to explain these observations, but especially those models that emphasise the importance of morphological productivity, like Bybee’s connectionist model and Schreuder & Baayen’s Meta model, can account for them simply and straightforwardly. In Schreuder & Baayen’s (1995)

<sup>17</sup> According to Marchand’s (1969) extensive and thorough typology, for instance, *-al* combines with Latinate bases only, and the last syllable must be stressed.

model, for example, only the morphologically complex words that are based on (very) productive types will be decomposed; all other forms will have their own lexical representation. The (pseudo) compositionality of words like *government* or *document* is irrelevant to this model, as very little activation feedback will flow back to the affix *-ment* due to their lack of transparency and high surface frequency. Neither is homonymy problematic: similar to Booij's proposal, in monomorphemic words, homonymous affixes of different derivation types will have separate access representations. A further advantage of the Meta Model is that it is able to deal with syntactic information through the separate syntactic representations mediated by the concept nodes: in this way it can also account for the different subcategorisation frames of the two types of *un-* mentioned above. Although the notion of morphological types has not as such been incorporated in this (or any other) psycholinguistic model, it is compatible with, for instance, the Meta Model. A morphological type must be seen as a lexical representation relating a particular (morphemic) concept to its semantic/pragmatic, syntactic and orthographic/phonological properties, very similar to other lexical representations.

### 2.5.3 The nature of lexical representations

The content of the lexicon presumed, in the form of Lexical Representations (LRs), largely depends on the framework of morphological processing adopted. However, speakers/listeners will need a minimum amount of information at several different levels to be able to correctly produce or comprehend words for morphologically complex as well as monomorphemic forms. Miller (1978) (quoted in Butterworth, 1983: 258) summarises the most essential properties of LRs in a list, categorised for the different modalities:

#### A. Pronunciation

- phonology (including stress features)
- morphology (including inflected and derived forms)

#### B. Syntactic categorisation

- major category (N,V,A,P)
- subcategory (syntactic contexts)

#### C. Meaning

- definition (concept expressed; relation to other concepts)
- selection restrictions (semantic contexts)

#### D. Pragmatic constraints

- situation (relation to general knowledge)
- rhetoric (relation to discourse contexts)

Now let us compare the items in this list to the way LRs are represented in some present-day models of morphology in the lexicon. Obviously, this list is geared to supporting a full-listing hypothesis, and has to be adjusted to account for morphological decomposition as an integrated part of the lexicon, as postulated in most models. Consequently, morphology should not reside under pronunciation, but

should be given a more independent status. This can be accomplished either by including information about the compositionality of morphologically complex words in the lexical entry ( $[un[[reach]_V[able]]_A]_A$ ), as proposed by Bybee, or by assuming a morphological parser at the level of access representations (MRM, AAM, Meta Model).

The phonological information of a word form is indeed essential for the correct pronunciation of the word, but less essential for its recognition. In the Meta Model, the phonological information is not included in the LR, but is taken care of at the level of segmentation. In this way the Meta Model enables filtering of the raw input forms to the Access Representations (by assigning stress patterns and recognising morphological bases), which, as we have seen, poses a problem for the AAM model. Morphologically simple words can have unpredictable stress patterns that seem to be lexically determined, and it may be argued that phonological information should be stored at the same level as syntactic and semantic information, i.e. at the level of lexical representations. For comprehension, there are often other ways to select the right concept. For instance, the voicing of the final fricative in the word *house* differs between the noun and the verb, which is lexically determined. The Meta model can account for this without referring to the phonology by assuming differential access representations for the verbal and the nominal form. But if the model is extended to language production, the need for phonological information being available beyond the level of the access representations becomes more pressing. However, this does not necessarily imply that this information must be stored as part of the lexical entry. This point will be elaborated on in 2.5.4.

The syntactic categorisation of a word is essential to achieve correct recognition and production. For morphological processing (sub-)categorisation information is important: at this level information must be stored about the morphological category affixes can attach to. The syntactic properties that are included in the lexical representations must contain the syntactic category of all lexical elements. They may include subcategorisation frames, as proposed by Lieber (1981) (see 2.3.1), but may also take the form of an argument structure. The affix *-able*, for instance, only attaches to verbs with an external argument<sup>18</sup>. The Meta Model postulates lexical representations that comprise separate syntactic and semantic representations that interact through the concept nodes. Other models are far less explicit about this. In Bybee's model, the syntactic information will be stored with the lexical representation, but in the AAM model, being modality specific, syntax and semantics are assumed to be processed separately by different modules, while the links among the modules remain obscure. For morphology, interaction between syntactic and semantic nodes is particularly important at the level of licensing: the co-activation of semantic properties has to be licensed by subcategorisation frames or argument structures.

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<sup>18</sup> This observation generally holds: *washable*, *readable*, but not *\*laughable*, *\*dieable*. However, the productivity of this affix seems to increase judging from new coinages like *microwaveable* (as in "a microwaveable dish"), where  $[microwave]_N$  has been converted to a (transitive ?) verb to form a legitimate base to attach *-able*.

Meaning should obviously also be incorporated in the LRs. In the MRM, the Meta Model and Bybee's model, semantic information is treated similar to syntactic information, while the AAM again shifts meaning to a separate module. As has been argued in 2.4.3 above, placing the semantic and the syntactic specifications of a LR at the same level is not in agreement with Levelt's widely accepted model of language production (Levelt 1989, 1993). This implies that adjustments will have to be made to this position if this model is applied to language production. If the model is limited to comprehension, a minimal requirement is that the relations between concepts in Miller's (1978) list are linked in an interactive network that might consist of direct links or of links among semantic and syntactic representations mediated by concept nodes. None of the models discussed so far have anything to say about the exact nature of the semantic information, and opinions differ according to the different semantic theories adhered to.

None of the models explicitly mention pragmatics, even though pragmatic information is very relevant for the choice of the most appropriate word in a particular context (the register is likely to affect the activation of a set of words associated with that register), and is clearly lexically determined. In Bybee's model, this could easily be incorporated in the LRs, and in the Meta Model pragmatic representations can simply be regarded as part of the semantic properties of a lexical representation. The AAM will have to assume links to other modules to account for the essential interaction between morphology, syntax and semantics/pragmatics.

The difference in nature between visual and auditory recognition and production of words is regularly mentioned in the literature about lexical processing. De Bot et al. (1995), for instance, plead in favour of different theories and models to explain visual and auditory lexical processing. They point to evidence from cognitive neuroscience, which shows differential dysfunctioning of the two modalities in cases of aphasia and that visual and auditory inputs stimulate different parts of the brain. The model that is most strongly constrained by modularity is the AAM model, which only deals with word recognition in reading. However, if we assume that the LR comprises a full representation of all relevant information, differential processing of different modalities is not very likely. If the LR were considered the nucleus of the lexicon, it would indeed be uneconomical and illogical to assume that each module has a similar set of LRs. It makes more sense to assume that each module has its own interface to access the central and nuclear LRs.

Finally, two more issues are of concern in relation to LRs: the order or grouping of LRs and the distinction between inflection and derivation. The distinction between inflection and derivation is discussed in 2.5.5 below. The idea that the lexicon, or in this case the lexical representations it contains, is ordered according to some guiding principle like their position in the alphabet, their frequency, their acoustics properties, or whether they are function words or lexical words (Bradley, 1980), must be regarded as a reflection of our concrete way of dealing with words and is probably a gross oversimplification of the complex and abstract network of relations that the lexicon is likely to be. The questions about the ordering of lexical representations will become irrelevant if activation is used as the starting point of morphological processing. Words or concepts with strongly activated links will inherently form highly abstract groups based on their pragmatic properties (like the

formal/informal register), other aspects of meaning, syntax, morphology or sound. These groups will be interrelated, and will to a certain extent be individually determined in a system that is constantly changing. Indirectly, frequency may be considered the only guiding principle at work, as activation inherently depends on the frequency of forms occurring.

In sum, it can be said that (1) all concepts (related to words and morphemes) can have their own LR, (2) LRs must contain or must be linked to phonological, syntactic, semantic/pragmatic information, (3) interactive relations must be assumed among all these information types for each LR and among LRs themselves, leading to an abstract and complex lexical network, (4) in which the most strongly activated items are most readily available, and (5) LRs, representing the nuclei of the lexicon, should not be regarded modality specific.

#### **2.5.4 Comprehension and production**

A distinction that is pertinent to lexical processing is the one between production and comprehension. This distinction is reflected in the different sizes of passive and active vocabulary: passive vocabulary, used for comprehension, largely exceeds active production vocabulary for most people. In addition, acquisition data show that children's comprehension vocabulary may not only be larger than their production vocabulary, but may also be essentially different (see Chapter 3). Based on observations from diary studies, Clark (1993) postulates separate representations for production (P-representations) and comprehension (C-representation). However, for the same reason that it is unnecessary to assume differential representations for each module, it is not probable that lexical representations for comprehension and production have their own independent representations. The seemingly different sizes of passive and active vocabulary can be accounted for in terms partially developed "concept nodes" for particular lexical entries. LR that have not (yet) been fully specified do allow for (global) interpretation, but not for production, as production requires more fully specified LRs. Secondly, it may be presumed that only highly activated LRs are eligible for production. This would account for the observation that (especially) language learners tend to "echo" words they have recently heard to be used in their own production; listening to speech results in the activation of recent utterances, which increases the chance that precisely these words are used in speech. These issues are further discussed in the chapter about lexical acquisition (3.2.2). The conclusion is that no separate lexicons will have to be assumed for production and comprehension.

To account for production and comprehension making use of the same lexicon, it is necessary to look beyond models of the lexicon and to consider language processing in a more general framework. In the influential model proposed by Levelt (1989, 1993), the lexicon constitutes the core of information processing. This model is generally recognised in all its aspects, and a detailed discussion of it will go beyond the scope of this study, as morphology is not a central issue in this model. However, a schematic overview of this model, clearly reveals the central position of a lexicon that is neutral between production and comprehension (see Figure 7). The

simplified description of this model presented here will focus on the role of the lexicon.

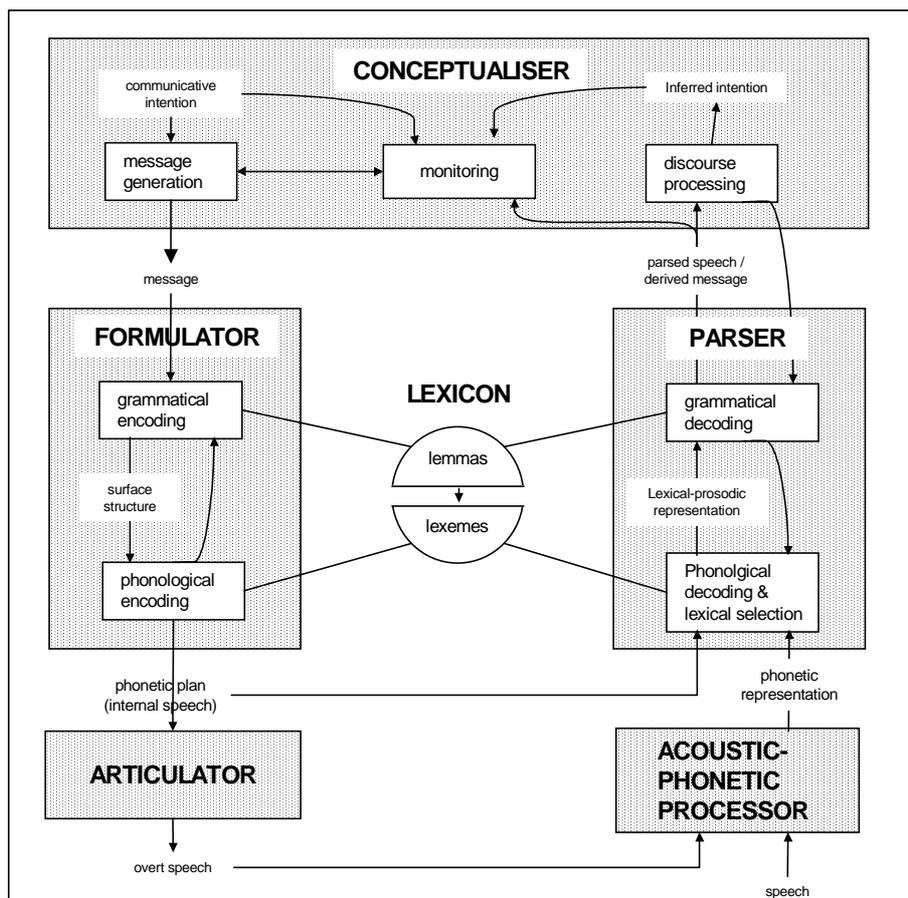


Figure 7. Schematic representation of the processing components for the comprehension and production of spoken language (After Levelt, 1993).

In Levelt's model, the production of speech takes place in three relatively distinct stages. The starting point of lexical access is the Conceptualiser, generating a preverbal message that triggers a set of conceptual characteristics. The co-activation of these conceptual characteristics leads to the activation of a particular node, which in production studies is conventionally called the "lemma". The lemma thus activated is associated with a set of syntactic properties that determine its syntactic category and its argument structure. The interactive association of lemmas and their syntactic properties to combine into well-formed sentences is labelled "grammatical encoding". Grammatical encoding can be compared to, as Levelt puts it "solving a

set of simultaneous equations” (1993:4): the eventual output of the process of grammatical encoding, the “surface structure”, satisfies all the syntactic properties of all the lemmas selected. The surface structure has not yet been specified for its phonological characteristics. This is taken care of in the next stage, “phonological encoding”, where the phonological information associated with the selected lemmas is matched to phonologically encoded word frames. This procedure takes place in two steps: first an empty skeleton is generated which is then filled with the segmental content retrieved from the lexicon. Hence, the lexical representation in Levelt’s model comprises two elements: the lemma, containing semantic and syntactic information, and the phonological form associated with that lemma, which is used at a different moment in speech processing; the latter is conventionally labelled “lexeme”. In Levelt’s conception of the lexicon, morphology is included at the level of the lexeme. Speech comprehension can broadly be regarded to involve the same steps as production in reversed order, although the two directions have their own specific problems. A problem for comprehension that has not yet been satisfactorily solved, for instance, is the segmentation of speech to account for the accurate activation of access representations. For production, the problem that is pertinent to the current discussion is the mapping of concepts to lexical structures. In the remainder of this section, these two problems will briefly be elaborated on. Finally, the position of morphology in this model will be discussed.

### *Comprehension*

It has been argued in the previous sections that access representations are modality neutral, and that different interfaces have to be presumed to account for the activation of access representation. For the visual modality, this does not cause many problems, as words can easily be visually recognised. Only spelling rules, like doubling consonants in, for instance, *clapped* may complicate segmentation into *clap* and *-ed*. But it can be assumed that this is solved by a supra-lexical spelling parser as far as this concerns regular processes, while in case of real idiosyncrasy unitary access will take place. Phonological segmentation may not be equally straightforward, as words are not normally pronounced separately. One solution to this problem is the assumption that word-initial cohorts play an important role (see Marslen-Wilson & Tyler, 1980). An initial cluster, like [tr], will conjure up a range of possible words. Upon the perception of subsequent sounds (for instance [treɪ]), this range is narrowed down (*train*, *trade*, *trail*, *trace*, *train*, etc.). In the course of speech, the listener constantly narrows down the range of possibilities, eventually coming to an identification of access representations. Another solution to this problem is found in prosodic cues (see Cutler & Norris, 1988 and Cutler, 1994). Cutler (1994), for instance, stresses the importance of rhythmic segmentation, which is language specific and independent of previous (successful) parsing and the frequency of occurrence of forms in the input. Evidence for this position is found by the observation that pre-linguistic children develop sensitivity to rhythmic structure to enable them to solve the segmentation problem. The latter solution is particularly appealing, as it is in line with the view that prosodic frames play an important role in production too. The details of these solutions will not be discussed here; the main point

is that either approach is compatible with the Meta Model of morphological processing. Particularly the idea of prosodic segmentation is attractive, since this does not require the interaction of phonological and semantic cues at the level of what Schreuder & Baayen (1995) called the intermediate access representations.

### *Production*

With regard to production, one of the problems that have to be solved concerns the matching of concepts to lemmas. The selection of a concept triggered by the conceptualiser must eventually converge into the activation of one particular lemma. To attain this, it could simply be assumed that there is a one-to-one relation between conceptual representations and lemmas. Although this might be the case for concrete nouns, a one-to-one relation probably cannot hold for concepts that are more abstract. The activation of several conceptual primitives converges into the selection of one particular lemma. However, the consequence of this position is what Levelt calls “the hypernym problem”: “When lemma A’s meaning entails lemma B’s meaning, B is a hypernym of A. If A’s conceptual conditions are met, then B’s are necessarily also satisfied. Hence, if A is the correct lemma, B will (also) be retrieved.” (Levelt 1989: 201). In other words, the mechanism of convergence cannot account for the selection of more specific lemmas: if *cat* is selected, then *animal* will automatically also be selected. Recently, two interesting solutions for the hypernym problem have been proposed. One (Roelofs, 1992, 1993, 1997) argues in favour of a strict one-to-one relation between concepts and lemmas, thereby avoiding the hypernym problem, the other (Bierwisch & Schreuder, 1993) postulates an additional stage between the conceptualiser and the formulator to solve the problem.

Roelofs’s (1992) proposal entails that all concepts in the lexicon are related by conceptual links that express the relation between the concepts. For instance, the concepts *cat* and *animal* are linked by a conceptual link specifying that an IS-A relation between the concepts. Through activation spreading, the activation level of a particular concept node is enhanced, causing an activation spreading to the associated lemma. This proposal has been convincingly tested for the lemma selection of concrete nouns. However, defining the specific conceptual links for abstract nouns and verbs may be problematic. Moreover, the ultimate purpose of the present book is to account for morphology in a second language. It will be argued later (in Chapter 3) that lemmas are language specific, but conceptual structures are not: there may be considerable conceptual overlap between similar lemmas across languages, but hardly ever will they form a complete match. The partial overlap between lemmas and the different ways in which the same concept can be expressed makes that a model that advocates a one-to-one relation between concepts and lemmas is not very suitable for the current purpose.

The starting point of the proposal by Bierwisch & Schreuder (1993) is that the meaning of lexical entries is composed of multiple primitive elements. The core of their proposal is an elaboration of Levelt’s (1989) model in which the mapping processes (from conceptual structures to semantic forms and vice versa) interact with the grammatical encoder and the mental lexicon. This is done by postulating an interface between the purely non-linguistic conceptual structure (the “output” of the

Conceptualiser) and the linguistic semantic form (the semantic properties of a particular lemma): the Verbaliser. Their main reason to do this is that linguistic information is potentially ambiguous, while conceptual information, by its very nature, is not.

In Figure 8 an outline is presented of their proposal. The conceptual structure (CS) contains the non-linguistic semantic information that the speaker wants to express. The function of the Verbaliser (VBL) is to “split up CS into chunks that can be lexicalised” (Bierwisch & Schreuder, 1993: 43) and to pass on these chunks to be matched to the semantic form of the appropriate lexical entries ( $E_i$ ). Together with the selection of the SF of a lexical entry  $E_i$ , also the argument structure,  $AS(E_i)$ , and the grammatical functions,  $GF(E_i)$  of the lemma are selected and made available to the formulator. The integrated semantic form of the entire utterance (SF) is assembled on the basis of information from the selected lemmas combined with information from the VBL, mediated by the Formulator. The possibility of feedback is created by an interpretation mechanism (INT), which also accounts for speech comprehension. The output of the formulator, the surface structure (SS) forms the input of the articulator, which in conjunction with the phonetic information contained in the lexicon generates the phonetic form (PF).

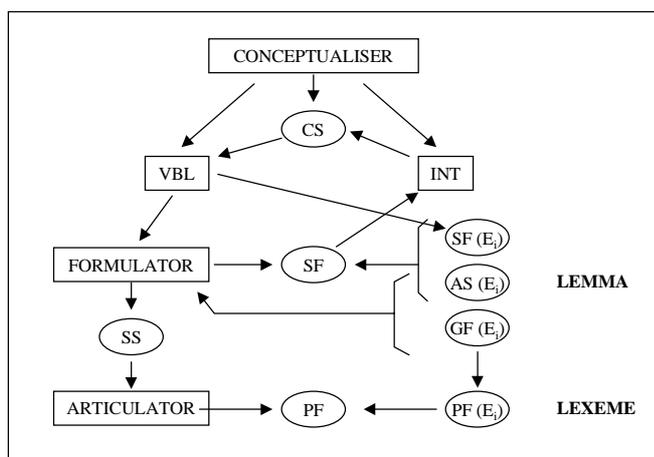


Figure 8. Representation of the interaction of the components in language production (after Bierwisch & Schreuder, 1993). It should be noted that the arrows in this figure do not represent the actual flow of information in time, but represents the way in which the different elements of the system depend on each other.

A problem for this approach (and for that of Levelt, for that matter) is what Bierwisch & Schreuder call “the chunking” problem, which is a consequence of the modular nature of their model (similar to that of Levelt). Since the conceptualiser has no access to the lexicon, no information is available to the conceptualiser about the availability of semantic forms in the lexicon. Similarly, no interaction is possible

between the formulator and the conceptualiser, so that no feedback is possible either. Consequently, it is unclear how the elements in the CS are identified that can actually be lexicalised. Bierwisch & Schreuder postulate an interface between the Conceptualiser and the lemma: the Verbaliser. The Verbaliser translates the non-linguistic information in the CS into elements in the SF that can be verbalised. Contrary to the Conceptualiser, therefore, the Verbaliser must have knowledge about which information chunks can be lexicalised. This mechanism is a first step in finding a solution for the chunking problem, though it shifts the major problem from the Conceptualiser to the Verbaliser. It is still not clear how chunking takes place. Bierwisch & Schreuder acknowledge this and argue that the chunking problem cannot yet be solved, as little is known about the precise nature of the processes underlying conceptualisation. Possibly, some mechanism of activation feedback is involved. Similar to the function of the access representations in comprehension (see 2.4.3), abstract semantic primitives could be postulated at the level of the Verbaliser. Upon a successful match of a SF to a lemma, activation may flow back to the primitives contained in the Verbaliser. Of course, this is an oversimplification that says nothing about the actual translation from conceptual chunks to verbalisable chunks in the Verbaliser. But it does provide a metaphor to express the interaction between the non-linguistic information originating from the Conceptualiser to the selection of lexical elements.

An additional problem in Levelt's model is that the conceptualiser is directly responsible for the selection of lemmas. This, we have seen, leads to the hypernym problem. The solution that Bierwisch & Schreuder offer is to be found in the introduction of the Verbaliser. As has been argued above, contrary to the conceptualiser, the Verbaliser is not blind to language-specific information. The following processing principle could be formulated upon this basis:

“An SF(i) triggers Lemma (m) if and only if there exists complete match of all structures in SF(i) with all structures in the semantic representation of the lemma.” (p. 51).

This principle enforces a one-to-one relation between the semantic form and the lemma, given the non-existence of pure synonyms. It implies that the semantic properties of the lemmas to be selected must have precisely those characteristics that are contained in the chunks of the CS. This will include pragmatic information, like the choice of register.

### *Morphology*

In Levelt's model, morphological information of the lemma is positioned at the level of the lexeme, similar to phonology. However, in the previous sections it has been argued that lexical representations should include morphological types. As Bierwisch and Schreuder (1993) acknowledge, “affixes combine with major lexical entries to create combinations that are again lexical items” (p. 29). Therefore, it is necessary to account for an infinite number of “virtual” lexical entries in the lexicon. In section 2.4.3 the representation of the lexicon by Meijs (1975, 1979, 1981b, 1985) gives a clear impression of this. Moreover, productive morphological types have a conceptual interpretation and must be represented in the conceptual structure of the

message; these types are constantly used to accomplish complete matching of lemmas onto the semantic form (SF) of the entire message. This implies that productive morphological types should be regarded as declarative rather than procedural knowledge, very similar to lemmas. Meaning can be expressed and interpreted by the activation of morphological types. However, contrary to other lemmas, morphological types that have been activated will have to be combined with the root they are to be attached to. Following Schreuder & Baayen's (1995) model of morphological processing in comprehension, this combination has to be licensed on the basis of the syntactic properties of the affix and the root. A crucial role in the licensing of combinations of roots and affixes is played by the argument structure of the lemma. In the proposal of Bierwisch & Schreuder, the semantic form of the message not only triggers the semantic information contained in the lemma, but also the argument structure. Argument structures, they argue "are clearly based on the conceptual content to be associated with the lexical entry" (p.29). It is the argument structure of the lemma that specifies the syntactic arguments required or licensed by the lemma. In the case of morphology, the argument structure associated with the lexical representation of the affix type determines whether the combination of root and affix are legal. Furthermore, the argument structure of the resulting combination will inherit the argument structure of the morphological type. One of the possible accounts of this process is the one presented by Lieber (1981), discussed in 2.3, which takes the subcategorisation frames (i.e. the predecessor of argument structure) as the starting point for the coinage of morphologically complex forms. The central issue here is that the argument structure of all the morphemes in a word must be satisfied.

This approach has great advantages in that it accounts for the apparent conceptually determined nature of morphological types. Moreover, the independent position of morphology has a great explanatory power in accounting for type-familiar and item familiar access of morphologically complex words in language comprehension (see 2.4.3). Yet, for language production one problem remains to be solved. Some morphological types cannot be uniquely selected based on their conceptual characteristics, while the strict modular organisation of the main elements in Levelt's model blocks the possibility of feedback or lookahead. For instance, consider the selection of a morphological type expressing the conceptual structure of "the quality of being X". The lexicon contains two entries that match this conceptual representation: *-ity* and *-ness*. How can the system make a choice? Different from the hypernym problem, there seems to be no conceptual ground for the selection of one of these affix types. However, these types can be distinguished on the basis of lexical criteria. For instance, *-ity* attaches to Latin roots, while *-ness* normally does not. The selection can also be morphologically conditioned: *-ity* can productively be used in combination with *-able*, while *-ness* is more productive in most other contexts. If it is assumed that the conceptual structure cannot "look inside" the lemmas before selection takes place, these lexical criteria cannot be used to distinguish between these two affix types. Unfortunately, no solution to this problem is found yet without affecting any of the principles advocated here. One solution is that the matching mechanism does not "blindly" select a lemma, but negotiates with the syntactic properties of the lemmas to be selected and takes account of other lemmas that have

been selected to verbalise the message. Another solution is to assume a loop that returns a failed licensing attempt to the Verbaliser. The Verbaliser can then select a new affix type, or after several failed attempts, may even rechunk the message. Both of these solutions affect the strict modularity of the system. However, some form of interaction between the Verbaliser and the lemma must be assumed to account for this apparent problem and the latter solution is the least radical. Further need for the existence of a feedback mechanism between the Formulator and the Verbaliser is motivated by language acquisition (see 3.2.3 and 3.3.2). It should be noted that, the chance of choosing the “wrong” affix type can be reduced by assuming that initially the affix type is selected with the highest level of resting activation.

In sum, morphological types must be regarded as having their own lexical representation containing declarative knowledge. The selection of a morphological type is motivated by the matching of conceptual chunks in the preverbal conceptual structure to the lexical representation of the affix type. The combination of a morphological type and another lexical entry is driven by the argument structure of a selected morphological type. For instance, consider the production of the morphologically complex word *greyness*. The starting point is the conceptual structure that is passed on from the Conceptualiser, mediated by the Verbaliser. Bierwisch & Schreuder’s matching principle will ensure the selection of precisely those lexical representations that accomplish full matching between structures in the semantic form with the semantic properties of the lemmas selected. If *greyness* is present as a unitary representation in the lemma, matching will be accomplished and *greyness* will proceed into the system. However, if *greyness* is not present, matching can only be accomplished by selection of the lemma *grey* and the morphological type *-ness*. The argument structure of *grey* will fulfil the requirements expressed in the argument structure of *-ness*, and the combination will be licensed to enter the Formulator for further processing. Whether unitary representation of morphologically complex words are present in the lexicon depends, as has been argued in the previous sections, on the level of resting activation of the morphological type relative to that of the morphologically complex words that contain them. The level of resting activation, we have seen, is determined by the frequency of the morphological type relative to that of the whole word. This entails that the presence of an independent representation of a morphological type in the lexicon is determined by the perceived productivity of the type, based on the input. In this way, the production of morphologically complex words is indirectly affected by type familiar comprehension of words containing the type. Finally, to account for cases where a combination cannot be licensed, a feedback mechanism must be assumed that returns information from the formulator to the Verbaliser. This mechanism must be seen as safety net that is only used when the most likely solution (i.e. using the most productive morphological type) fails to result in a licensed combination.

### *Interaction*

For comprehension, the processing of words starts with segmentation based on phonology and spelling, as described in section 2.4.3. Morphologically complex words that are opaque will have their own lexical entries; morphological types with a relatively high type frequency will also have their own representation in the lexicon.

Production will start with a conceptual structure that, mediated by the Verbaliser, triggers the activation of a set of lexical properties, which is matched to the semantic form of a particular lemma. The result of this process is that that one particular lemma receives the highest degree of activation and is, in this way, “selected”. The “lemma node” is the representation of the lemma that contains a link to the semantic form of the lemma, to the syntactic properties of the lemma and to the lexeme. Lemma nodes are essentially neutral between comprehension and production. This implies that an interaction can be postulated between comprehension and production: activation of lemma nodes due to the frequency of forms in the input will affect production. Evidence for this interaction (facilitation and inhibition) is found in many empirical studies involving picture naming (see, for instance, Roelofs, 1993), in which the subject has to name a picture (for instance of a tree), while a distracter word (for instance *dog*) is presented simultaneously. The type of error that is common in these experiments is that the subject says *fish* instead of *dog* in naming a picture of a dog presented simultaneously with the word *fish*. This can be interpreted as a result of the activation of lemma nodes: the lemma node that has the highest level of activation is used in production, even if the activation is not conceptually driven. Further support for this model will be presented in Chapter 3, where the current discussion is extended to language acquisition processes.

### 2.5.5 Inflection, derivation and compounding

Traditionally, in the literature on morphology a distinction is made between inflection, derivation and compounding. Two questions must be answered with regard to this distinction: is it possible to make a clear-cut and unambiguous theoretical distinction between inflection and derivation, and what will this distinction imply for models of morphological processing?

Proponents of the distinction between inflection and derivation usually point to the greater regularity, semantic transparency and productivity of inflectional affixes. While inflection mostly leads to words that can easily be interpreted on the basis of their morphological constituents (stem + case, number, tense, etc.), words containing a derivational affix are often not semantically transparent (*wholesome, handsome, mindful*). This would be reflected in the productivity of the affixes; the *P*-values of inflectional affixes indeed turn out to be generally higher than those of derivational affixes. However, not all inflection is fully regular and not all derivation is idiosyncratic. The difference in productivity between the least productive inflectional affix and the most productive derivational affix will be minimal. There may even be an overlap between inflection and derivation in terms of productivity. Especially when languages other than English are taken into account, the distinction based on regularity cannot hold: agglutinating languages have a very productive system of derivation. So, although regularity and semantic transparency, as expressed in productivity, may contribute to the perceived difference between derivation and inflection, this does not support a principled dichotomy of the two.

The distinction between derivation and compounding is often based on the same principle of transparency. Henderson (1985) claims that the semantic composition of

compounds is rather unpredictable (*honeymoon*), and that derivational forms are more predictable than compounds. Here too, however, this is by no means true for all cases of derivation and compounding. While derivations can be completely opaque (*handsome*), compounds may be completely transparent (*dark blue; houseboat, salad dressing*). Moreover, in terms of productivity compounding will generally be more productive than derivation. Here too, compositionality cannot serve as a sound basis to distinguish these concepts.

A further observation that will balk the hopes of a neat division into inflection, derivation and compounding, is the lack of clear dividing lines: there are many cases where these concepts overlap. An example of a borderline case of derivation and compounding is the nominal head *man* in many root compounds (*postman*). This form, occurring in a weak syllable, is less and less likely to be interpreted as “male human being”, and it is doubtful whether this form should be regarded as a free root; as compounds only take free morphemes as their constituents, *-man*, might be seen as an affix. The same holds for the first constituent in the compound (?) *cranberry*: as *cran* is not an independently occurring free morpheme, it might be considered as a prefix instead. Also, consider forms like *red-haired*. The compound status of this word would be based on its analysis as  $[[red]_A[haired]_A]_A$ . But as *haired* in itself is not an independently occurring word, the only valid interpretation of this word would be its interpretation as a “derived” compound:  $[[red\ hair]_{Ned}]_A$ .

Another common argument for distinguishing inflection from derivation (and compounding) is that inflection is “part of syntax” whereas derivation is not. This is based on inflectional affixes like English third person singular *-s*: inflection creates forms of words that have a syntactic function (agreement in this case), rather than “new” words. But, many affixes that are traditionally regarded as inflectional affixes do not seem to be syntactic, because they involve change of syntactic category like the creation of particles, gerunds and infinitival forms. Matthews (1974:53) give examples of this: the adjectival *-ed* participle in

a very crowded room

is generally seen as a derivational, whereas the same participle in

a well heated room

is generally considered inflectional. The argument that inflection tends to organise in paradigms, while derivation does not, is rejected by Spencer (1991:194), who shows that Spanish derivation may in some cases be organised paradigmatically. So, although the syntax argument is intuitively appealing and partly true, this too cannot lead to a clear, consistent and systematic distinction between inflection and derivation.

In arguing in favour of the distinction, Scalise (1988), lists nine differences between inflexion and derivation. As his starting point is a rule-based system, Scalise labels them Inflection Rules (IR) and Derivation Rules (DR) respectively:

- 1) DRs but not IRs, change the syntactic category of their base.

- 2) Inflectional morphemes are peripheral with respect to derivational suffixes.
- 3) Derivational suffixes are heads, where inflectional suffixes are never heads.
- 4) DRs and IRs "do" different things (DRs are more powerful rules).
- 5) DRs allow recursivity, IRs do not.
- 6) Readjustment rules (RRs) that operate on the output of IRs are different from the RR's that do so on the output of DRs.
- 7) Productivity in derivation is restricted to a number of very subtle types of restrictions. productivity in inflection is more "blind".
- 8) Inflection and derivation behave differently with respect to the prediction made by the atom condition: derivation can be sensitive to prefixation, whereas inflection cannot.
- 9) The structure of an inflected word is probably different from the structure of a derived word.

Some of these arguments have already been refuted in the discussion above, and some are extremely vague (4,7,9). However, these observations do point toward an observed difference between inflection and derivation (and compounding). But this cannot take the form of a clear-cut dichotomy and should be regarded as a cline with gradual transitions and with wide borders where the concepts overlap.

In some models of morphological processing, the distinction between derivation and inflection does play an important role. In Aitchison's (1994) model inflection is regarded rule-based and is applied at the same level as syntax, while derivationally complex words are stored in the lexicon with a "backup store" containing morphological information that is used when everything else fails. In parallel processing models the distinction is sometimes seen as determining the route to process morphologically complex words:

Inflectional processes might be called upon each time that we understand or produce a sentence, but derivational processes might be called upon only when we have to manipulate particular lexical forms.

Chialant & Caramazza (1995: 71)

Since we have seen that a sharp distinction on these grounds is not tenable, it is unlikely for this distinction to play a determining role in the route taken. In other models, like Bybee's (1985) connectionist model and Schreuder & Baayen's (1995) Meta model, no principled distinction between inflection, derivation and compounding is made. The latter, for instance, always takes the distributional properties of an affix as a starting point, regardless of the nature of the affix. Since words containing inflectional affixes will usually be very transparent and require little computation they are likely to be decomposed rather than stored. But in spite of the high transparency, also regularly inflected forms may be stored if their token frequency is sufficiently high. The same position is taken by Meijs (1981b) and Bybee (1995). In this way, it can also be explained why some (stored!) plural forms are more frequent than their singular counterpart, as in words like *legs* and *horns*. Similarly, very transparent derivations (Schreuder & Baayen mention Dutch diminutives) will not be stored, but will be computed, as little computation is required.

In terms of the terminology used for morphological generalisations, as presented in the discussion about the relation between meaning and form, it is more correct to speak of “morphological types” than of derivation types. Morphological types capture both inflectional and derivational generalisations in the lexicon that are used to comprehend and to produce morphologically complex words.

### 2.5.6 Methodological issues

Studies investigating the mental lexicon have yielded many contradictory results. One of the causes of the inconclusive findings is the wide variability of the methods used. The famous discussion about Taft & Forster’s (1975) prefix stripping model, for instance, has mostly been focused on methodological issues. Even recently, in Schreuder & Baayen (1995), more methodological flaws of Taft & Forster’s study have been revealed. Since methodological issues have been crucial in models of morphological processing, this section will briefly elaborate on the most relevant points of discussion. Two of the main points are the definition of terms and the (non-) use of control conditions, leading to weaknesses in validity and reliability respectively.

A powerful experimental device to investigate access procedures in the mental lexicon is the use of non-words or pseudo-words. Apart from the terminological confusion (see the discussion about this in section 2.2), the use of these words has been criticised for reasons of validity: presenting subjects with pseudo-words will create an artificial situation that may induce morphological decomposition that might not be used otherwise. It is therefore unclear to what extent findings from studies using this device can be generalised to normal word processing. In addition, Henderson (1985) points to the inconsistency in studies involving pseudo-affixed words concerning the different definitions used for pseudo-affixation, which could explain the variability in the results. In some studies (Manelis and Tharp, 1977; Rubin et al., 1979) the criterion used for affixedness is that the root of the derivative is a free morpheme, while this has not been a criterion for all. Taft (1981), for instance has limited his choice of prefixed items to roots that do not enter into other word formation (monogamous roots, like *trieve* in *retrieve*) while others (Henderson et al., 1984) have only used polygamous roots for prefixed words, the root not necessarily being a free morpheme. Since most of the studies are based on the difference in latencies between affixed and pseudo-affixed words, this is an important consideration. Moreover, it limits the possibilities to compare studies investigating reaction time differences between affixed and pseudo-affixed words.

Some controversy can also be found in the selection criteria for words and pseudo-words. Taft & Forster (1976) report that it had been difficult to determine whether a word is morphologically complex or not (admit, devout, infant). To solve this dilemma, they relied on their own intuition, using as a leading cue whether the prefix contributes to the meaning of the whole word (645). This, of course, is an arguable criterion that has been severely criticised. In a later study (1981), Taft presented the words to 10 judges who were asked to assess them on morphological complexity beforehand. Although this must certainly be seen as an improvement, the

reliability of such judgements has also been questioned. Smith (1988), for example points out that when judges are given explicit instructions, they are likely to give back what they were instructed, which is not necessarily their own instructions. Henderson (1985:63) also points to the inaccurate selection criteria that Taft & Forster (1975) used for their words and pseudo-words. Taft & Forster report that words that were the bound roots of prefixed words (like *-juvenate* for the word *rejuvenate*) took longer to reject than non-morpheme end portions (*-pertoire* for the word *repertoire*). But they did not take into account that many of the bound roots they used were polygamous (for the bound root *-semble*, based on *assemble*, they neglect the coexistence of *resemble*, *dissemble*, etc.). In response to Taft & Forster (1975), Schreuder & Baayen (1995) propose a motivated set of criteria for pseudo-stems, relating to their syllabification, length, transparency and their participation in productive word formations. Objective selection criteria like these are essential in conducting reliable and valid experimental studies. Finally, the criteria for the selection of pseudowords should include the “neighbourhood” of the pseudo-word. Coltheart et al. (1977) demonstrated that the more words that are one letter different from a non-word, the longer the lexical decision responses to that non-word tend to be.

Many studies have failed to incorporate variables like word length and frequency as a control variable, though these, and frequency in particular, turn out to be major variables affecting word recognition. On the other hand, frequency should not be confused with familiarity: frequency figures are not necessarily reflecting the familiarity of words. A word like *sleet* (Cobuild/CELEX lemma frequency = 1), for instance, might be more familiar than a word like *fen* (Cobuild/CELEX lemma frequency = 57 tokens) or *bailiff* (Cobuild/CELEX lemma frequency = 56 tokens). The latter observation has hardly been taken into account in psycholinguistic experiments, mainly because no objective measure of familiarity is yet available.

## 2.6 Requirements for a model of morphological processing

The aim of this chapter has been to establish a set of requirements that an adequate model of morphological processing should comply with. The ultimate purpose is to make a motivated choice for a particular model that can be adopted (and adapted) to account for the processing and development of L2 morphology. Out of all the models that have been discussed in the previous sections, only few remain that can explain all the data observed.

It is sometimes argued that morphology should be regarded as part of the periphery of language processing. Henderson (1985), for example, maintains that “morphological rules have been incorporated into the systems for reasons of convenience rather than necessity” (Henderson, 1985: 65). However, a careful examination of the linguistic theories of the lexicon in combination with an evaluation of the main findings of experimental studies investigating the mental lexicon reveals that the contribution of morphology in verbal processing is more important than Henderson assumes.

Linguistic theories have provided insights into several aspects related to morphology, but no suitable model has been proposed. Theories using word formation

rules cannot adequately account for the productivity problem and other models usually provide synchronic pictures of the lexicon that are unable to account for dynamic language processing. Some theoretical implications, however, may contribute to the formation of an adequate model of morphological processing. The productivity problem, for instance, provides us with another argument to include a mechanism of (de)composition into a model of morphology. The same problem also shows that this should probably not take the form of word formation rules. Another outcome of linguistic theory that can be directly applied to modelling morphological processing is the idea of subcategorisation frames. Subcategorisation frames, or argument structures provide a typical example of the type of syntactic information that lexical representations should contain.

The main question of this chapter concerns the preferred access strategy of morphologically complex words. With regard to this, it can safely be concluded that the two systems, direct access or decomposition, are not mutually exclusive. The argument of efficiency is often mentioned as the main reason to compose words rather than store them. Indeed, it seems highly inefficient to store regularly formed words like *read*, *reader* and *reads*. However, the same argument of efficiency can also be used against the application of rules: in order to correctly produce a morphologically complex word according to some rule, the language user will have to apply rules at three different levels: syntactic, semantic, and (morpho-) phonological / orthographic. It follows from this that before an affix can be attached to a base form, knowledge is required about the syntactic category of the base form and of the target form, and of the correct phonological / orthographic representation of the desired target form (as determined by morpho-phonology). It is obvious that for a process like this to operate successfully and efficiently, only the most productive and most frequent complex morphological items are likely to be (de)composed. Furthermore, with regard to decomposition, transparency will be of great importance; only fully transparent complex items can be decomposed unambiguously. For this reason it is most likely that the language user has the competence of (de)composing morphologically complex words, but will not always use this ability. One of the major problems in the current discussion is the extent to which “rules” are used, and which factors determine whether a word will be (de)composed or not. The answer to these questions is most likely to be found by referring to the activation metaphor, in which the level of activation encompasses a complex interrelation between different variables, like transparency, productivity, frequency and processing complexity.

The main conclusions of this chapter are summarised in the following requirements:

1. Direct access and (de)composition are not mutually exclusive. Whether words attain their own representation is dependent on their individual activation level. The activation level is determined by transparency, productivity, frequency and processing complexity. Productivity varies as a function of transparency and frequency.
2. For comprehension, access procedures serve as filters for the access of lexical representations, taking care of spelling and phonology.

3. Lexical representations should contain or refer to properties defining syntactic, semantic/pragmatic information. The syntactic properties can be seen as (sub-)categorisation frames or argument structures of the lexical representation.
4. Morphological regularity in the lexicon is not organised as procedural knowledge, like Word Formation Rules, but is driven by the argument structure of the lexical representations. The lexical representation of morphological constituents is organised in morphological types that are expressed in terms of their semantic/pragmatic, syntactic and orthographic/phonological properties.
5. Lexical representations should be considered modality-neutral. Different access procedures must be assumed for the different modalities.
6. Lexical representations are neutral between comprehension and production; production can roughly be seen as the reverse of comprehension. The interaction between production and comprehension must be accounted for.
7. A model of the role of morphology in the mental lexicon should fit into an overall account of the production and comprehension of language.
8. Although there are some clear practical differences between derivation and inflection, no principled distinction between inflection and derivation can be made

Two models that were discussed in this chapter most clearly satisfy these criteria or can easily be modified to account for them: Schreuder & Baayen's (1995) Meta Model and Bybee's (1995) connectionist model. These models are essentially of a different nature; Bybee's model has great explanatory power, but is more theoretical in nature, and therefore less testable and thus not suitable for the current purpose, while Schreuder & Baayen's Meta model is geared towards computation and is more likely to be empirically testable. However, in the Meta model not all points mentioned above are accounted for or made sufficiently explicit. Therefore, some alterations and additions to this model are proposed, the result of which is presented in Figure 9. After these adjustments, the model meets all the necessary requirements listed above. The schematic overview in this figure is simplified in several respects, and the arrows represent the way in which the elements in the model depend on each other rather than a processing sequence. One of the simplifications, for instance, concerns the interaction between the lemma nodes and grammatical encoding and decoding and the nature of the lemma nodes. It has been argued in section 2.5.4 that word coinage is driven by the argument structure of the morphological type. Yet, in this figure no argument structures have been represented at the level of the lemma nodes. A representation of the elements contained in a lexical entry is given in Figure 10. This figure shows which elements a lexical entry must consist of and how these elements interact with each other and with the conceptual structure as generated by the Verbaliser. A morphological type is presumed to have a representation that is very similar to that of a lemma. In the remainder of this section, this model will be discussed in terms of the requirements postulated above.

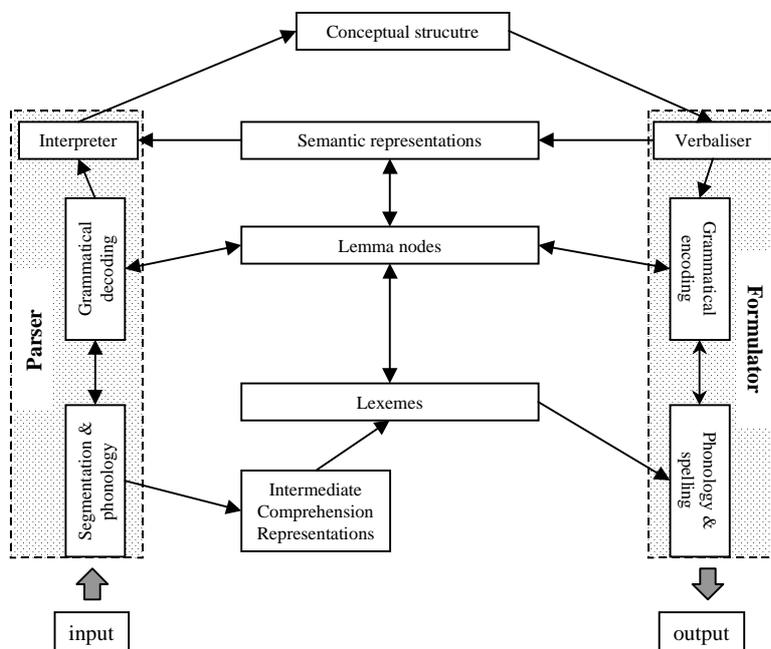


Figure 9. The Lexicon in a model of language processing

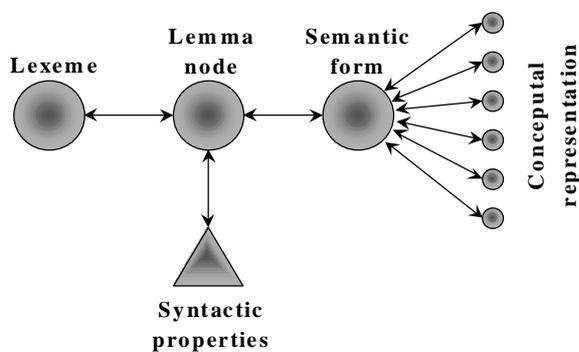


Figure 10. Schematic representation of the elements of a lexical entry and their interaction with the conceptual structure

That this model meets Requirement 1 can be illustrated by some simple lexical examples. In Figure 11, the differential processing of three morphologically complex words has been worked out for recognition: *frankness*, *darkness*, and *grateful*. It will be shown that the processing of these words can be accounted for in terms of transparency, frequency and productivity. For all these words, the examples repre-

sent a particular moment in time for a particular speaker. It should be noted that the representation in this figure has been abbreviated by omitting the semantic form attached to the lemma nodes. Since a one-to-one relation between the lemma node and the semantic form can be assumed, the semantic form has been left out.

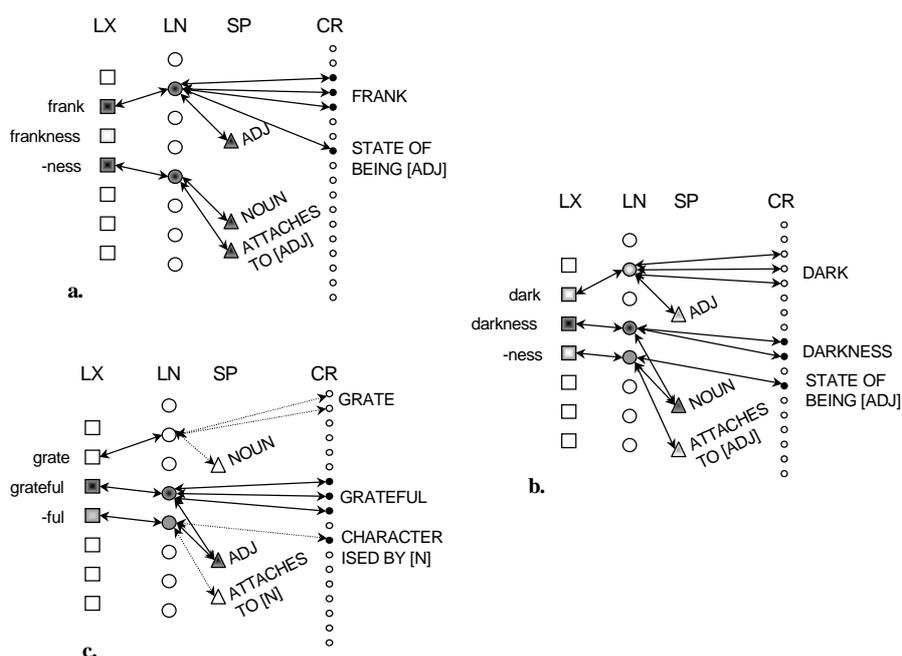


Figure 11. Processing of the words *frankness*, *darkness*, and *grateful* according to the modified Meta Model. Activation spreads between the Lexemes (LX), the Lemma Nodes (LN), the Syntactic Properties (SP) and the Conceptual Representations (CR). The level of activation is represented by the degree of shading of the nodes. The dotted lines represent potential links that are not currently activated. This figure has been abbreviated by omitting the "semantic form".

*Frankness* (a. in Figure 11) is fully transparent and based on a productive morphological type. This can be illustrated by some simple lexical statistics. The root *frank-* occurs in five different forms: *frankincense*, *frankly*, *frankness*, *frank*, and *franking machine*<sup>19</sup>, with a cumulative root frequency of 511. The surface frequency

<sup>19</sup> All data have been taken from the CELEX lexical database; the frequency figures refer to the cumulative COBUILD frequencies for written and spoken sources. As the purpose of the data presented in this section is to illustrate a point, these data have not been carefully verified (for instance for double occurrences due to the selection criteria).

of *frankness* is 44. The relative frequency of the surface form as a function of the root can be expressed by calculating  $F_{\text{frankness}} / F_{\text{frank-}} = 0.09$ . However, *-ness* occurs with 1353 different roots, and has a cumulative type frequency of 20.179. In terms of activation, this implies that *-ness* will have a high resting activation, because it occurs with many different roots and is very productive. The productivity can be expressed by calculating the average frequency of the different types, so by dividing the cumulative type frequency ( $F_{\text{type}}$ ) by the number of different types ( $N_{\text{type}}$ ), resulting in the average type frequency ( $F_{\text{av}}$ ), which is 14.9. A more adequate measure of productivity can be computed by taking into account the number of hapaxes and calculate  $P = n_1/N$  (see 2.5.1). For the corpus used, this amounts to  $P = 0.011$ . The combination of the low relative surface frequency of *frankness* and the high type frequency of *-ness* will make it unlikely that the surface form has an independent lexical entry. The word will therefore be processed type-familiarly.

The same line of argumentation can be applied to the next word in Figure 11, *darkness* (b.). If we look at the statistics, however, we will have to conclude that *darkness* has much more chance to be given its own lexical entry, although it is fully transparent. The root *-dark* occurs in seven different forms, and has a  $F_{\text{root}}$  of 4815. The surface frequency of *darkness* is 969. So the relative surface frequency of *darkness* is 0.20 (the number of occurrences of the word *darkness* accounts for 20 per cent of all words containing the root *dark*). The data for *-ness* are, of course, the same as those of *frankness*. This means that for *-ness* we find again a high type frequency, but this time combined with a high relative surface frequency. Compared to *frankness*, the chance that *darkness* will have its own lexical entry is much bigger. In Figure 11 this is indicated by the high activation of the lemma node of *darkness* and the conceptual representation it is connected to. This figure also shows that there will be some activation of the constituent morphemes, *dark-* and *-ness*. Since the suffix *-ness* is responsible for the syntactic category of the whole word, the lemma node of *-ness*, including its syntactic properties, is activated. It should be noted, though, that (unlike *-ness* in *frankness*) the conceptual representations of the suffix receive very little activation. Activation feedback will flow back to the lexeme connected to the whole word, and to a lesser extent to its constituents (due to the activation of the syntactic category, more activation feedback will flow to the suffix than to the root).

The third word in this example, *grateful* (c. in Figure 11), has a cumulative root frequency of 117 and a surface frequency of 80. The relative surface frequency is 0.68 (the form *grateful* makes up 68 per cent of all words containing this root, including the root itself!). In addition, the productivity of the suffix is considerably lower than that of *-ness*. The suffix occurs with 15823 different roots, which seems to indicate productivity, but the  $N_{\text{type}}$  is only 117 (The form *beautiful* alone accounts for 2075 tokens), resulting in a  $F_{\text{av}}$  of 135. There are no more than eight hapaxes, so that  $P = 5 \times 10^{-4}$ .<sup>20</sup> The combination of a high relative root frequency with low pro-

<sup>20</sup> The productivity of this type may well be low because the form of the affix represents many homonymous different morphological types. Webster's Ninth gives four different, though semantically related interpretations: "1: full of <eventful>; 2: characterised by <peaceful>; 3: having the qualities of <masterful>; 4: tending, given, or liable to <mournful>". The in-

ductivity will make it very unlikely that this form is given its own lexical entry. Activation feedback will largely flow back to the whole word, and no activation will flow back to the root, because the root *grate* is not semantically related to *grateful*, so that licensing and composition will not yield a positive result; in other words, the word *grateful* is not transparent<sup>21</sup>. Some activation will flow back to the suffix due to the activation of its syntactic properties.

The three examples worked out in Figure 11 demonstrate that both direct access and decomposition may be used in lexical processing. The choice between the two strategies is determined by the productivity of the word, which is expressed by an interaction of the relative root frequency, the type frequency, and the transparency of the affix type.

The second criterion (“access procedures serve as filters for the access of lexical representations, taking care of spelling and phonology”) is a basic assumption to the Meta model. The lexical representations, consisting of the semantic representations plus the syntactic properties that are associated with a lemma, can only be accessed if the lexemes are regarded as “normalised” forms. This is taken care of by assuming additional intermediate access representations for comprehension. The lexemes may be modality neutral, but the intermediate access representations are not. It is at this level that differential representations for visual and auditory recognition may be distinguished (requirement 5).

The lexical representations in the Meta model are attached to syntactic and semantic information (requirement 3). In the modified model (Figure 9) pragmatic properties can be assumed at the level of the semantic representation associated with a particular lemma to account for pragmatic differences between otherwise synonymous forms. For example, for the correct interpretation and production of words information is required about the register to which the word belongs. Activation feedback can also account for partial co-activation of several properties. Even if a morphologically complex word is not semantically compositional, the syntactic properties of an affix in that word may be activated, resulting in activation flowing back to the lemma node of the affix type and eventually to the lexeme associated with that affix type. This has been exemplified in Figure 11, where co-activation takes place of some of the syntactic properties of the affix *-ful* and the whole word. Although the affix in this case does not contribute to the semantic representation of the word, it does determine its syntactic category. It may even be argued that only the syntactic information of the affix is used, and that the lemma node of *grateful* does not refer to a syntactic category of its own.

Rather than defining morphological regularity in terms of traditional word formation rules, the Meta model allows us to express morphological regularity in terms of frequency and productivity of morphological types (requirement 4). A morpho-

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terpretation indicating “the number or quality that fills <roomful>” is left out of all analyses.

<sup>21</sup> Transparency should be interpreted as a synchronic phenomenon. Speakers who have some etymological knowledge or speakers who know Latin may realise this from *is* derived from obsolete *grate*, meaning “pleasing”, from Latin *grātus*.

logical type is no more or less than the observed generalisation of an affix to attach to a particular kind of root. If licensing and combination on the basis of an affix is successful, the affix will receive activation feedback. In this way, affixes, like words (and roots, for that matter) can be given their own lexical entries.

Comprehension and production make use of the same lexical entries (requirement 6). Although the discussion thus far has primarily focused on recognition and comprehension of morphologically complex words, there is no reason to assume that production processes are essentially different. The model sketched in Figure 9 is fully compatible with the Meta model on the one hand and with generally accepted production models on the other. In both comprehension and production, phonological decoding and encoding are external to the lexicon. The lexemes (which in the original Meta Model are labelled “access representations”), however, will contain phonological information that has been derived from comprehension and that can be used to fill the phonological frames that are established by the formulator.

Requirement 7 states that a model accounting for the production and comprehension of morphologically complex words should fit into an overall account of production and comprehension. The overall model that has been adopted for this purpose is Levelt’s “Speaking” model, as this model has great power in explaining empirical facts and allows for the neutral position of the lexicon between production and comprehension. However, some tension occurs between requirement 4 and requirement 7. Placing morphological types at the level of lemmas creates a problem for the selection of morphological types, because morphological types are not always conceptually unique; they may differ only with regard to their syntactic properties. In Levelt’s model, conceptual uniqueness is a requirement for the one-way selection of lemmas: lemmas are selected on the basis of conceptual information only. In the original Meta Model this problem did not occur, as this proposal was limited to comprehension only. Moreover, this problem is avoided in the original Meta Model by positioning syntactic characteristics at the same level as conceptual properties. Generalising the model to production and adjusting it to fit Levelt’s model of language processing causes this problem to surface. The solution proposed was to assume a loop from the Formulator back to the Verbaliser that can be used when the licensing of a morphologically complex word fails. Although this compromise goes against the strict modular nature of Levelt’s model, it conveniently solves the current problem. Moreover, a similar feedback mechanism is required to account for the acquisition of this system of language processing (see Chapter 3).

Finally, the model should not make a principled distinction between inflection and derivation (requirement 8). This requirement is not problematic for the Meta Model, as this distinction is not used as a criterion for the access strategy that is applied. Fact is that the application of inflectional affixes is usually extremely productive, as regular inflectional affixes will occur with an infinite number of different roots. Therefore, no separate processing procedure will have to be assumed for inflection. Also, exceptions can easily be accounted for by assuming that these forms have their own lexical entries. For instance, irregular plural formations, like *children* and *oxen* may have their own lexical entries.

## **2.7 Conclusion**

The theories and models reviewed in this chapter led to the choice of one model, Schreuder & Baayen's Meta Model to be adopted to account for the processing of morphologically complex words. Several adjustments to this model were proposed. The most important adjustments were to make it account for the neutral position of the lexicon between production and comprehension and to suit it to a general model of language processing. One of the differences compared to the Meta model is that in the modified model the original "concept nodes" do constitute part of the information contained in the lexicon, and that the syntactic characteristics associated with a lexical entry cannot be represented at the same level as the semantic information. One of the consequences of this operation is an adjustment of the terminology that was utilised for the Meta model. The "Access Representations" in the Meta model are labelled "Lexemes" in the modified model, the "Concept nodes" have become "Lemma nodes", "Syntactic nodes" have become "Syntactic Properties" and the "Semantic nodes" have become "Semantic forms". Further adjustments concern the terminology used for the general model of language processing, adapted from Levelt (1993). Following the proposal by Bierwisch & Schreuder (1993), an additional component (the "Verbaliser") was added to Levelt's Formulator, which mediates between the lexical form of the lemma and the purely conceptual information resulting from the Conceptualiser. Furthermore, the possibility of feedback from the Formulator to the Verbaliser could not be excluded.

In the chapters that follow, the modified Meta Model as presented in this section will be used as a starting point for further development. In Chapter 3, this model will be put to the test of language acquisition data from L1, and it will be adjusted to account for observations about the bilingual mental lexicon and L2 morphology. The final version of the model will be presented at the end of that chapter.