The Unfolding of Suprasegmental Representations: A Cross-Linguistic Perspective

Author(s): Thomas Berg and Hassan Abd-El-Jawad

Source: *Journal of Linguistics*, Sep., 1996, Vol. 32, No. 2 (Sep., 1996), pp. 291-324

Published by: Cambridge University Press

Stable URL: http://www.jstor.com/stable/4176370

J. Linguistics 32 (1996), 291–324.

The unfolding of suprasegmental representations: a cross-linguistic perspective[1]

THOMAS BERG AND HASSAN ABD-EL-JAWAD

University of Oldenburg and *Yarmouk University*

(Received 23 June 1993; revised 4 March 1996)

An analysis of phonological speech errors in Arabic, English and German is carried out with a view to probing into the organization of segments within syllables and words. Arabic slips are shown to be less structure-sensitive than English and German ones. Being absent from underlying representation, suprasegmental structures are assumed to unfold gradually in real time. The erection of hierarchical representations is claimed to be slower in Arabic than in English and German because the non-concatenative morphology of Arabic prevents an early assignment of consonants to structural slots. In contrast, English and German words allow the early build-up of hierarchical structures because sufficient phonological information is available from the beginning of the derivation.

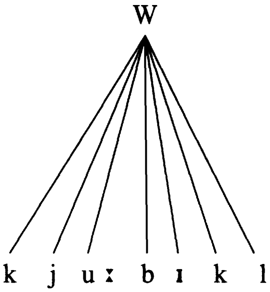
1. Introduction

The relationship holding among subordinate and superordinate units is a focal point in virtually all branches of linguistics. One foremost task for phonological research is to elucidate the organization of segments within words. The simplest option is that all segments link directly to the word node.[2] Such a suprasegmental word structure is shown in (1). This representation is regarded as unsatisfactory because it does not make reference to syllables which are generally recognized as important. A more adequate conception therefore includes a syllabic level, with the syllables themselves being linearly ordered, as in (2). This is the received view in theoretical phonology (see, for example, Goldsmith 1990).

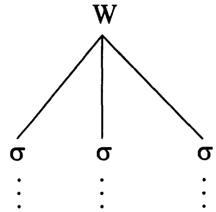
[1] Work on the research reported here was begun while the first author was a Visiting Fellow at the Max-Planck-Institute for Psycholinguistics in Nijmegen, The Netherlands. Preliminary results were presented at the 7th International Phonology Meeting at Krems in 1992. We wish to express our thanks to Stephen Monsell for enlightening discussions in the early phases of this project. Issam Abu-Salim, Winfried Boeder, Hugh Buckingham, Ulrich Schade and Nora Wiedenmann have contributed their insights on earlier versions of this article. The *JL* referees deserve our greatest respect for their penetrating comments which have led to significant changes in content and scope.

[2] In order to avoid complications introduced by the notion of foot, it will be assumed that the word is stressed on the first syllable.

(1)

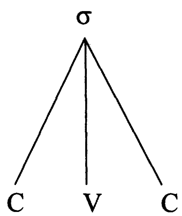


(2)

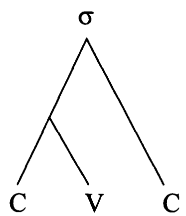


The introduction of syllable nodes raises the issue of how to organize segments within syllables. By analogy with (1), all segments may be directly connected to the syllable node. Because of the absence of any kind of internal organization, such a structure is characterized as flat (see (3)). A more complex option is to posit additional nodes and levels below the syllable and above the segment. In this view, at least some segments are only indirectly linked to syllables via these intermediate nodes. This model has come to be known as the hierarchical approach to syllable structure. In a CVC syllable, for instance, there are two kinds of intermediate structure, depending upon whether the vowel is associated with the onset (4) or the coda consonant (5). These alternatives are called left-branching and right-branching, respectively.

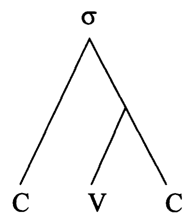
(3)



(4)



(5)



The fundamental difference between flat and hierarchical structures is that the segments are of equal status in the former but of unequal status in the latter. Unlike the flat model, the hierarchical approach makes a provision for expressing privileged relationships among segments. In (4), the nucleus is more closely tied to the preceding than to the following consonant. The onset and the nucleus form a unit in a sense that the nucleus and the coda do not. This is formally represented through the creation of a node, termed the BODY by Vennemann (1988a), which dominates the onset and the nucleus and is itself dominated by the syllable node. Case (5) is the mirror-image of (4). The intermediate node is named the RIME.

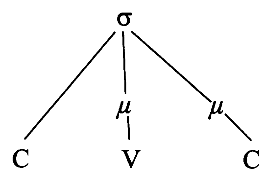
The nodes in the representations (3)–(5) may be labeled or unlabeled. As pointed out by Steriade (1988), node labeling interacts with the issue of flat vs. hierarchical structures. A flat structure with labeled nodes does some of the work that a hierarchical model without labels is capable of doing. By assigning labels such as ONSET and CODA to a flat structure, the consonantal segments enjoy an unequal status as in a hierarchical structure. However, as will be argued below, this overlap is only partial and does not imply that the two models are empirically indistinguishable.

Many different sources of evidence have been used to arbitrate among the alternatives (3)–(5). These encompass distributional biases, phonological rules (for example stress rules), low-level articulatory phenomena, poetic rhymes, speech errors, word games as well as experimental data (as obtained for example in priming tasks). Let us quickly look at the first as an illustration of the empirical differences that follow from the flat and hierarchical models. In a flat structure, the phonotactic constraints holding among any pair of adjacent elements are equally strong. By contrast, the hierarchical account assumes stronger constraints between segments sharing the same parent node than between segments which are dominated by different nodes. In right-branching structures, the co-occurrence restrictions are presumed to be tighter between the nucleus and the coda than between the onset and the nucleus. The opposite is true of left-branching structures.

As demonstrated by Fudge (1987), there exist in English co-occurrence restrictions of both kinds although they are much more severe between the nucleus and the following than between the nucleus and the preceding consonant. Given that the models (3)–(5) make predictions about preferences, that is tendencies rather than absolute laws, this line of evidence lends support to the right-branching structure of the English syllable.

A large number of phonologists concur with Fudge (1987) in favoring the right-branching hierarchical model of the syllable (for example Selkirk 1982; Booij 1983; Vincent 1986; Dow & Derwing 1989), even though dissenting voices are not uncommon. There are proponents of left-branching hierarchies (Kouloughli 1986; Iverson & Wheeler 1989; Kubozono 1989) as well as adherents of flat structures (Clements & Keyser 1983; Wiese 1986; Laubstein 1987; Wilbur & Allen 1991). More recently, yet another approach to syllable structure has found much acclaim – the moraic model (compare Hayes 1989; McCarthy & Prince 1990; Pierrehumbert & Nair 1995). This hypothesis assigns moraic status to vowels and postvocalic consonants though not to prevocalic ones. In a sense, the moraic conception represents a compromise between flat and hierarchical models. It is more hierarchical than a flat model in that it introduces an intermediate level of organization. At the same time, it is less hierarchical than a hierarchical model in that it dispenses with body and rime nodes. Mora nodes are less complex than body or rime nodes because they do not normally branch. Refer to (6).

(6)



Two reasons that have led phonologists to disagree about the issue of suprasegmental structure deserve mention in the present context. First, it cannot be taken for granted that all types of evidence invite the same interpretations. Vennemann (1988b) points out that different data sources may lend themselves to different conclusions. This cautionary notice may be particularly relevant in the case of moraic and non-moraic theories which tend to cover different phonological territory. Secondly, there is no reason to believe that all languages structure the syllable in exactly the same fashion. It may be that different suprasegmental structures represent language-specific solutions to language-specific problems.

What has hardly been considered so far is that two seemingly contradictory analyses may be equally valid. Such conflicts could be reconciled by taking recourse to a further dimension, for example, the temporal one. It is a real possibility that one representation prevails at one point in time while another prevails at a different point in time. It might be that a less complex representation is present during an earlier phase and a more complex one during a later phase. Indeed, Levitt, Healy & Fendrich (1991) report evidence to suggest that hierarchical syllabic organization is present in later but absent in earlier derivational stages.

These latter two points of the preceding discussion will be explored in detail in this article. A cross-linguistic comparison will be carried out with a view to determining whether different languages prefer different suprasegmental structures and whether these differences result from disparate ways in which linguistic representations are built up. This approach allows us to enquire into the generality of particular suprasegmental representations as well as into the process of how these representations unfold over time.

2. Method and rationale

The ensuing analysis is based upon one line of evidence which has proven quite informative in previous investigations, to wit: inadvertent errors in speech (see, for example, Fromkin 1971; Fudge 1987; Stemberger 1992). The fundamental premise of speech error research is that slips of the tongue are shaped by the same representational system which is responsible for the production of correct language. The basic logic is that if the representational system has a certain property, this property should constrain the occurrence of errors. Let us take a simple example from the word level. If lexical items are represented in terms of their word class, this property may be presumed to make certain errors likely and others unlikely. To be specific, lexical items of the same word class would be expected to interact frequently in slips of the tongue while interactions between words from differing categories would expectedly be infrequent. If tongue slips show this sensitivity to word class, we would observe an effect of similarity between the interacting elements. In fact, as demonstrated by MacKay (1970), the more similar two given units are, the more likely they are to interact in speech errors. This is what makes tongue slips fall into patterns even though their very occurrence is unpredictable.

As we are concerned with the organization of segments within larger units, the errors which are of particular relevance are those occurring at the melodic level. Our focus will be upon those aspects which speak directly to the issue of suprasegmental configurations. Specifically, three different predictions follow from the flat vs. hierarchical conception of suprasegmental structure. These predictions concern the size of the units being involved in slips of the tongue, the frequency with which individual units undergo malfunctioning and the question of which units may, or may not, interact in errors. Let us examine each in turn.

The argument pertaining to the size of the linguistic unit is straightforward. Elements which constitute a linguistically relevant unit should be more often involved in errors than those which do not. What functions as a unit is represented by a node in the diagrams (3)–(5) above. In a right-branching hierarchical structure, rime errors (that is, the simultaneous involvement of nucleus and coda) are predictably more common than body errors (that is, the simultaneous involvement of onset and nucleus)[3] because there is a rime but no body node. The opposite prediction holds for the left-branching hierarchy. In a flat structure, there is no skewing to be expected one way or the other. Body and rime errors stand an equal chance of occurrence, including the possibility that they do not occur at all in view of the absence of any nodes to support them.[4]

[3] We take rime and body slips at face value, that is, we assume that they are brought about by a single error process affecting both segments at the same time. This view is contradicted by Laubstein (1987) who asserts that putative rime errors represent a combination of two distinct error processes. Initially, a dislocation at the lexical or morphological level occurs, which is then followed by a dislocation of the onset segments. This construal is highly unlikely for two related reasons. The existence of two-process errors has not been independently established. If two-process errors are real, many other conspiracies of single-process slips should be attested in the available error corpora but are not. In short, Laubstein's account is entirely ad hoc. What is more, given the low rate of one-process errors, two-process errors should be exceedingly rare (the combined frequency of occurrence of the two single-process errors). However, this error type is not all that infrequent (N = 57 in Stemberger's (1983) corpus).

[4] The relationship between syllable structure and the frequency of rime and body errors has recently been questioned by Dell, Juliano & Govindjee (1993). In their model, the asymmetry between rime and body slips emerges in the absence of any structural representations. However, the authors introduced biases which mimic the effects of syllable structure and probably are brought about by it. To be specific, identical rimes recur more often than identical bodies in the word lexicon used by Dell et al. We submit that this frequency bias is a spin-off of the asymmetric structure of the syllable because segments dominated by the same node form a more natural unit than those which are dominated by different nodes. And it is a typical feature of human languages that more natural units figure more frequently than less natural ones. Therefore, the link between syllable structure and the size of error units is not severed by the Dell et al. study. Note also that the errors that their model attempts to explain are quite unlike those upon which the present paper is based.

As regards the frequency of single-segment slips, the flat-structure hypothesis makes a very clear prediction. All errors, be they onset, nucleus or coda errors, should be equally frequent (ceteris paribus), given that all constituents enjoy the same representational status. The situation is different for the hierarchical models. On the commonsense assumption that structure is a means of integrating elements into a larger organizational unit, we may formulate the following predictions. In a left-branching structure, the onset is more strongly integrated than the coda because the former, unlike the latter, is part of a larger intermediate unit. Metaphorically speaking, the onset is 'buried' more deeply in the suprasegmental structure. By implication, it is more difficult for the onset to break loose and be mislocated. A structure such as is represented in (4) would therefore predict a higher number of coda than of onset slips. Of course, the opposite prediction follows from the right-branching structure in (5).[5]

The constraints upon the interaction of two linguistic units may be regarded as the hallmark of suprasegmental analysis. The basic argument is as follows. Owing to the principle of similarity referred to above, two segments are more likely to interact when they are represented in similar or identical fashion. Conversely, the improbability of interaction is indicative of disparate representations. Similarity or disparity is measured by comparing the segments' links to their superordinate nodes. If they share the same parent node, they can be said to be similar in this respect; if they are dominated by different nodes, their suprasegmental representation is dissimilar. In a flat model of the syllable, the pre- and postvocalic consonants link to the same superordinate node and therefore are free to interact in slips of the tongue. By contrast, the fact that pre- and postvocalic consonants connect to different nodes in hierarchical models (both left- and right-branching) puts a (non-absolute) ban on their interaction.[6]

[5] Dell et al. (1993) also challenged the view that the frequency of single-segment slips is linked to syllable structure. However, their account has been shown to be empirically inadequate by Berg (1991). A further explanation for the differential frequency of single-segment slips has been advanced in the relevant literature. For example, Nooteboom (1967) claimed that units that are more frequently involved in errors are more highly activated. Actually, both accounts, the activation and the syllable-structure account, are quite compatible and related. Because in a right-branching hierarchical model, onsets are less constrained by subsequent material, they can be activated more easily. This is not to say, however, that syllable structure is the only determinant of activation levels. Rather, the point is being made here that activation levels may depend upon representational aspects and that therefore processing accounts are not apt to replace representational ones.

[6] There is one potential alternative of accounting for the position-bound interactions, but it is not workable. It might be held that the restrictions on possible interactions can be defined in terms of position with respect to an adjacent vowel rather than in terms of syllable position. In this view, any positional restriction follows from the claim that prevocalic (postvocalic) consonants interact only with other prevocalic (postvocalic) consonants. This hypothesis is weaker than a syllable-based constraint because it accounts only for restrictions on the interaction of C_1 and C_2 in a C_1VC_2 word but it does not make the interaction of C_1 and C_4 in a disyllabic $C_1C_2V_1C_3.C_4V_2C_5$ word more likely than that

It is important to view all three lines of argument in conjunction. If these lead to consistent results, a stronger case can be made for a particular conclusion. In fact, when only a single line of argument is considered, alternative interpretations cannot be ruled out. For example, the rarity or absence of non-homologous segment interactions can be interpreted in two ways. It may be taken as supporting a flat model with labeled nodes as well as a hierarchical model without node labeling. However, when the positional constraints co-occur with a predominance of rime errors, there is good reason to prefer the hierarchical to the flat model. In addition to strengthening the theoretical analysis, consistent results would also lend credence to the view that the three argumentative strands are related.

It is widely agreed that underlying representations contain only distinctive information. Syllables, or to be more precise, syllable boundaries are redundant in that languages do not have words which are solely distinguished by syllable-boundary placement. Hence, underlying representations are generally assumed to lack syllabic information, both in linguistics (for example, Donegan & Stampe 1978) and in psycholinguistics (for example, Levelt & Wheeldon 1994). It follows from this that the suprasegmental structure of a word has to be built up in the course of the derivation. This process may be reasonably presumed to take time (rather than to be instantaneous). Consequently, little suprasegmental structure is to be expected in the early stages but a more highly structured representation in the late stages of the derivation. As a matter of fact, speech errors also speak to this issue. Some types of errors can be chronologically ordered relative to one another such that one type may be argued to occur relatively early and the other relatively late. This logic lets us expect that the early errors exhibit less suprasegmental structuring than the late ones.

In the next section, the predictions from the flat vs. hierarchical conceptions of the syllable will be put to the test. In particular, it will be explored whether different languages follow the same route in erecting their suprasegmental structure. Possible explanations for the empirical results will be discussed thereafter.

3. Data analysis

The ensuing analysis will present a comparison of speech errors from English and German on the one hand and Arabic on the other. The German data base was collected by the first author (for details, see Berg 1988), the Jordanian Arabic corpus by the second author and various other people (for a summary analysis and a sample of errors, see Abd-El-Jawad & Abu-Salim

between C_2 and C_4. However, Stemberger & Treiman (1986) argue that the rate of C_1–C_4 interactions would have to be lower than it actually is if a syllable-position effect did not exist. We therefore conclude that the restrictions on segmental interactions are best captured by taking recourse to the syllable.

	within-word	between-word	total
English	280 (13.7%)	1763 (86.3%)	2043
German	70 (6.4%)	1024 (93.6%)	1094
Arabic	330 (80.5%)	80 (19.5%)	410

Table 1
Frequency of within-word and between-word consonant substitution errors in English, German and Arabic

1987). Like most standard data bases for Indo-European languages, the Arabic corpus is an aural one. That is to say, ambient conversations were monitored for unintentional output which was written down immediately. As much of the linguistic and extralinguistic context was noted as was deemed relevant and could be accurately remembered. All errors occurred in spontaneous, unscripted speech.

The Arabic corpus is smaller (N > 1000) and has been amassed less systematically than the German sample (N > 6000). However, it is highly unlikely that a larger collection would display tendencies opposite to those reported upon below because the relevant error categories are well represented and the trends of interest emerge very clearly even in this limited sample.

The main comparison will be performed on German and Arabic for which the complete data sets are available. Additionally, quantitative information on, and examples from, English will be taken into account to the extent that they have been made available in the pertinent literature.

We will begin with a general characterization of the tongue slips in terms of the linguistic distance between the target and the error/source unit.[7] The most basic choice is a binary one. The interacting elements may come from the same or from different words. These classes are known as WITHIN-WORD and BETWEEN-WORD slips. The former category is exemplified in (7), the latter in (8). The actual slip appears before the corrected or reconstructed utterance. The critical portions are in bold.

(7) cor**c**ical. for: cor**t**ical. (from Fromkin 1973: 244)
(8) **t**eep a **c**ape. for: **k**eep a **t**ape. (from Fromkin 1973: 245)

The two slips of the tongue document the interaction of /k/ and /t/. While the alveolar stop is replaced by the velar stop in (7), the two exchange places in (8).

The rate of consonant-substitution slips as a function of distance between target and error is given in Table 1. To ensure maximum comparability

[7] This distance can only be gauged in syntagmatic errors. Paradigmatic slips will consequently be ignored in this analysis.

between German and Arabic, the German data do not include errors occurring in post-initial and pre-final positions. Because consonant clusters are uncommon in Arabic, tongue slips are almost completely excluded from these positions on purely structural grounds. The numbers for English are based upon Stemberger's (1985) large error corpus (N = 6300) and include all single-consonant slips.

A minor difference emerges between the English and German data sets. Within-word errors appear to be somewhat more common in English than in German. However, we hesitate to attach much importance to this result as the two collections are not entirely comparable. It is clear, though that between-word slips by far outnumber within-word slips in both languages. And it is equally clear that there is a vast difference between English and German on the one hand and Arabic on the other. The Arabic corpus evinces a strong preponderance of within-word errors. The difference between German and Arabic is hugely significant ($\chi^2(1) = 839.0$, $p < 0.0005$). It may thus be concluded that interacting consonants in Arabic stay closer together than interacting consonants in German (and English).

Because of this large difference in error distribution, it seems wise to treat the two error categories separately. It may be that these are differentially sensitive to the factors to be studied below.

3.1 *Constraints on consonant interactions*

The first issue to be addressed is the possible interactions among consonants. The fundamental division that needs to be made is between position-preserving and position-changing slips. Onset-onset as well as coda-coda interactions count as position-preserving while onset-coda interactions count as position-changing errors. The first type is illustrated in (9), the second in (10). Both cases are taken from the German collection. All non-English examples are augmented by a phonetic transcription of the relevant parts and an English gloss.

(9) Kein Wunder,
daβ ich pessimi**sch**tis – pessimisti**sch** in die Zukunft sehe.
[pɛsi:mɪʃtɪs pɛsi:mɪstɪʃ]
'No wonder that I have a pessimistic view of the future.'

(10) Aber wir haben mal
die Problema**k**i**k** – die Problematik
[pro:ble:ma:kɪk pro:ble:ma:tɪk]
angesprochen.
'But we have at least broached the problem area.'

Two coda segments are reversed in (9). In (10), a coda consonant ousts an onset consonant. The frequency of slips such as (9) and (10) is reported in

	within-word p.c.:p.p.	between-word p.c.:p.p.
English	60:220 (78.6%)	28:1735 (98.4%)
German	14:56 (80.0%)	40:984 (96.1%)
Arabic	172:106 (38.1%)	13:57 (81.4%)

Table 2.
Frequency of position-changing and position-preserving errors in English, German and Arabic (percentage of position-preserving errors in brackets) (p.c. = position-changing; p.p. = position-preserving)

Table 2. Two error types in the Arabic corpus had to be discarded because they could not be easily assimilated into the dichotomy of respecting or violating the positional constraint. For one thing, singleton consonants may interact with geminates (see Abd-El-Jawad & Abu-Salim 1987 for examples and discussion). Since intervocalic geminates are ambisyllabic (Abu-Salim 1982), they defy an unambiguous classification. For another, Arabic speakers make tripartite slips in which as many as three segments are misordered in a single word. As the three consonants most usually occupy differing syllabic positions, they also resist an unequivocal categorization. This leads to a reduction by 62 items (38 geminates and 24 triples). Again, the English data come from Stemberger (1985).

The most general result from Table 2 is that all three languages have significantly more violations of the positional constraint in within-word than in between-word slips ($\chi^2(1) = 232.3$, $p < 0.0005$ for English; $\chi^2(1) = 44.6$, $p < 0.001$ for German; $\chi^2(1) = 41.3$, $p < 0.001$ for Arabic). The English and German slips pattern quite similarly. Within-word violations occur equally often in the two languages. The higher percentage of between-word violations in German as compared to English might be due to slightly different error-classification strategies on the part of the collectors. It does not probably reflect a genuine processing difference. Much more significant is the error pattern in Arabic. Violations of the positional constraint are reliably more frequent in Arabic than in German (and English), both in the within-word domain ($\chi^2(1) = 38.0$, $p < 0.001$) and the between-word domain ($\chi^2(1) = 36.8$, $p < 0.001$). We infer from these results that while between-word slips are more sensitive to positional effects than within-word slips in all three languages, Arabic is much more oblivious of this constraint than German and English.

So far, the discussion has turned on the distinction between position-preserving and position-changing slips and cross-linguistic differences in the proportions of these. Unfortunately, this approach does not tell us anything about the reality of the positional constraint. For English and German, the existence of what has been termed the PARALLEL SYLLABLE STRUCTURE CONSTRAINT has always been assumed even without an elaborate statistical argument. This assumption is most obviously correct in the case of between-word errors where the number of violations is vanishingly small. However, a more careful procedure is required for within-word slips. This involves estimating the frequency with which position-preserving and position-changing errors occur by chance, given the structural properties of the language. To this end, it was determined how many slips of each category could be fabricated in a particular word. However, it would not be appropriate to count the number of slips that could THEORETICALLY take place. The question is rather how many slips could REALISTICALLY take place. That is, the fabrication of errors must by and large respect the constraints to which actually attested slips are subject. The most important constraint on German within-word errors in the present connection is the one which strongly discourages the interaction of segments from non-adjacent syllables. To derive realistic chance levels, it is therefore imperative to fabricate only errors involving segments from adjacent syllables. In the word *Diabetiker* [di:a:be:tɪkɛr] 'diabetic' for instance, there are three opportunities of fabricating position-preserving errors (/d/ – /b/, /b/ – /t/, /t/ – /k/) and one opportunity of fabricating a position-changing error (/k/ – /r/). Pooling together all opportunities that arise in the 70 within-word slips, we obtain 134 position-preserving and 120 position-changing cases. Thus, the chance level for a slip to obey the syllable structure constraint in this error class is 52.8%. Whenever the percentage of actual position-preserving errors significantly exceeds this level, we are entitled to claim that there is a sensitivity to this constraint. As a matter of fact, this is clearly the case. The difference between chance and actual outcome is statistically reliable ($\chi^2(1) = 13.6$, $p < 0.001$). Hence, even within-word slips in German honour the parallel syllable structure constraint. In all probability, the same also applies to English.

We now turn to the within-word slips in Arabic with the object of determining whether there is any evidence for the parallel syllable structure constraint in this language. To calculate chance, a similar procedure was used as for German. A list of the first 100 words lodging within-word exchanges was compiled and the number of theoretically possible interactions in each word was counted. To make sure that these fabricated errors are as realistic as possible, only those interactions were taken into account which could have occurred in reality. Importantly, the Arabic data are subject to the proximity constraint which is so strong that the skipping of consonants in malfunctions (that is, an interaction between A and C in the sequence ABC) is greatly discouraged. Therefore, only interactions between consonants which are not separated by another consonant were included in the analysis. Take the word *θaɣraat* 'openings' as an illustration. In view of the proximity constraint, the number of possibilities of consonant reordering runs to 3 all of which are of the position-changing type (/θ/ – /ɣ/, /ɣ/ – /r/, /r/ – /t/).

On the list of 100 within-word exchanges, we counted 84 opportunities of fabricating position-preserving and 180 opportunities of fabricating position-changing errors. Calculation of χ^2 reveals that this chance distribution of 31.8% – 68.2% is not significantly different from the actual error pattern displayed in Table 2 ($\chi^2(1) = 2.6$, $p > 0.1$). This finding invites the conclusion that the Arabic within-word slips are NOT sensitive to the parallel syllable structure constraint. They respect this constraint as often as they would be expected to by chance, given the structure of Arabic words and the proximity constraint on speech errors. It seems, then, that the positional constraint does not operate AS A GENERAL PRINCIPLE in this language.

However, it would be unjustified to infer from this that the parallel syllable structure constraint does not exist at all in Arabic. As shown in Table 2, it is obeyed in 81.4% of the between-word cases. Again, the null hypothesis is needed. It was derived by calculating the number of theoretically possible cross-word reversals in the between-word error set. In the example *qaṣṣ iṭ-ṭarniib* 'ace of trump', four position-preserving (/q/ – /ṭ/, /q/ – /n/, /ṣ/ – /r/, /ṣ/ – /b/) and four position-changing (/q/ – /r/, /q/ – /b/, /ṣ/ – /ṭ/, /ṣ/ – /n/) slips can be fabricated. The 38 between-word exchanges give rise to 140 position-preserving and 128 position-changing cases. The chance level of 52.2% position-preserving errors is significantly less than the actually observed percentage ($\chi^2(1) = 18.9$, $p < 0.001$). We therefore conclude that the parallel syllable structure constraint is in effect in Arabic between-word errors.

This puzzling situation in Arabic deserves closer scrutiny. How is it possible for between-word errors to respect the positional constraint and for within-word errors to disrespect it? A detailed look at the within-word category will be of help in answering this question. As these errors come in several subtypes, it may be instructive to probe into the sensitivity of each of these subtypes to the parallel syllable structure constraint. It is at least conceivable that the general absence of this constraint is brought about by the insensitivity of one frequent subtype which might conceal a possible sensitivity of a less frequent subtype.

A more fine-grained analysis of within-word slips necessitates two basic distinctions, one between adjacent and non-adjacent segment interactions (at the melodic tier) and the other between within-syllable and between-syllable interactions. All four possible combinations will be illustrated with examples from Arabic. These are given in transliterated form which roughly corresponds to the standard phonetic symbols in the case of consonants.

(11) wa**ʕd**. for: wa**dʕ**.
'situation'

(12) bur**gd**aan. for: bur**dg**aan.
'orange' (fruit)

(13) **ru**ɣfa. for: ɣ**ur**fa.
'room'

(14) **milih**. for: **hilim**.
'dream'

While adjacent consonants are exchanged in (11)–(12), non-adjacent ones are implicated in (13)–(14). The difference between (11) and (12) is that the two consonants constitute a (tautosyllabic) coda cluster in (11) but are separated by a syllable boundary in (12). Similarly, the interacting consonants belong to the same syllable in (13) but to different syllables in (14).

All within-word slips in Arabic are divided into six categories in Table 3. The four categories exemplified in (11)–(14), which are all of the position-changing type, are augmented by two position-preserving sets: the initial-initial and the final-final interactions. In the interest of completeness, the Arabic data are confronted with the corresponding German slips even though these are not at issue at the moment.

The adjacent-consonant errors will be investigated first. If the parallel syllable structure constraint is absent, we may expect interactions of adjacent between-syllable consonants to be as common as those of adjacent within-syllable consonants. In a word, C.C = CC. (The dot designates a syllable boundary.) As indicated in Table 3, the Arabic corpus contains six within-syllable and 90 between-syllable slips. These raw data are uninterpretable unless the linguistic opportunities of occurrence are taken into account. Therefore, all words in which a reversal of consonants took place were inspected for clusters. The 258 words house 197 heterosyllabic and 13 tautosyllabic consonant sequences. That is, the ratio is 15:1. Remarkably, this is exactly the same ratio as found between the actually occurring error sets (90:6). On the basis of this finding, we are led to conclude that the syllable boundary between two adjacent consonants remains without effect upon their susceptibility to interaction. In other words, the slips are blind to the syllable boundary.

In a next step, the non-adjacent slips will be scrutinized. To ascertain whether the syllable boundary makes an impact upon this error category, it is necessary to compare the frequency of consonant interactions in .CVC. and .CV.C sequences. By analogy with the above argument, if the consonants interact equally often in the two conditions, we would be entitled to claim that the parallel syllable structure constraint is missing. According to Table 3, there are 69 within-syllable and 99 between-syllable slips. However, not all of the 99 between-syllable slips qualify for a direct comparison with the within-word slips. Of course, only those initial-initial errors are eligible which do not skip a coda consonant. By this criterion, seven items have to be eliminated, which leaves us with 92 errors.

	position-preserving		position-changing			
	initial–initial	final–final	within-syllable adjacent	between-syllable adjacent	within-syllable non-adjacent	between-syllable non-adjacent
Arabic	99 (35.5 %)	7 (2.5 %)	6 (2.2 %)	90 (32.4 %)	69 (24.8 %)	7 (2.5 %)
German	45 (56.3 %)	11 (13.8 %)	2 (2.5 %)	4 (5.0 %)	7 (8.8 %)	1 (1.3 %)

Table 3

Frequency of subtypes of within-word errors in Arabic (N = 278) and German (N = 70)

To estimate the linguistic opportunity of occurrence for the two error subsets in question, it was determined how often two non-adjacent consonants are tautosyllabic or heterosyllabic. An analysis of the 258 lexical items lodging within-word reversals yields 374 closed syllables (.CVC.) and 248 open syllables which are followed by a consonant (.CV.C). Thus, within-syllable slips have a higher baseline probability than between-syllable slips. To make up for this imbalance, the number of within-syllable errors was multiplied by 248:374 = 0.66. This procedure brings down the number of within-syllable slips to 46, which makes them half as frequent as the between-syllable slips (46 vs. 92). This difference is statistically reliable ($\chi^2(1) = 15.4$, $p < 0.001$). We conclude that the syllable boundary does seem to matter in that it encourages the interaction of consonants from different syllables (or discourages the interaction of consonants from the same syllable).

We are faced with two seemingly contradictory findings. While adjacent interactions are wholly insensitive to syllabic information, non-adjacent interactions display such a sensitivity. In this respect, then, non-adjacent within-word slips join the (non-adjacent) between-word category. The only structural difference between adjacent and non-adjacent within-word interactions is the intervention of a vowel which increases the linear distance of the interactants. Consequently, it appears that the greater the distance between the interacting elements, the greater their sensitivity to syllabic effects.

By way of summary, the investigation of positional restrictions on the interaction of consonants has produced the following results. Within-word slips are less constrained than between-word slips in all three languages. In all error conditions, Arabic is much less subject to the positional constraint than German and English.[8] However, the cross-linguistic difference is not of the categorical kind. The parallel syllable structure constraint is not completely absent even in Arabic within-word slips where it emerges in one subset but not in the other.

3.2 *Onset vs. coda errors*

The focus of this subsection will be upon the frequency of consonant slips as a function of their position. It will be asked whether prevocalic consonants are more susceptible to dislocation than postvocalic ones. This issue has to

[8] Safi-Stagni (1990, 1992, 1994) also looked at syllable structure restrictions on speech errors in Arabic. In her publication of 1990, she appears to endorse the view that the parallel syllable structure constraint is valid in Arabic as much as in English, stressing the universality of the principles underlying the generation of slips of the tongue. However, she takes a more critical stance on this issue in her later work (1992, 1994). Unfortunately, both positions are ill-founded because Safi-Stagni bases her claims upon individual examples and does not provide the requisite statistical back-up. Besides, she relies upon a very slender data base (N = 115 of all types) and fails to distinguish between within-word and between-word errors.

be addressed at both the word and syllable levels. Let us begin with the suprasegmental structure of words. Are word-initial positions preferred sites for slips of the tongue? Refer to Table 4.

	within-word	between-word
Arabic	70 (25.2 %)	28 (40.0 %)
German	26 (37.1 %)	647 (63.2 %)

Table 4
Frequency of word-initial errors in Arabic and German

The data displayed in Table 4 mesh well with the results of the previous section. Between-word slips more frequently implicate word-initial positions than do within-word slips in both languages ($\chi^2(1) = 5.6$, $p < 0.05$ for Arabic; $\chi^2(1) = 18.6$, $p < 0.001$ for German). Furthermore, German errors occur more often in word-initial sites than Arabic errors.[9] This is true of both within-word slips ($\chi^2(1) = 4.4$, $p < 0.05$) and between-word slips ($\chi^2(1) = 14.5$, $p < 0.001$). Thus, there is a clear hierarchy of error-proneness. The vulnerability of the word-initial locus is strongest in German between-word slips, less strong in Arabic between-word slips and German within-word slips and weakest in Arabic within-word slips.

The frequency with which a word-initial position is involved by chance was calculated as follows. For Arabic, the ratio of word-initial consonants vs. non-word-initial consonants was determined on the basis of the list of 100 words referred to above. As vowel-initial words and syllables are prohibited in the dialect under consideration (Abu-Salim & Abd-El-Jawad 1988), the number of word-initial consonants is 100. We found 268 non-word-initial consonants on the list. Therefore, the likelihood of hitting upon a word-initial consonant is 27.2% (100:(100+268)). It can now be shown that within-word errors involve word-initial positions at chance level ($\chi^2(1) = 0.3$, $p > 0.3$) whereas between-word errors involve word-initial sites beyond chance level ($\chi^2(1) = 5.3$, $p < 0.05$).

[9] It might be that this finding can be partly attributed to segment-level differences between the two languages. German has a larger number of onset fillers than Arabic while Arabic has more coda fillers than German. The assumption that more competitors lead to more errors might partly explain the higher rate of onset slips in German than in Arabic. One uncertainty about this account is that very little is known about the details of competition. For example, Arabic has a higher number of fillers for coda sites but German has a higher number of coda cluster types (Arabic: C, CC; German: C, CC, CCC, CCCC). Which of these conflicting factors creates more competition is currently unknown. It is therefore not yet possible to derive predictions about error rates from segmental structures. What is more, segment-level differences cannot account for the other results of this paper and hence do not qualify as a general explanation for the data (see also footnote 13 below).

A similar procedure was applied to the German data. The 70 lexical items in which the within-word errors occurred were inspected for the number of word-initial and non-word-initial consonants. 66 tokens of the former type and 193 tokens of the latter type were found. The χ^2-test calculated on the basis of this proportion yields a marginally significant difference ($\chi^2(1) = 3.2$, $p < 0.1$). In view of this uncertainty, a further method of chance estimation was employed. The proportion of word-initial consonants was defined not against all other consonants but against all (non-word-initial) syllable-initial consonants. On this approach, the 26 word-initial slips accompany 19 syllable-initial slips and thus account for 57.8% of all initial errors. Given that the German words housing segmental errors have an average length of 2.6 syllables (Berg 1991), the probability of picking out a word-initial consonant from among all initial consonants is 38.5%. Again, the χ^2-test produces a marginally significant difference ($\chi^2(1) = 3.5$, $p < 0.1$). We therefore tentatively conclude that a word-onset effect exists in German within-word slips although it should be stressed that it is only weakly present. As shown in Berg (1991), it is clearly operative in German between-word slips.

Turning to the syllable level, the question is whether there is a difference in frequency between prevocalic and postvocalic slips. The vulnerability of initial and final positions can be gauged by restricting the analysis to position-preserving errors. Position-changing slips affect both positions alike and are therefore uninformative with respect to the research question. We will begin with the within-word slips in Arabic. A look at Table 3 reveals that the corpus contains 99 initial as against seven final errors. At first glance, these numbers appear to support the notion of enhanced vulnerability in onset positions. However, this impression is misleading because the 99 initial and the seven final errors are not comparable. Since, as mentioned, onsets cannot remain unfilled in Arabic, a position-preserving slip involving final consonants cannot help skipping an initial consonant (15). By contrast, since codas may be empty, two initial consonants may easily interact without skipping any other (16). An appropriate comparison of initial and final consonants can thus be based only upon those initial errors which skip a coda consonant, as in (17).

(15) yi**n**ʕa**l**. for: yi**l**ʕa**n**.
'curse'

(16) ħa**b**ii**s**i. for: ħa**s**ii**b**i.
'jailed'

(17) **m**ak**m**as. for: mak**b**as.
'piston of a pump'

The discarding of all initial errors which do not skip a coda consonant is conducive to a drastic reduction. In actual fact, we are left with seven initial errors of the type illustrated in (17) as opposed to seven final errors as exemplified in (15). However, the opportunity of occurrence is not equal for onset and coda errors. Coda errors can only occur in CVC.CVC contexts whereas onset errors may arise in either CVC.CVC or CVC.CV contexts. The frequency of these contexts was calculated on the basis of all within-word segment exchanges. It turned out that the baseline frequency for onset slips was exactly twice as high as that for coda slips. This difference was eliminated by doubling the number of coda errors. This gives us seven onset vs. 14 coda slips. In view of the low number of pertinent cases, this difference is not statistically significant ($\chi^2(1) = 1.2$, $p > 0.03$). There is thus no evidence against the claim that initial and final positions are equally susceptible to malfunction in the within-word domain.

Since the no-skipping constraint does not operate in the between-word domain, the comparison may draw upon the full number of pertinent errors. In the Arabic sample, we found 43 initial as against 14 final slips. The latter are disadvantaged for structural reasons. In the lexical items lodging the within-word reversals, 374 of the 645 syllables are closed (58.0%). To make up for the fact that all syllables begin with a consonant but need not end in one, the 14 final slips have to be multiplied by a factor of 1.72 (100:58), which raises their number to 24. Even with this correction, initial slips are still almost twice (1.8) as frequent as final ones. Unfortunately, the absolute numbers are so low that this difference is only marginally reliable ($\chi^2(1) = 3.0$, $p < 0.1$). Thus, the evidence for the claim that there is an onset effect in Arabic between-word errors is no more than suggestive.

The German data will be subjected to the same treatment that was chosen for the between-word slips in Arabic. Table 3 reports 45 initial and 11 final within-word errors. As in Arabic, German codas are more often empty than German onsets, although this asymmetry is less pronounced. According to Berg's (1988) count, onsets are filled 93% but codas only 69% of the time. The 11 final errors thus have to be multiplied by 1.35 (93:69), which increases their number to 15. With the structural bias eliminated, initial errors outnumber final ones by a factor of 3. This is significantly different from chance ($\chi^2(1) = 8.0$, $p < 0.01$). We conclude from this finding that initial and final positions are differentially susceptible to error in German within-word slips.

In the between-word set, 829 prevocalic errors accompany 155 postvocalic ones. When the structural asymmetry is corrected, we wind up with 829 initial and 209 (155×1.35) final slips. The high significance of this difference ($\chi^2(1) = 205.3$, $p < 0.0005$) lends support to the claim that prevocalic sites are more error-prone than postvocalic ones. Thus, between-word errors in German exhibit the same positional bias as their within-word cognates.

To conclude, a strong disparity emerges between Arabic and German. The former language is generally more symmetrical in its involvement of initial and final positions than the latter. This holds true regardless of whether initialness and finalness are defined at the word or the syllable level. Both languages show more sensitivity to positional effects in the between-word than in the within-word domain. Unfortunately, this difference does not clearly emerge in all conditions. In the cases where it does not, the uncertainty can, however, be attributed to the relatively low number of relevant errors. It should finally be noted that this uncertainty pertains to within-language, not to between-language differences.

3.3 *Body* vs. *rime errors*

The analysis in this subsection is guided by the question of whether there is a difference in frequency between body and rime slips. There is general agreement that the single segment is by far the most commonly affected phonological unit in speech errors. In English and German, slips involving combinations of segments also occur, though at a low rate. Their infrequency prevents us from maintaining the distinction between the within-word and the between-word subsets. All of the available errors in German and English are of the between-word type. The absence of within-word errors implicating two segments simultaneously is not unexpected given the uncommonness of within-word errors and segment-sequence errors taken individually. Two pertinent examples follow. No. (18) is from English, (19) from German.

(18) a **hunk** of **jeep**. for: a **heap** of **junk**. (from Fromkin 1971).

(19) Wir nehmen
den **hö**chsten **Hö**rer an. for: den **nä**chsten.
[deːn høːçstən høːrɛr deːn neːçstən]
'We put the next listener on the line.' (from Berg 1989)

The misordered unit is a nucleus/coda sequence in (18) but an onset/nucleus structure in (19). In both English and German, these errors exhibit a notable asymmetry. They implicate nucleus/coda sequences significantly more often than onset/nucleus sequences. The ratio of rime/body errors is 13:1 in Stemberger's (1983) data base and 8:1 in Berg's (1989).

By contrast, not a single segment-sequence error has found its way into the Arabic error collection. Upon a little reflection, the non-occurrence of body and rime slips is hardly surprising. The inherent unlikelihood of this error type implies that it will be encountered only in a frequent error category. This is the case for German and English between-word slips. As this very set has a much lower probability of occurrence in Arabic, it cannot be expected to accommodate many segment-sequence errors. Even though the within-word group is more strongly represented, it also cannot be expected to produce many body or rime slips because it is known to show little sensitivity to structural effects which are a prerequisite for more complex errors. In light of these considerations, we do not deem it justified to attach much significance to the lack of body and rime slips in Arabic. However, this lack, coupled with the asymmetry between rime and body errors in English and German, fits into the theoretical picture to be developed in the following section.

4. Theoretical discussion

Let us take stock. Three empirical effects have been investigated with an eye to sounding out their implications for the nature of suprasegmental representations across languages. It has been found necessary to examine these effects as a function of the linguistic distance between interacting consonants. In the within-word domain, Arabic errors occur equally often in initial and final positions and interactions between initial and final slips are largely (though not completely) unconstrained. German errors, by contrast, involve initial sites more often than final ones and obey the parallel syllable structure constraint. These findings from the within-word domain support the claim that the Arabic data testify to the (largely) EQUAL status of pre- and post-vocalic consonants whereas the German (and English) slips attest to their UNEQUAL status. In the between-word domain, both German and Arabic accord an advantage to initial over final slips and discourage the interaction of cross-positional errors. In addition, rime slips outnumber body slips in German and English. These findings from the between-word domain suggest that consonants have an unequal representational status in all three languages.

It should be emphasized that the cross-linguistic differences uncovered are a matter of more-or-less rather than of all-or-none. In all conditions, initial and final consonants are more equal in Arabic than in German. This difference holds good of the within-word and the between-word domains alike. Even if the application of statistical methods leads to binary decisions (that is, significant vs. non-significant), it is obvious from the data that the speech errors' (in)sensitivity to the three effects under study is gradual, not absolute. Two examples may suffice to bring home this point. The word-onset effect is absent in Arabic within-word errors, weakly present in German within-word errors and clearly present in German between-word errors. In a similar vein, the parallel syllable structure constraint is weakly respected by Arabic within-word slips, more strongly respected by German within-word slips and most strongly respected by German between-word slips. Any appropriate account of the data thus has to allow for these gradual differences.

As argued in the Introduction, the equal or unequal status of pre- and post-vocalic consonants can be straightforwardly translated into suprasegmental representations. An equal status implies a flat structure, an unequal status a hierarchical structure without node labeling or a flat structure with node labeling. The empirical data clearly distinguish between the latter two alternatives. The predominance of nucleus/coda errors in English and German supports the notion of a rime node which is only available in hierarchical structures. Hence, the flat model with node labeling is not a serious contender and will not be further considered. Because initial and final consonants in Arabic enjoy a relatively equal status, we may now advance the hypothesis that the suprasegmental structure is relatively flat in this language.[10] By the same token, the unequal status of pre- and post-vocalic consonants in English and German is taken as evidence for the claim that the suprasegmental representation is hierarchical in these two languages.

The wording RELATIVELY FLAT requires detailed explanation. Two types of flatness were introduced at the beginning of this article, a non-syllabic one in (1) and a syllabic one in (2). Clearly, only the non-syllabic representation is appropriate for Arabic. As shown in the empirical section, interactions between adjacent heterosyllabic consonants are as likely as those between adjacent tautosyllabic consonants. The fact that a syllable boundary does not discourage such interactions argues in favor of a non-syllabic representation at the moment at which this error type occurs. At a certain moment in time, then, Arabic is maximally flat, with no nodes intervening between the word and the segment levels.

The major challenge presented by the empirical data is the differing degrees of hierarchicalness that different error types and different languages attest. A promising approach assumes that the structure of suprasegmental representations changes with time and that different types of slips of the tongue arise at different phases in the derivational process. The former hypothesis is based upon the premise that underlying representations are exempt from suprasegmental structure which therefore has to be actively built up. This process is presumed to take time and to proceed from less complex (that is, flat) to more complex (that is, hierarchical) structures. Although it might be held that the shift from flat to hierarchical representations is an abrupt process, we prefer to conceive of it in gradual terms, that is, as a shift from less to more hierarchicalness. This view is buttressed by the fact that the slips of the tongue display varying degrees of sensitivity to structural effects. So it is not a matter of whether an initial and a final consonant may, or may not, interact but how strongly their interaction is encouraged or discouraged.

---

[10] Note in the present connection that the empirical data are incompatible with the moraic model for Arabic – precisely the language for which the mora has been so vigorously propounded (see McCarthy & Prince 1990). Since the pre-vocalic and post-vocalic consonants are dominated by different nodes in the mora model, the logic adopted in this paper would let us expect that they are reluctant to interact. However, as demonstrated above, this is not the case. This difficulty with the mora model adds to the list of other problems previously noted in the literature (such as Rubach (1993) on phonological rules, Stemberger (1990) on speech errors and Treiman & Kessler (1995) on word games).

The claim that different error types arise at different points in time has been put forward by Stemberger (1985). He argues that within-word slips occur earlier during sentence generation than between-word slips.[11] The former may happen when the segments of a word are accessed. The latter, in contrast, presuppose that two different lexical items are activated strongly enough for their segments to be able to interact. The activation of different lexical items within the same planning unit requires an additional mechanism (that is, syntax) because sentences or phrases cannot normally be retrieved ready-made from the lexicon. The process of stringing words together thus tends to be subsequent to the access of individual words. As a consequence, between-word slips arise at a later stage than within-word errors.

These two strands of reasoning can now be woven together. Between-word slips exhibit a higher degree of sensitivity to structural effects because they arise at a later stage at which a hierarchical representation has already been built up. However, within-word slips are less sensitive to structural effects because they occur at an earlier stage at which the suprasegmental representation is still largely flat.

The empirical data suggest that the distinction between within-word and between-word slips is rather coarse-grained and that a more fine-grained assignment of error types to different temporal stages is warranted. It will be recalled that among the within-word errors, contiguous slips are less subject to structural constraints than non-contiguous ones. Accordingly, we would like to argue that the contiguous errors arise earlier than the non-contiguous ones. This contention agrees well with the claim that within-word errors arise prior to between-word slips. One crucial variable distinguishing the two error types is linear distance, and it is exactly this variable which distinguishes between contiguous and non-contiguous slips. We thus submit that contiguous errors are less sensitive to structural effects than non-contiguous slips because the former arise earlier than the latter. On a more general level, our claim would be that the greater the distance between two interacting units, the later they occur in the derivational process and the more strongly they are constrained by structural factors.

Consonant with this logic, it is tempting to argue that the Arabic slips of the tongue demonstrate a lesser sensitivity to structural effects than German errors because they generally occur earlier in the derivation when the suprasegmental structure has only just begun to unfold. Apparent support for this conjecture comes from the fact that unlike speakers of German, speakers of Arabic predominantly make within-word slips, a category that is purported to arise early. However, we will resist this temptation and argue

[11] Our confidence in endorsing this claim was considerably strengthened by computer simulations run by Ulrich Schade. When random noise was introduced early in the activation process, the error tended to be of the within-word type while late noise was more likely to induce between-word slips.

instead that speech errors in Arabic, English and German show the same distribution across the time span of the derivation. That is to say, the errors are free to occur any time during the derivation and do not cluster in an early phase in one language but in a late phase in another. The assumption that languages differ in their predilection for early or late errors strikes us as unlikely. It is not only entirely ad hoc but also has certain untenable implications. In particular, it would imply that languages can protect from error one temporal stage more efficiently than another and that languages may differ in the selection of their 'protectorates'. This view is implausible because it invokes a mechanism of doubtful status and origin. If a language can principally protect one temporal stage, one wonders why it does not protect all stages. It is much less contentious to presume that any temporal stage is prone to error and that this error-proneness is more or less constant across languages.

Moreover, there is an empirical argument in favor of a similar genesis of Arabic and German/English slips of the tongue despite massive structural differences between the languages. The most important one is morphological in nature. Whereas English concatenates (independent) stems and affixes to form words, Arabic is standardly characterized by its non-concatenative morphology (McCarthy 1981). The basic situation in most Semitic languages is that the morphemes of a word are made up of a discontinuous sequence of consonants and vowels. Another way of stating this difference is that English has continuous stems, prefixes and suffixes whereas Arabic has discontinuous roots and transfixes. Word formation in Arabic involves the intercalation of these discontinuous morphemes. The example most often discussed in the relevant literature is the verb root *k-t-b* 'to write' which gives rise to the following sample of inflectional and derivational forms: *katab* 'he wrote', *katabu* 'they wrote', *kitaabun* 'book' and *maktab* 'office'.[12]

To express the fact that the discontinuous morphemes individually contribute to the meaning of a word, they are assigned to separate levels of representation. Because lexical morphemes are carried by consonants and grammatical morphemes by vowels, it is customary to create a consonantal and a vocalic tier (see (20) below). During the derivation, the morphemes have to be intercalated to generate a linear sequence of segments. This process is known as TIER CONFLATION (McCarthy 1986, see (21) below). We may now envisage two distinct loci for Arabic speech errors. They may occur before the conflation of the consonantal and the vocalic tiers or thereafter. The two possibilities are illustrated in (20)–(21). The sample word is *ʔaktab* 'to cause to write'. The separate tier required for the glottal stop is of no relevance to the ensuing argument and will therefore be ignored.

[12] Various morphophonological modifications that the derived forms undergo do not play a role in the present context.

```
(20) consonant tier   ʔ       k   t       b
                      |       |   |       |
     skeleton tier    C   V   C   C   V   C
                           \         /
     vocalic tier              a

(21) melodic tier     ʔ   a   k   t   a   b
                      |   |   |   |   |   |
     skeleton tier    C   V   C   C   V   C
```

According to the stage at which errors arise, different predictions may be formulated. Our point of departure is the proximity constraint on Arabic speech errors which makes interactions between adjacent segments more likely than those between non-adjacent units. As argued by Odden (1994), adjacency may be defined at differing hierarchical levels. In (20) and (21), the consonants /k/ and /t/ are adjacent at both the consonantal and the melodic tier. However, /t/ and /b/ are adjacent at the consonantal though not at the melodic tier. The relative frequency of these two potential errors may be taken as a clue to their localization. If errors arise at the consonant tier (that is, before tier conflation), the probability of an interaction between /k/ and /t/ and between /t/ and /b/ should be equal. By contrast, if slips arise at the melodic tier (that is, after tier conflation), /k/ and /t/ should interact more frequently than /t/ and /b/, all other things being equal.

In an attempt to test these predictions, it was determined whether adjacent and non-adjacent slips occur at or above chance. In the words in which the first 100 within-word exchanges are embedded, there are 62 adjacent and 199 non-adjacent consonants. Thus, the probability for an error to involve adjacent consonants by chance is 23.8 %. The actual number of adjacent slips in the Arabic corpus is higher (96 out of 278 = 34.5 %; see Table 3). This difference is statistically reliable ($\chi^2(1) = 7.5$, $p < 0.01$). We conclude that adjacency promotes the occurrence of error and implicationally, non-adjacency discourages the interaction of consonants. This result is incompatible with the assumption that consonant errors arise at the consonantal tier. However, it lends credence to the hypothesis that the Arabic tongue slips arise at the melodic tier.

Given that the distinction between a consonantal and a vocalic tier is not applicable to English (McCarthy 1989), the melodic tier is the obvious locus at which the English and German errors analysed in this paper can be identified. Hence, there is good reason to argue that the consonant slips in English, German and Arabic arise at roughly the same functional stage. This stage is unlikely to be deployed at an earlier point in Arabic than in English or German.

If it is not the case that Arabic slips generally occur earlier in the derivation than German slips, how else can we account for the fact that the Arabic errors are less sensitive to structure than the German ones? Our solution is to propose that while the errors in the different languages occur in the same phases of the derivation, the suprasegmental structure unfolds more slowly in Arabic than in English or German. As a result, the Arabic errors are as a rule less structure-sensitive than the German and English ones. Why should Arabic take more time than other languages to erect a suprasegmental structure? As we see it, the answer to this phonological problem is provided by the morphological level. We noted above that English morphemes are usually free-standing and 'self-sufficient'. When they are needed for speaking, they can be taken as ready-made units from the mental lexicon. A word like *window* for example can be selected and produced as such. By contrast, Arabic morphemes are not directly usable, not even pronounceable. To generate an independent, pronounceable word, at least two non-independent, unpronounceable morphemes have to be intercalated. Thus, English speakers use a non-compositional, direct-retrieval method whereas Arabic speakers employ a compositional strategy of word formation. It is true that the compositional strategy is not unknown to speakers of English. It is likely to be used for the generation of inflected forms such as *to try* → *he tries*, but it is certainly not used for the generation of words such as *try*. Note also that two different kinds of composition are at issue. English speakers compose by concatenating morphemes while Arabic speakers compose by intercalation.

What are the implications of this cross-language difference for the build-up of suprasegmental structure? In English, the full phonological form (at least of monomorphematic words) is available right from the onset of the derivation. It is known that *window* is a disyllabic word; that the /w/ occupies the word onset; that the alveolar nasal is syllable-final; that the alveolar stop is syllable-initial and so on. Because the position of each segment within the syllable or the word and its immediate context are clear, all the information that is required for the erection of suprasegmental structure is on hand. For example, since it is known at the outset that *window* begins with a closed syllable, the tonic vowel can be associated with the consonant to its right to form a rime. In short, the possibility for structure-building is given right from the start.

However, this is not so in Arabic. When the verb root *k-t-b* is selected, it is not clear which segments will be inserted into the vowel slots, nor whether a given vowel slot will be filled at all. By implication, it is not known at the beginning in which syllable position a radical consonant will ultimately appear. For instance, the first radical is syllable-initial in *kitaabun* but syllable-final in *maktab*. The same is true of the third radical /b/. Thus, neither the position of a given consonant nor its segmental context are known beforehand. They are the outcome of the intercalation process. This state of affairs has a crucial consequence. The hierarchical structure cannot be built up because of the non-availability of relevant details. If it is not known whether a given vowel will be followed by a tautosyllabic consonant, it is evidently impossible to create a (branching) rime node. Similarly, if it is not known whether the first radical will begin a word (as in *kitaabun*) or not (as in *maktab*), it is difficult to assign a special status to the word-onset consonant. Our claim is then that as long as neither position nor context of a given segment are fully specified, the elaboration of a hierarchical suprasegmental structure is a difficult, if not impossible task.

Again, we do not claim that the differences between Arabic and English/German are absolute. In particular, we do not deny that position-changing operations also occur in the course of the derivation of English words, as for example in certain derived and inflected forms such as *bake*+AGENS → *baker* and *wait*+PAST → *waited.* In both cases, resyllabification takes place. However, important differences between English and Arabic undoubtedly remain. In English, it makes perfectly good sense to speak of onsets and codas in base forms such as *bake* and *wait* because these are readily pronounceable and used as actual words. By contrast, this is quite impossible with Arabic root morphemes.

The outline of the theoretical model that emerges is as follows. Linguistic derivations operate in real time. All three languages have at their disposal roughly the same fixed amount of time to run through the derivation. One major task of the derivation is to build up a suprasegmental structure, which is not present in underlying representation (see Sevald et al. (1995) for independent support for this claim). The successive stages of the derivation can therefore be characterized by the gradual creation of structural nodes, that is, by a gradual shift from flat to hierarchical representations. Critically, languages may differ in the time they take to erect suprasegmental structures. Given the assumptions that the amount of time available is fixed and that the erection of suprasegmental structures is a time-consuming process, 'slow' languages are under the influence of flatter representations during a longer period of the derivation than 'quick' languages. We may push this claim further by looking at the frequency of within-word and between-word slips in the languages in question. While 80% of all errors in Arabic are of the within-word type, more than 80% of all German and English errors belong in the between-word domain. This is an extraordinarily large difference. Since the former error category is under the control of relatively flat and the latter under the control of relatively hierarchical representations, we advance the claim that the suprasegmental structure of Arabic is predominantly flat and that of English and German predominantly hierarchical. Our model is epitomized in Fig. 1.

Fig. 1 makes the simplest assumption about the time course of suprasegmental representations, namely that they unfold in linear fashion (as indicated by the straight lines). The dashed horizontal line is not meant to imply a categorical segregation between flatness and hierarchicalness. It merely serves to visualize the hypothesis that Arabic segments are dominated by flatter structures while English and German segments are dominated by more hierarchical structures during the larger part of the derivation.

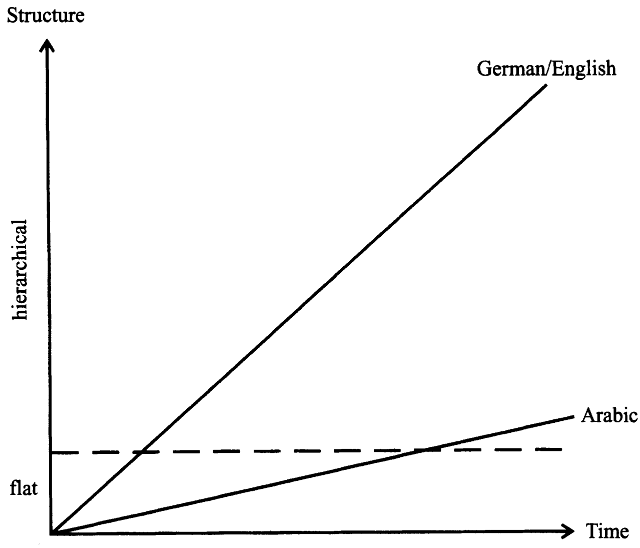


Figure 1

The unfolding of suprasegmental structure in English, German and Arabic.

The graphs in Fig. 1 neatly capture the speech error patterns uncovered. They show that within-word slips are governed by a flatter form of representation than their between-word counterparts in all three languages and that Arabic slips are mainly shaped by flat representations but English and German errors by hierarchical representations. The structural constraints differ at any given point in time during the derivation. Fig. 1 also helps explain why within-word slips are preponderant in Arabic though uncommon in English and German. As within-word errors arise under a relatively flat representation and as this representational type persists longer in Arabic than in English, these errors have more time to occur in Arabic than in English. It is only natural to presume that the more time that is available for a certain error type, the more frequent it will be. This account hinges upon the assumption, stated above, that each temporal stage in the derivation is as susceptible to malfunction as any other and that languages are not radically different in this respect.

This gradient conception of hierarchicalness might be held to be at odds with the prevailing view in linguistics. Theoretical phonologists customarily regard syllable structure in binary terms: it is either flat or hierarchical with no intermediate shades. Our conception follows from the incorporation of the temporal dimension into our model as well as from our assumption that structure unfolds in real time. If we conceive of flat and hierarchical structures as PROTOTYPES (Taylor 1995), there is no necessary conflict between the standard view and ours. We may then simply say that our model has a more fine-grained structure than others in that it transforms the binary distinction into a gradient one while retaining the notions of flatness and hierarchicalness as convenient landmarks.

The conjecture that phonological derivations in Arabic are governed by both flat and hierarchical representations (with the former predominating) has a number of implications for the phonological component of the language. While it leaves room for rules which are sensitive to hierarchical structure, it predicts that the larger part of the phonology is insensitive to hierarchicalness.

Stress rules may illustrate the need to invoke hierarchical representations. As in many other languages, Arabic stress rules make crucial reference to the rime node, in particular to whether it is branching (heavy) or non-branching (light). The general rule is that heavy rimes attract stress while light rimes shift stress to the left. This reliance on coarse-grained phonological information necessitates a hierarchical representation to which the stress rules may refer. Hence, our derivational model can cope with lexical-stress assignment. More specifically, it makes the claim that this process occurs relatively late in the derivation.

Consonant with the above prediction, Arabic abounds with phonological processes which are insensitive to syllable structure and illustrate the weak bond between segments and their syllabic positions. We will focus our attention upon vowels because deleting and inserting them almost inevitably leads to a restructuring of the whole word. In point of fact, there is a great amount of vowel-based variation within and across spoken varieties of Arabic, with vowel epenthesis and truncation figuring prominently (Angoujard 1990). Vowel epenthesis may be used to avoid consonant clusters as in *ʤisr* → *ʤisir* 'bridge'. The opposite process, vowel deletion, is shown in *θaɣaraat* → *θaɣraat* 'openings'. The important point to note in the present connection is the resyllabification that these vowel-based processes entail. The /s/ in *ʤisr* shifts from (pre-)final to syllable-initial position while the /ɣ/ in *θaɣaraat* does the reverse. All these changes can be readily accommodated in the early phases of the derivation when the syllable structure has not yet been worked out. If they occurred at later stages, they would necessitate the abolition of the original structural representation and the erection of a new one. This is unparsimonious and therefore unlikely. Note that the localization of these processes at early stages of the derivation provides an explanation for their commonness. Because the constraints imposed by the hierarchical structure arise only at a late stage, the segmental representation is free from them during the larger part of the derivation. This freedom is at the heart of the alterations under discussion.

We now turn to cross-linguistic aspects. The claim that the suprasegmental structure of Arabic is largely flat while that of English and German is largely hierarchical allows us to predict that the phonetic-phonological component of Arabic should be less structure-sensitive than that of English and German.

In the following, we will briefly discuss two areas which lend themselves well to a cross-linguistic comparison.

In the introductory section, phonotactic rules and articulatory constraints were noted among the pieces of evidence that are brought to bear upon the issue of suprasegmental structure. Since hierarchical representations are more restrictive and flat representations more liberal, we would expect phonotactic constraints to be stronger in English and German than in Arabic. This prediction tallies reasonably well with the empirical facts. Excluding the co-occurrence restrictions that hold among the radicals of tri- and quadriconsonantal roots which are of a different nature (see Greenberg 1950), segments are as liberal with their right-hand as with their left-hand neighbours in Standard Arabic. Any consonant can occur in initial or final position in unclustered syllables. It is quite striking that in (final) tautosyllabic consonant clusters, almost all consonants can occur in either final or pre-final sites, which leads to frequent violations of the sonority hierarchy. The proportion of actually attested to theoretically possible consonant clusters is astonishingly high. According to Abu-Salim's (1988) study, 63% of the theoretically possible clusters are attested. Cairene Arabic seems to be even more extreme in this respect. Broselow (1979) reports that co-occurrence restrictions on consonant clusters are completely missing in this dialect. What makes these observations so remarkable is that low-level articulatory constraints undoubtedly impose serious limitations upon the combinatorial possibilities in all human languages.

Notably, the phonotactic situation is quite different in English and German. To make the languages maximally comparable, our exclusive focus is upon final tautosyllabic two-consonant clusters, the only type found in Arabic. Our counts indicate that only 11.3% of the points in the theoretical cluster space are exploited in German and only 14.0% in English. This is a dramatic difference which is in full agreement with the predictions from our model.

Turning to the phonetic level, it is well-known that there is a trade-off relationship between the length of a consonant and the length of the preceding vowel. A thoroughly studied example is the effect of consonant voicing on the duration of the preceding vowel. Voiced consonants, which are considerably shorter than voiceless ones, are preceded by longer vowels than are voiceless consonants. This temporal compensation holds good of English and several other languages (see Chen 1970). It is readily explained by the rime hypothesis which makes a provision for the interaction between the nucleus and the coda. Since the suprasegmental representation in Arabic is, by hypothesis, largely flat, we would predict that no or relatively little such temporal compensation is observed in this language. This prediction appears to be borne out. Port, Al-Ani & Maeda (1980) find little evidence for compensatory effects. They report on a study of their own (in footnote 4) in which speakers of Jordanian Arabic pronounced the vowels in English minimal pairs such as *bat* and *bad* with equal duration, that is, they did not lengthen the /æ/ in *bad* as is typical of native speakers. This result implies that the Arab speakers have no such temporal regulation in their native language.

These analyses provide some support for the validity of the claims regarding the suprasegmental structure of English/German and Arabic. Clearly, further tests are necessary for a fuller assessment. Some more can be found in Berg (in press), others have yet to be performed.

Summarizing, a case has been made in this paper for an intricate interaction between phonology and morphology. It has been claimed that a non-concatenative morphology leads to predominantly flat phonological structures but a concatenative morphology to hierarchical phonological structures. The erection of hierarchical suprasegmental representations is a goal that every language attempts to reach. However, it is not equally easy to do so in all languages. The non-concatenative morphology withholds the information that the phonological component needs to build up a hierarchical representation. Therefore, this process is slowed down in Arabic and the suprasegmental representation attains only a weak form of hierarchicalness at the end of the derivation.[13] An interesting issue that is raised by our model is why it is apparently impossible to prolong the derivation in Arabic so that the eventual outcome is as hierarchical as in English. An answer to this question must await a clearer understanding of the temporal constraints upon the processes underlying the generation of language.

5. An afterthought on the nature of lexical entries in Arabic

In languages with a concatenative morphology, which constitute the majority of the world's languages, there is no sensible alternative to modeling the underlying in terms of the surface form. In languages with a non-concatenative morphology, by contrast, two distinct modes of lexical representation are conceivable – the holistic and the analytical one. Words such as *maktab* may either be represented in holistic fashion, resembling their surface forms, or dissected into their morphological components, that is, into discontinuous roots and transfixes. From the perspective of production and comprehension, the problem of lexical access is alleviated by holistic representations but

[13] Note that the particularity of Arabic appears to be confined to the suprasegmental level. Processes operating at the segment level are similar to what has been reported for the Germanic languages. A salient example is the segment-similarity effect whereby similar segments are more likely to interact than dissimilar ones. This effect seems to be as strong in Arabic as in English and German (see Abd-El-Jawad & Abu-Salim 1987). This observation is important in that it suggests that the suprasegmental differences uncovered cannot be reduced to processing differences at the segment level.

exacerbated by analytical representations. In the former case, the integrity of lexical items is left intact so that they can be stored and retrieved as wholes. In the latter case, the words are 'taken to pieces' and stored in such a form that they have to be synthesized in production and split up in comprehension. This appears to be a cumbersome procedure, in particular for those words which are frequently used in the language. Thus, the argument from lexical access favors holistic over analytical representations.

However, this is only part of the story. If words like *maktab* and *kitaabun* for instance are represented holistically, the morphological relationship between them would be blurred or even lost (although their phonological similarity would be preserved). This would lead to a mismatch between the morphological and the semantic levels in that the obvious semantic relationship between these words would not be reflected at the morphological level. Analytical representations fare better in this respect. They fully respect the morphological similarity among the members of morphosemantic families. From this vantage point, analytical representations are advantageous to holistic ones.

Our analysis of Arabic suggests (and relies heavily upon the assumption) that more weight is given to representational than to processing considerations. The creation of a morphological level is more highly valued than a simple access procedure.[14] The representation of morphological relationships is ensured at the expense of an increase in processing difficulty. The speech error data indicate that the mental lexicon is organized not unlike a typical dictionary of Arabic. From the point of view of lexical access, this is undoubtedly a counterintuitive result. It is therefore incumbent for us to ask what advantage there is to having a morphological level.

Our answer comes in two parts, the one revolving around similarity and the other around creativity. Perhaps the most important guiding principle in the construction of the mental network is the desire to represent similarity relationships as faithfully as possible. This means that similarity relationships are expressed at all linguistic levels at which this can be usefully done. The morphological level is one of them because Arabic exhibits a systematic relationship between form and meaning. To capture this relationship, it is necessary to extract the recurrent features (for example, *k-t-b* in the above examples) and assign them to a level of their own. This is what leads to the creation of a morphological level of analysis.

The reliance on similarity is not an end in itself. The major advantage of a multi-level system is its creative potential. Morphological analysis is the prerequisite for the formation of new words on the basis of old principles. Let us consider two examples. Not long ago, there was no verb corresponding to the noun *ʔiTaar* 'framework'. Now, however, the verb *yuʔaTTir* 'to frame'

[14] Further psycholinguistic evidence for the reality of the morphological level in non-concatenative languages can be found in Feldman, Frost & Pnini (1995).

is widely used even though it is still felt as a neologism. A slightly different case is presented by the noun *furSa* 'holiday'. As yet, no corresponding verb exists although it could certainly be derived on the basis of the root morpheme *f-r-S*. For instance, a question such as *eemta bitfarSiSu* 'When will you go on holiday?' would be easily producible and comprehensible to an Arabic speaker because it is consonant with the principles of word formation in this language. Without a morphological level, the creation of neologisms would be a much more laborious task. With a morphological level, however, speakers of Arabic may capitalize upon a flexible and powerful system which is adaptive to changing communicative needs.

REFERENCES

Abd-El-Jawad, Hassan & Abu-Salim, Issam M. (1987). Slips of the tongue in Arabic and their theoretical implications. *Language Sciences* **9**. 145–171.

Abu-Salim, Issam M. (1982). Syllable structure and syllabification in Palestinian Arabic. *Studies in the Linguistic Sciences* **12**. 1–28.

Abu-Salim, Issam M. (1988). Syllable structure constraints and the sonority hierarchy in Arabic. *Dirasat* **15**. 44–77.

Abu-Salim, Issam M. & Abd-El-Jawad, Hassan (1988). Syllable patterns in Levantine Arabic. *Studies in the Linguistic Sciences* **18**. 1–22.

Angoujard, Jean-Pierre (1990). *Metrical structure of Arabic*. Dordrecht: Foris.

Berg, Thomas (1988). *Die Abbildung des Sprachproduktionsprozesses in einem Aktivationsflußmodell. Untersuchungen an deutschen und englischen Versprechern*. Tübingen: Niemeyer.

Berg, Thomas (1989). Intersegmental cohesiveness. *Folia Linguistica* **23**. 245–280.

Berg, Thomas (1991). Phonological processing in a syllable-timed language with pre-final stress: evidence from Spanish speech error data. *Language and Cognitive Processes* **6**. 265–301.

Berg, Thomas (in press). *Linguistic structure and change: an explanation from language processing*. Oxford: Oxford University Press.

Booij, Geert E. (1983). Principles and parameters in prosodic phonology. *Linguistics* **21**. 249–280.

Broselow, Ellen (1979). Cairene Arabic syllable structure. *Linguistic Analysis* **5**. 345–382.

Chen, Matthew (1970). Vowel length variation as a function of the voicing of the consonant environment. *Phonetica* **22**. 129–159.

Clements, George N. & Keyser, Samuel J. (1983). *CV phonology: a generative theory of the syllable*. Cambridge, MA: MIT Press.

Dell, Gary S., Juliano, Cornell & Govindjee, Anita (1993). Structure and content in language production: a theory of frame constraints in phonological speech errors. *Cognitive Science* **17**. 149–195.

Donegan, Patricia J. & Stampe, David (1978). The syllable in phonological and prosodic structure. In Bell, Alan & Hooper, Joan B. (eds.) *Syllables and segments*. Amsterdam: North Holland. 25–34.

Dow, Maureen L. & Derwing, Bruce L. (1989). Experimental evidence for syllable-internal structure. In Corrigan, Roberta, Eckman, Fred & Noonan, Michael (eds.) *Linguistic categorization*. Amsterdam: John Benjamins. 81–92.

Feldman, Laurie B., Frost, Ram & Pnini, Tamar (1995). Decomposing words into their constituent morphemes: evidence from English and Hebrew. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **21**. 947–960.

Fromkin, Victoria A. (1971). The non-anomalous nature of anomalous utterances. *Language* **47**. 27–52.

Fromkin, Victoria A. (1973). Appendix: a sample of speech errors. In Fromkin, Victoria A. (ed.) *Speech errors as linguistic evidence*. The Hague: Mouton. 243–269.

Fudge, Eric C. (1987). Branching structure within the syllable. *Journal of Linguistics* **23**. 359–377.

Goldsmith, John A. (1990). *Autosegmental and metrical phonology*. Oxford: Basil Blackwell.

Greenberg, Joseph P. (1950). The patterning of root morphemes in Semitic. *Word* **6**. 162–181.
Hayes, Bruce (1989). Compensatory lengthening in moraic phonology. *Linguistic Inquiry* **20**. 253–306.
Iverson, Gregory K. & Wheeler, Deirdre W. (1989). Phonological categories and constituents. In Corrigan, Roberta, Eckman, Fred & Noonan, Michael (eds.) *Linguistic categorization*. Amsterdam: John Benjamins. 93–114.
Kouloughli, Djamal E. (1986). Sur la structure interne des syllabes "lourdes" en arabe classique. *Revue Québecoise de Linguistique* **16**. 129–155.
Kubozono, Haruo (1989). The mora and syllable structure in Japanese: evidence from speech errors. *Language and Speech* **32**. 249–278.
Laubstein, Ann Stuart (1987). Syllable structure: the speech error evidence. *Canadian Journal of Linguistics* **32**. 339–363.
Levelt, Willem J. M. & Wheeldon, Linda (1994). Do speakers have access to a mental syllabary? *Cognition* **50**. 239–269.
Levitt, Andrea, Healy, Alice F. & Fendrich, David W. (1991). Syllable-internal structure and the sonority hierarchy: differential evidence from lexical decision, naming, and reading. *Journal of Psycholinguistic Research* **20**. 337–363.
MacKay, Donald G. (1970). Spoonerisms: the structure of errors in the serial order of speech. *Neuropsychologia* **8**. 323–350.
McCarthy, John J. (1981). A prosodic theory of nonconcatenative morphology. *Linguistic Inquiry* **12**. 373–418.
McCarthy, John J. (1986). OCP effects: gemination and antigemination. *Linguistic Inquiry* **17**. 207–263.
McCarthy, John J. (1989). Linear order in phonological representation. *Linguistic Inquiry* **20**. 71–99.
McCarthy, John J. & Prince, Alan (1990). Prosodic morphology and templatic morphology. In Eid, Mushira & McCarthy, John J. (eds.) *Perspectives on Arabic linguistics*. (Vol. II.) Amsterdam: John Benjamins. 1–54.
Nooteboom, Sieb G. (1967). *Spontane fonologische versprekingen*. (IPO Technical Progress Report No. 93). Eindhoven, The Netherlands.
Odden, David (1994). Adjacency parameters in phonology. *Language* **70**. 289–330.
Port, Robert F., Al-Ani, Salman & Maeda, Shosaku (1980). Temporal compensation and universal phonetics. *Phonetica* **37**. 235–252.
Pierrehumbert, Janet & Nair, Rami (1995). Word games and syllable structure. *Language and Speech* **38**. 77–114.
Rubach, Jerzy (1993). Skeletal versus moraic representations in Slovac. *Natural Language and Linguistic Theory* **11**. 625–653.
Safi-Stagni, Sabah (1990). Slips of the tongue in Arabic. In Eid, Mushira (ed.) *Perspectives on Arabic Linguistics*. (Vol. I.) Amsterdam: John Benjamins. 271–290.
Safi-Stagni, Sabah (1992). *Normal and pathological breakdown in Arabic*. Ph.D. dissertation, Louisiana State University.
Safi-Stagni, Sabah (1994). Arabic segmental errors and segmental phonology. In Eid, Mushira, Cantarino, Vicente & Walters, Keith (eds.) *Perspectives on Arabic linguistics*. (Vol. VI.) Amsterdam: John Benjamins. 169–184.
Selkirk, Elisabeth O. (1982). The syllable. In van der Hulst, Harry & Smith, Norval (eds.) *The structure of phonological representations*. (Part II.) Dordrecht: Foris. 337–383.
Sevald, Christine A., Dell, Gary S. & Cole, Jennifer S. (1995). Syllable structure in speech production: are syllable chunks or schemas? *Journal of Memory and Language* **34**. 808–820.
Stemberger, Joseph P. (1983). *Speech errors and theoretical phonology: a review*. Bloomington: Indiana University Linguistics Club.
Stemberger, Joseph P. (1985). *The lexicon in a model of language production*. New York: Garland.
Stemberger, Joseph P. (1990). Wordshape errors in language production. *Cognition* **35**. 123–157.
Stemberger, Joseph P. (1992). Vocalic underspecification in English language production. *Language* **68**. 492–524.
Stemberger, Joseph P. & Treiman, Rebecca (1986). The internal structure of word-initial consonant clusters. *Journal of Memory and Language* **25**. 163–180.
Steriade, Donca (1988). Review of: Clements & Keyser (1983). *Language* **64**. 118–129.

Taylor, John R. (1995). *Linguistic categorization: prototypes in linguistic theory*. Oxford: Clarendon Press.
Treiman, Rebecca & Kessler, Brett (1995). In defense of an onset-rime syllable structure for English. *Language and Speech* **38**. 127–142.
Vennemann, Theo (1988a). *Preference laws for syllable structure*. Berlin: Mouton de Gruyter.
Vennemann, Theo (1988b). The rule dependence of syllable structure. In Duncan-Rose, Caroline & Vennemann, Theo (eds.) *On language. Rhetorica, Phonologica, Syntactica*. London: Routledge. 257–283.
Vincent, Nigel (1986). Constituency and syllable structure. In Durand, Jacques (ed.) *Dependency and non-linear phonology*. London: Croom Helm. 305–318.
Wiese, Richard (1986). Zur Theorie der Silbe. *Studium Linguistik* **20**. 1–15.
Wilbur, Ronnie B. & Allen, George D. (1991). Perceptual evidence against internal syllable structure in American Sign Language syllables. *Language and Speech* **34**. 27–46.

Authors' addresses:

(Berg)
FB 11,
University of Oldenburg,
P.O. Box 2503,
26111 Oldenburg,
Germany.
FAX: +49-441-798-3771

(Abd-El-Jawad)
Department of English,
Yarmouk University,
P.O. Box 4570,
Irbid,
Jordan.
FAX: +962-2-274725