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Phonological chunking in German and English: Segment, juncture, and boundary

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PHONOLOGICAL CHUNKING IN GERMAN AND ENGLISH:
SEGMENT, JUNCTURE, AND BOUNDARY

by

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ABSTRACT

Linguistic knowledge implies the ability to identify and manipulate phonological segments of various sizes. Such "chunks" are often, although not always, demarcated by phonetic clues to phonological organization. The American Structuralists in the 1930's - 1950's posited a demarcative phoneme called "juncture," which raised questions about the legitimacy of phonological analyses which rely on grammatical information about the language.

Data from language games, diachronic resegmentation, and phonological reduction all show that a competent speaker can "chunk" phonological material in a variety of ways. The field linguist, the armchair analyst, and the ordinary listener are all playing the same segmentation game, listening for phonetic clues to linguistic structure.
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"...in devising a transcription for the language as a whole, we need to allow for the fact that open juncture may or may not occur at a given point."

--Moulton (1962:143)

I. Introduction

In this essay I intend to discuss the concepts of "segment" and "boundary" in relation to the historical development of phonological theory, with particular emphasis on the rise of phonemic theory and the suprasegmental phoneme of "open juncture." Representative examples are taken largely from German and English. The evolution of segmental phonemic theory, which gave special status to a phonological segment of speech-sound size, also recognized the need for a variety of special, "supra-segmental" phonemes, such as stress and "juncture." Structuralist phonological theorists soon began to ask about the nature of the reigning segment, the phoneme. Hockett (1942), for instance, strongly argued that phonological segments must be identified on the basis of phonetic information alone, without recourse to grammatical information. Moulton (1947) showed that positing a phoneme of juncture could simplify phonemic analysis and account for heterogenous phonetic effects, but he insisted with Hockett
that phonological segmentation (or boundary placement) refer only to empirical phonetic data. Critics such as Leopold (1948) charged, however, that Moulton's posited phoneme of juncture covertly smuggled illegitimate grammatical information into the phonological analysis. There arose a theoretical debate about the proper phonemic representation of word boundaries, which I have called the "Juncture Controversy." At issue was not only the ontological nature of the phoneme, nor the use of juncture as an analytic tool, but the structure of phonological representations in general. In tracing the debate about segments and boundaries, I argue that some notion of "segment" (and therefore also "boundary") is necessary to describe phonological representations and processes. Moreover, I invoke the notion of "boundary" in order to illustrate and account for the facility with which speakers manipulate segments and boundaries.

The debates which occurred in the mid-thirties to mid-fifties over the ontological nature of the phoneme and how to deal with boundaries represent an important chapter in the history of linguistics. Although current phonological theory (particularly "multi-dimensional" or "non-linear" phonology) has abandoned many of the debates which once inflamed linguists, the issues raised during the "Decade of the Phoneme" have important implications for current work—not only for phonological analysis of field data, but also for
theoretical discussions about linguistic units, levels of structure, and analytic methodology. Moreover, all of the theories of phonological representation surveyed here—from structural analysis to generative analysis, from the London School to "multi-dimensional" theories—employ the concepts of the segment and boundary at some level.
II. Segments and Boundaries

II.1 Terminology

When surrounded by phonetic brackets [], the following non-standard symbols are used: ə stands for schwa, ng stands for engma, and ae stands for asch. As for terminology: I use the terms "phonological segment," "unit," "stretch," and "chunk" interchangeably to refer to a section of phonological material, the edges of which are somehow demarcated, which may be said to represent (in the case of the analyst) or underly (in the case of the speaker) a given phonetic realization of speech. The edge of the segment is referred to variously as "boundary," "boundary marker," "Grenzsignal," and "juncture." I will use the term "boundary" to refer to any marker which functions to keep phonemes, syllables, morphemes, words, etc., separate. Thus, my use of the term "boundary" blurs the distinction between boundaries of various segment types.

C. Hockett has warned against confusing "juncture" and "word-boundary" (personal communication, Dec. 1989). All languages have words, he argues, and thus all languages have boundaries between successive instances of words, regardless of whether such boundaries are audible. French and Spanish, he claims, contain no audible clues to the presence of word boundaries in the speech stream, although these languages do
have words. There is simply no phonetic signal which indicates where one word ends and another begins. Hockett's claim that word boundaries are universal follows from his conception of the "word" as universal, but says nothing about why, when one considers the range of potentially relevant linguistic segments, the word should play such an important role. As I will show, there are good reasons to treat the "word" as a delimited segment in language production and analysis; thus it is legitimate to treat words as "bounded" entities. "Juncture," on the other hand, should be reserved for the segmental phoneme of the American structuralist variety, Hockett argues (1958). Hockett does recognize "some positive correlation" between the occurrence of juncture and the location of word boundaries, but he emphasizes that the two do not always chaucer. In general, I will be concerned here with juncture as it functions to demarcate segments of various types; for my purposes, the distinction between juncture and other segment boundary markers is relatively unimportant.

II.2. Are Boundaries Real?

Use of the terms "segment" and "boundary" should not be taken as an ontological claim that a psychologically real junctural phoneme exists, although I do believe that knowledge of boundaries must be represented in the speaker's mind. It
is striking that the major phonological theories surveyed below employ concepts of segment and boundary which are remarkably similar. There is evidence that a competent speaker can manipulate boundaries in order to organize or "chunk" information in a hierarchical structure. Linguists can account for evidence of boundaries in linguistic structure in any of three ways:

1) by nesting boundaries on the segmental level of a phonological representation.

2) by indicating boundaries hierarchically, i.e., on a suprasegmental level or tier.

3) by predicting boundaries from the presence of contiguous segments.

However they may be treated by a given phonological theory, the functional linguistic structures of a given analysis must not be confused with actual, extant mental structures. The "elegance" of a particular phonological analysis employing a segment boundary (however conceived) as compared to a competing phonological analysis is insufficient evidence for the actual existence of such a segment boundary in the speaker's mind. Moulton's (1947) postulation of a phoneme of open juncture, for example, has significant explanatory power and descriptive economy, yet his analysis raises serious questions about the existence and nature of the
junctural marker which he posits. Nevertheless, evidence from language games, the application of phonological rules, diachronic change, and so forth, does suggest that speakers recognize and manipulate boundaries in language structure.

Although I hope to demonstrate that the speaker does have (at least tacit) knowledge of segments and boundaries, it must be kept in mind that boundary markers are not directly observable, and their number and nature is largely dependent on the theoretical framework adopted. Whether the phonetic effects discussed below are most appropriately considered the effects of a psychologically real boundary marker in the mind is, it appears to me, not a question which is open to empirical proof. However, I accept the premise as a prerequisite for performing linguistic analysis. The approach adopted here thus shares the view of linguistics expressed in Hockett (1948), which conceives of linguistics as a "science" of matching an analysis to independently existing linguistic structures rather than as a "game" of abstract symbol manipulation.

II.3. Segment or Boundary?

Technically, the notions "placement of a boundary" and "segmentation" are quite different: the former implies a reification of the marker of segmentation, while the latter
stresses the segments themselves. However, the differences are not as great as they might at first appear. Compare Figures 1 and 2:

```
|______A______| |_______B______|
```

**Figure 1.**

```
+|______A______|+|_______B______|+
```

**Figure 2.**

The schematic segments indicated are of indeterminate size (phoneme, morpheme, word, phrase, discourse unit).

Figure 1 purports to show two contiguous phonological segments, A and B, which are not marked for juncture, but merely abut. Figure 2 shows the same segments delimited by explicit boundary markers (+) which indicate where the segments begin and end. A is separated from B by the presence of the boundary marker (+). Figure 1 represents a point of transition from one segment to another. The speaker somehow "knows" where segments begin and end, and therefore does not need to mark the margins of the segment. In Figure 2, the speaker "knows" where the segment boundary is located, which
at first glance seems to be quite different. However, the apparent difference between Figure 1 and Figure 2 is illusory. The vertical lines which indicate the edges or margins of the segments in Figure 1 mark the presence of a "juncture" between the segments just as well as any other marker of boundary. The speaker's putative "knowledge" of where segments begin and end amounts to a claim that the beginnings and endings are marked somewhere, perhaps on a higher level of phonological representation, as in Figure 1a, where B and E mark the beginning and end of a segment, respectively.

```
"Higher" Level
|-----------|

|-----------|

Segmental Level
|________A______| |________B______|

Figure 1a.

It seems impossible to conceive of a segment without thinking of it as a entity which is bounded, and thus as an entity which has boundaries. In general, simplicity along the segmental line represents a trade-off for increased complexity in the form of additional levels, although the trade-off may be covert (as exemplified in Figure 1a). Conversely, reducing the amount of complexity represented by proliferating levels increases the amount of complexity on the segmental level, viz., by introducing an explicit marker of segment boundary.
On the basis of these reflections, I reject the potential distinction between an actual marker of juncture which indicates where one segment ends and another begins (whether psychologically real or merely useful analytically), as in Figure 2, and the figurative "place" where two segments abut, as in Figure 1 (Figure 1a). I assume that these functional structures are represented somewhere in the speaker's knowledge of (the structure and organization of) her language. Information relevant to determining the limits of a given segment might include structural organization at any level, including syllable structure, phonotactics, the identity of words, etc. Assuming that such structural information is present in the speaker's linguistic system, I intend to treat "segment" and "boundary" as complementary notions, without making further ontological claims. As a general rule, then, references to "resegmentation" and "placement of a boundary marker" are to be considered equivalent descriptions of the same process of phonological organization, a process which is not perfectly understood.

II.4. "Chunking"

That the speaker has knowledge of delimited segments is not difficult to demonstrate, although linguists disagree about the organization of linguistic structure. Indeed, linguists tacitly recognize the segmentability of language
whenever they select a "chunk" of language for analysis. Some linguists, notably Sapir (1921, 1933), claim that segments of various sizes are "psychologically real." As will be seen, Sapir believed not only in the psychological reality of phonemes, but also of words. Boundaries are useful for linguistic analysis in general because particular phonetic effects may be predicted wherever a segment boundary is indicated. Conversely, the native speaker uses her knowledge of phonological segmentation to produce phonetically correct utterances. The competent speaker has control over the size of phonological segments produced during speech and produces "phonological chunks" of various sizes to perform a variety of functions in speech. Phonological chunking allows the speaker to organize and structure an utterance and enables the linguist to perform phonological analysis.

Moreover, a non-native speaker who produces phonological "chunks" of the wrong size or misplaces a boundary marker will necessarily produce flawed speech. The speaker must be able to produce, and the analyst must be able to account for, phonetic contrasts like bereinigen -- vereinigen, Bereisen -- vereisen, Schuhlatz -- Schulamt, Beinahme -- Reinader, Weihnachten -- Wein achten. Some phonological processes affect chunks of only certain sizes, but not others, and faulty chunking can lead to misunderstanding or incomprehension. The crucial issues in phonological theory,
therefore, involve not whether the speaker knows where one segment ends and another begins, but rather how the competent speaker's knowledge of the structure and organization of German is realized, how it is perceived, and how it should be represented.

Knowledge of German requires recognition of a variety of segment sizes (or boundary domains). There is evidence, discussed below, that even a single articulatory feature such as voicing or aspiration may behave like a segment, undergoing such effects as metathesis. Phonological assimilation may be blocked by the presence of a boundary between two speech sounds. At the other end of the scale a segment as large as a discourse unit may be bounded; topic shifts in discourse, for example, may be marked by the presence of a discourse boundary (cf. Brown and Yule 1983:94: "...[B]etween two contiguous pieces of discourse which are intuitively considered to have two different 'topics', there should be a point at which the shift from one topic to the next is marked."). A competent speaker is able to identify segments and delimit them from one another at some level. From the speaker's perspective, speech may be segmented or "chunked" at various sizes to indicate a particular organization of linguistic information. Such chunking is under the speaker's control, though usually at beneath the conscious level. From the analyst's perspective, certain phonetic effects are
predictable if and only if they are associated with the transition from one phonological segment to another. In other words, it is the presence of certain phonetic effects which signals the organization of phonological information which the speaker intends. Finally, positing a segment boundary marker may significantly simplify the analyst's description of the language, as in Moulton's (1947) phonemic description of German, discussed below.

II.5. Linguistic Knowledge

A linguist has conscious, metalinguistic knowledge of linguistic structure which is stored in a grammar, a set of rules, a computer program, or a phonological description. The native speaker, however linguistically naive, also possesses metalinguistic knowledge, although it may be below the level of consciousness. For example, speakers in any culture know that some words are magical or taboo, that some are longer or shorter than others, that some sounds made with the mouth are not speech sounds, and that utterances will have more-or-less predictable effects. Moreover, the native speaker knows unconsciously how to pronounce words, produce novel utterances, and so on, and can instantly recognize whether a particular utterance is a part of her language or not. Native speakers can instantly recognize well-formed syllables, for example. Competent speakers produce utterances which reveal
their ability to manipulate segments of various sizes. The speaker's knowledge of the linguistic structure of his or her language is no less real for being less conscious or explicit than the linguist's. In some sense, then, the speaker may be said to "know" the structure and organization of her language. This knowledge is manifested in speaking appropriately: to the right people, in the right way, at the right time, in a way that expresses the right meaning. Linguistic knowledge involves knowing how quickly to speak, where one may pause, which words to select, how to string them together, how to pronounce them, and much more. Although the precise movements of the articulatory organs are no more (or less) subject to conscious control than, say, sweating or heart rate, and although phonological rules of a language may be beneath the level of consciousness, a speaker can produce the phonetic effects appropriate to express her meaning.

The nature of this linguistic knowledge is surprisingly unclear. There is clearly a difference between knowing a fact about language (wissen) and knowing how to speak a language (können). Tyler (personal communication, 1989) stresses that "knowing" a language like German is more akin to knowing how to ride a bicycle than to knowing a fact; language is a way of doing things. Generative linguists, on the other hand, identify linguistic knowledge with universals of human mental organization. Knowing a language means possessing a
"grammar," in the technical sense of a finite set of rules which, taken together, specifies all the well-formed sentences in a given language (cf. Anderson 1985:6-10). For some semioticians, like Umberto Eco (following De Saussure), linguistic knowledge resides in a systematically related network of endlessly proliferating, interconnected signs (cf. Eco 1985). The metaphor of linguistic knowledge residing in the interconnections among elements in a network is also promoted by connectionist cognitive scientists, such as Marvin Minsky. For Structuralists and Neo-Structuralists, the speaker's linguistic knowledge resides in a hierarchical relation of linguistic signs on various levels (cf. Hockett: 1948). More recently, Autosegmental Phonology has returned to the representation of linguistic knowledge on levels (now called "tiers") (cf. Goldsmith 1976, Kenstowicz and Kisseberth 1979, Pulleyblank 1989). One scholar even claims ingenuously that linguistic knowledge must be spread uniformly throughout the body. He notes that severing one's pinkie will forever change the way one speaks about knives, the meaning of "finger" in relation to the rest of the lexicon, and so on--it will affect the language (E. Mitchell, personal communication, 1988). The variety in these characterizations of linguistic knowledge tends to obscure the truth that the competent speaker--whether consciously or not--"knows" the structure and organization of her language.
III. The Phoneme

At this point I would like to examine the development of the phonemic principle. The concept of the phoneme, the reigning segment of the Structuralist era, developed gradually from phonetic studies and nineteenth-century diachronic linguistics. As will be seen, the principle of the phoneme raised a range of questions about the nature of segments and boundaries, particularly the kind of boundary called "juncture."

III.1. Origin of the Term "Phoneme"

The term "Phoneme" originated in the early 1870's as a French translation of the German Sprachlaut, literally "speech sound." According to Fischer-Jorgensen (1975), it replaced the "clumsy" expression son du langage. The term was coined by the Frenchman A. Dufriches-Desgenettes, who used it as "une façon générale les voyelles et les consonnes." (Revue Critique d'Histoire et de Litterature 7:386 (1783)) As Anderson has pointed out, the modern use of the term "phoneme" for a distinctive speech sound is quite different from what Dufriches-Desgenettes intended (Anderson 1985:38). At first, the term simply meant a single speech sound, without any sense of an abstract or psychological unit. The word was adopted by other French scholars (notably L. Havet, who used the term in
1874), and then by F. de Saussure (1878). Saussure used the term "phoneme" in a slightly different sense from Dufriches-Desgenettes; for him it meant a common prototype in a parent language, as reflected in the sounds extant in daughter languages. From Saussure the term "phoneme" passed to Baudouin de Courtenay through his student Kruschevsky. The first occurrence of the word in English is in G. Dunn's Classical Review (1894:8.95).

III.2. The Phonemic Insight

By "phonemic insight" and "phonemic principle" (the former term is from Anderson 1974), I mean the recognition that most of the acoustic-phonetic detail in human speech is unimportant, predictable, or irrelevant, but that there is more abstract level at which sounds are significant or functional. This insight applies whether the phonemic level is understood in purely phonetic terms (as for Bloomfield) or purely psychological terms (as for Sapir), or as a mere fiction of the analysis (as for Bloch). As Bloomfield (1933:77) writes, "...the working of language depends on our habitually and conventionally discriminating some features of sound and ignoring all others." For instance, in English aspirated [p] is felt to be in some important sense "the same" as the unaspirated version, despite measurable, perceptible phonetic differences. Yet [p] is also perceived as different
than, say, [b]. In short, then, the phonemic insight attempts to account for the linguist's observation that the native speaker perceives some objectively different speech sounds, but not others, as somehow "the same." An early statement of the phonemic principle appears in Swadesh (1934. In Joos 1957:32):

The phonemic principle is that there are in each language a limited number of elemental types of speech sounds, called phonemes, peculiar in that language, that all sounds produced in the employment of the given language are referable to its set of phonemes, that only its own phonemes are at all significant in the given language.

The principle as stated does not make any particular ontological claims about the nature of the phoneme, although by naming the phoneme one is perhaps already guilty of reifying a concept which does not objectively exist. For the time being, it is best to consider the phonemic principle an observation about a speaker's intuition, without theoretical claims about the audibility, psychological reality, or possible fictiveness of "the phoneme" as an entity.

C.F. Hockett has described the phonemic principle as the synchronic equivalent of the diachronic Neogrammariian Hypothesis, which he formulates as: "Sounds Change!" (personal communication, 1989) The key to such a formulation is the recognition that phonetic change is not equivalent to phonemic change, which is a change in the systematic relationship of
elements of language. Put another way, the crucial concept is an appropriate understanding of what a "sound" is. Not until the development of the phonemic insight, Hockett believes, was it possible to state the Neogrammarians Hypothesis in clear, meaningful terms, for only with the evolution of the concept of the phoneme did it become clear to linguists what was meant by "sound."

III.3. Pre-phonemic Phonological Theory

Early students of language had misconceptions about the relation between phonetic facts and more abstract units, but one can discern hints of the ideas which would later be codified as phonemic theory (cf. Fischer-Jorgensen 1975:4-6). Around 150 B.C.E. the Indian grammarian Patanjali wrote about the concept of varna sphota, a permanent unit of distinctive sound capable of differentiating meanings. He also distinguished between sphota, a constant, invariable linguistic entity, and dhvani, an actual event realizing the sphota in speech. Ancient Greek grammarians developed the concept of stoicheion, the atomic components of speech. There was one stoicheion per letter of the alphabet, and together they formed a coherent system. One can perhaps also see in the Platonic distinction between perfect Essence and imperfect Accidence an early ancestor of the modern distinction between abstract phoneme and imperfect phonetic realization.
The grammatical treatise of the Icelandic "First Grammarian" (c. mid-1100's) has been described as "the best phonological description of any language before the early 1930s" (Fischer-Jorgensen 1975:5). "First Grammarian" wrote unambiguously about the "commutation test" (the term is Hjelmslev's), in which one sound is replaced by another in order to identify functional phonological distinctions. The commutation test has been used, as will be seen in the discussion of juncture below, as a discovery procedure for phonemes, although such use is problematic. On the basis of minimal pairs revealed by the commutation test, "First Grammarian" proposed expanding the inventory of vowels in Icelandic from five to nine and writing the combination 'ng' with a single symbol. "First Grammarian's" work is characterized by a clear recognition of the distinctive function of significant sounds and their combinatory possibilities.

In addition to the ancient grammarians mentioned, one might also consider the influence of alphabetical writing systems on phonemic theory. A writing system represents an analysis of the speech signal into component parts. It is perhaps no coincidence that the modern conception of the phoneme is so close to a letter-sized unit of sound (as was the Greek stoicheion), rather than to a larger unit (eg., a syllable like [ba:]) or a smaller unit (eg., a phonetic
feature like bilabiality). Does the widespread use of alphabetic writing systems around the world reflect "the psychological reality of phonemes" in Sapir's sense (cf. Sapir 1925)? Or, conversely, does the concept of the phoneme reflect Western European reification of the level of abstraction already present in the alphabet? Such questions illustrate the need for cross-cultural histories of phonological theory. How did Chinese phonologists, for example, account for nonsegmental or suprasegmental "phonemes" (such as tone)? Did the lack of an alphabetic writing system retard the development of a phonemic principle based on letter-sized "chunks" of sound in cultures without alphabetical writing? The influence of writing systems on the evolution of phonological theory has not been examined sufficiently.

III.4. Classical Phonetics

According to Fischer-Jorgensen (1975:7), the classical phoneticians of the nineteenth and early twentieth centuries recognized that differences of speech sounds which functioned to distinguish meaning were important, but did not develop a theory or descriptive methodology from that insight. Moreover, they ignored the systematicity of phonemic relationships, as described in Sapir (1925). In general, their phonetic work was influenced by the orthographic systems
with which they were familiar. For instance, Grimm wrote about \textit{Buchstaben} 'letters' when it is clear that he intended speech sounds. Nor was the Saussurean distinction between synchronic and diachronic linguistics widely understood. Among the most important of the classical phoneticians were Winteler, Sweet, Passey, and Jespersen. Winteler distinguished between "essential" and "accessory" features, and applied the commutation test to identify the functional differences of various sounds. Sweet noted that a transcription need only indicate distinctive (i.e., meaningful) differences of sound, and that sound differences which are relevant in one language may be irrelevant in another. This was an important insight at the time, although it seems obvious today. Passey proposed using a separate letter for each distinctive sound in transcribing a language. Jespersen differentiated "internally determined quantity" (i.e., part of the word itself, used for distinctive purposes) from "externally determined quantity" (i.e., rule-governed, predictable phonetic conditioning), and gave examples of different distinctions relevant in various languages.

\section*{III.4.1. Saussure}

Saussure was influenced by the work of many scholars, including the Neogrammarians, von Humboldt (who distinguished between the \textit{innere Sprachform} and \textit{Lautform} of a language), von
der Gabelentz (who distinguished between language and speech, and between the "state" of a language and the "history" of a language), and Whitney (who held that language is a social institution, and that linguistic symbols are conventional). He was also probably influenced, if only indirectly, by Durkheim, the theoretician of "the social fact." These influences are apparent in Saussure's famous dichotomies. He distinguished between langue and parole, signified and signifier, form and substance (as in his famous chess analogy), syntagmatic and associative (= paradigmatic) relations, and between synchronic and diachronic descriptions of language. Saussure was able to combine these oppositions into a coherent theory about the nature of language as an arbitrary system of signs. He is for this reason considered a founder of Structuralism, with its emphasis on relations among units in a system.

Crucial for Saussurean structuralism is an emphasis on the value of a single element in relation to the entire system. Although he helped popularize the term "phoneme" (in a diachronic sense taken from Baudouin and Kruszewski), Saussure did not present a systematic theory of the phoneme or phonological analysis in his work. His importance for later phonological theory lies largely in his insistence on the systematicity of language and his emphasis on synchrony, ideas which "saturated" the atmosphere of phonological theory
throughout the twentieth century, to use Joos' metaphor (cf. Joos 1957:18).

III.4.2. Baudouin de Courtenay

The phonological work of J. Baudouin de Courtenay (1845 - 1929), conducted with his student, M. Kruszewski, was influenced by Saussure. Baudouin and Kruszewski defined the phoneme as a linguistic unit underlying an alternation between sounds in etymologically related forms (both in cognate languages and within a single language). In other words, they defined the phoneme in diachronic terms, just as Saussure had done. However, Baudouin's use of the term was inconsistent, and he continued to use the term phoneme in a variety of ways over the course of his life. In 1895 he rejected his old definitions of the phoneme and defined it anew, this time as a purely psychological entity. The phoneme was defined (Baudouin 1895, quoted in Fischer-Jorgensen 1975:9) as:

"a unitary concept [or image], belonging to the phonetic world, which develops in the mind [lit. soul] by means of a psychological fusion of impressions made by the pronunciation of one and the same sound = psychological equivalent of the speech sound" [my translation]
Baudouin was thus one of the first linguists to use the term phoneme in the sense of a mental abstraction. He also distinguished between predictable, phonetically-conditioned alternations and morphophonemic, or morphologically-conditioned, alternations.

III.4.3. Sapir

Sapir's (1925) discussion of phonemic systems is built on the intellectual foundation laid by Saussure. In "The Psychological Reality of Phonemes" (1933), he presents evidence that phonemes are real mental units. Sapir defines the phoneme itself in structuralist terms. The phoneme is "a functionally significant unit in the rigidly defined pattern or configuration of sounds peculiar to a language" as distinct from "an objectively definable entity in the articulated and perceived totality of speech." Some properties of the audible speech signal are irrelevant, while others possess "an unusual sign value." In other words, the phoneme is a unit which is abstract; it is a value (in the Saussurean sense) in a particular sound system, not the sum of its audible properties. The goal of linguistic analysis, it follows, is to describe the relations of the significant sounds to each other and to the entire linguistic system. Sapir's emphasis on systematic relations and the value of the phoneme is
strongly reliant on the concepts of *langue*, system, and the negative value of the sign found in Saussure's work.

As evidence for the existence of the phoneme as a psychological entity, Sapir notes the difficulty of teaching a linguistically naive informant to perceive phonetic differences which do not also correspond to phonemic differences. This difficulty results from "the unconscious reinterpretation of objective facts" under the influence of the phonemic level. "What the naive speaker hears is not phonetic elements," he writes, "but phonemes." Sapir also claims that "application of absolutely mechanical phonetic laws" can derive phonetic forms from a phonemic representation. Finally, Sapir claims that identical phonetic forms can "give the speaker the illusion of phonetic difference because of the different contexts in which they appear or because of the different positions they occupy in their respective form systems."

III.4.4. Bloomfield

Bloomfield's conception of the phoneme could hardly have been more different from Sapir's. Influenced by Behaviorism and guided by his own anti-mentalistic bent, Bloomfield refused to posit psychological entities which could not be empirically observed. Even if such entities did exist, they would be
inaccessible to scientific observation. Bloomfield defined the phoneme as the bundle of distinctive features found in all the phonetic segments that represented it in the actual current of speech sounds. Phonemes were thus purely phonetic entities with physically measurable parameters, "the units of signaling" (Bloomfield 1933:136). Bloomfield was willing to consider the phoneme per se as nothing more than a descriptive tool for the convenience of the analyst. He rejected the idea of a phonetic transcription as insufficiently precise to be useful; he believed that only phonemic transcriptions should be included in a grammar.

Anderson notes that Bloomfield diverged from his own conception of the phoneme in two ways (cf. Anderson 1974:24). First, by positing a morphophonemic level, he created a new, abstract (i.e., non-observable) level of representation. However, he considered the morphophonemic level to be "nothing but a descriptive device invented by the linguist to keep things straight, and to organize his data. Morphophonemic representations have no direct behavioral correlates (unlike phonemic representations), and hence cannot be anything but a convenient fiction" (Anderson 1974:24). Second, Bloomfield's own phonemicizing represents a compromise between observable phonetic facts and more abstract phonemic units. In transcribing reduced vowels, for example, Bloomfield usually wrote the full vowel as it might appear in another form of the
word. For instance, he might well have written *photographer* with [o] instead of schwa in the first syllable, on the basis of his knowledge of the form *photo*.

Bloomfield's ideas were immensely influential in American linguistics in the mid-thirties to mid-fifties. The publication of *Language*, with its important chapters on the phoneme, and Sapir's "Psychological Reality of Phonemes" in 1933 marked the beginning of the so-called "Decade of the Phoneme," which lasted until approximately the end of WWII (Hockett: personal communication, 1989). These publications were followed shortly by Swadesh's "Phonemic Principle" (1934) and Twaddell's "On Defining the Phoneme" (1935), papers which initiated a long-running debate between the two men on the nature of the phoneme as an entity. Trubetzkoy's *Grundzüge* was published in the last volume from the Prague Linguistic Circle in 1939. Finally, C.F. Hockett's "System of Descriptive Phonology" (1942) made current practices of phonemic analysis explicit. By 1945, the attentions of American linguists had largely moved from the nature of the phoneme to the morphophoneme and the morpheme and to working out the implications of phonemic theory.

III.5. The Post-Bloomfieldians

The Decade of the Phoneme saw the growth and consolidation
of the phonemic principle by a group of linguists known as the Post- Bloomfieldians. By and large, these scholars rejected Sapir's psychologism (as regards his conception of the phoneme), as well as his literary style, in favor of the more positivistic, empirical alternative represented by Bloomfield. The Post- Bloomfieldians included such important American linguists as Swadesh, Bloch, Hockett, Twaddell, Chao, Hill, Harris, Wells, Nida, and Joos, among others. Although not a closely knit school in the tradition of the Prague Circle, these American linguists shared a great many assumptions, methods, and concerns. For instance, their work sought to capitalize on the phonemic insight in order to produce descriptions of phonemic systems which were not merely subjective. It was also characterized generally by a structuralist concentration on linguistic units—especially phonemes—and their relations. In particular, individual units were described in relation to the entire linguistic system. These linguists were concerned to describe the precise nature of phonemic and phonetic representations, and to clarify the relations between them, in order to describe language as scientifically as possible.

The Joos anthology (1957) presents a selection of exemplary papers by some of the leading Post-Bloomfieldians; interestingly, Joos rejects the term "structural" in favor of "descriptive" to describe their methods (Joos 1957:96).
However, Joos' *ex cathedra* commentaries, his calculated omissions (Pike, e.g., is conspicuously absent, banished for the sin of violating the "biuniqueness" condition) and his tendency to speak on behalf of the entire "linguistic community," probably imply more unanimity among the Post-Bloomfieldians than actually existed.

III.6. Major Concerns of the Post-Bloomfieldians

Briefly, some of the major concerns during the Decade of the Phoneme were the ontological nature of the phoneme, whether a given phone was a single phoneme or a cluster, whether phonemes could "overlap," and the role of suprasegmental phonemes in phonological analysis, especially juncture, but also stress and tone.

1) The Ontological Nature of the Phoneme

American linguists in the pre-war years held a variety of competing views of the phoneme. Anderson identifies four distinct senses of the term "phoneme" which were current at that time. The phoneme was alternatively conceived of as:

a) A psychologically real, ideal phonetic segment, realized by a particular speech sound (Sapir).

b) A subset of the phonetic properties of the speech sound itself, i.e., a purely phonetic entity (Bloomfield).
c) An artefact of the linguist's description (Bloch).

d) A class of phonetically similar segments in complementary distribution with one another (cf. Anderson 1974:26).

2) Phoneme or Cluster?

The heterogeneity of definitions of the phoneme testifies to the concern of linguists to discover the nature of the phoneme as an entity. For example, it is unclear whether a given sound (such as the affricate at the beginning of church) should be considered a single phoneme or a cluster of phonemes for the purposes of phonemic analysis. It was noted that ch does not pattern like the other English voiceless stops [p], [t], and [k], since the latter series of stops can, for example, precede [r] in a cluster. This seems to be evidence for a complex phonemic representation. However, ch is apparently not analyzed as a complex cluster of phonemes in speech errors or games like "Pig Latin" (ie., church is pronounced with initial [u], not initial [§]). Bloomfield analyzed affricates as "compound phonemes" with close transition (Bloomfield 1933:120); that is, they were units one-and-a-half phonemes long.
3) Phoneme or Allophone?

It is not always clear whether a given sound is an allophone or a phoneme. This is the case with the German phones [x] and [ç], which tantalizingly contrast only in very limited contexts, and then only when the morpheme -chen 'little' is involved. Moreover, the commutation test is not always helpful in deciding the phonemic inventory of a language. Hockett noticed that even sounds normally considered allophones of a single phoneme can produce a contrast in meaning certain environments, as in the following examples (Hockett, personal communication, 1989; cf. Hockett 1958:57):

\[
\begin{align*}
[sk^h] & \quad 'S \text{ cold!} \\
[sg] & \quad 'S \text{ gold!} \\
[sk] & \quad 'S\text{cold!}
\end{align*}
\]

How should such cases be analyzed? And what is to be done when the data admit of more than one possible solution?

4) Does Phonetic Identity Imply Phonemic Identity?

Can two phonemes share a single allophone, i.e., can phonemes "overlap"? German has [t] finally in Bund and bunt, leading one to posit a single phoneme /t/ in the underlying representations of both words. Yet the allophones differ in Bunde [d] and bunte [t]. What should
the phonemic representation be? One solution to this problem was found in positing a higher level of linguistic structure, namely the morphophonemic level (cf. Bloomfield 1933). Other linguists, however, reject the morphophonemic level.

5) Are Suprasegmentals Phonemes?

There are cases in which stress, intonation, and pitch can distinguish meaning in English (eg., 'convert' [n.] vs. 'convert' [v]; 'Yes.' vs. 'Yes?'; 'John sings' vs 'John sings'). Tonal languages aside, are suprasegmentals to be considered phonemes simply because they appear to distinguish meaning in a few instances? This problem is related to the problem of juncture, which was itself associated with the onset of stress (cf. Hockett 1958, Moulton 1962, Chomsky, Halle, and Lukoff 1956).

By and large, these were exemplary problems which were used to test or expand phonological theory as it gradually evolved. Many of the theoretical issues which were raised at that time have never been resolved, and some have now come to be seen as pseudo-problems. Judging from the papers reprinted in Joos, the period of Post-Bloomfieldian descriptivist linguistics lasted at

"The classical theory, to the small extent that it faced these questions, proposed various alternative answers, none definitive. Then, around the turn of the half-century, there was a lively debate....The issue: RESOLVED, that words and word boundaries must be known and heeded before phonemic analysis can be accurately completed....The matter was never settled. The argument was simply broken off in the middle as a new and seemingly revolutionary dispensation (TG) preempted the podium."
IV. Juncture and the "Biuniqueness" Constraint

IV.1 History of the Juncture Controversy

Much of the linguistic work which has invoked the notion of segments and boundaries may be said to fall within the structuralist tradition. The Juncture Controversy evolved naturally from the phonemic theory developed in the early decades of this century, and it was pursued with vigor in the post-WWII period. The history of this debate parallels the codification of the phonemic principle. Eighty years ago, H. Sweet urged that the phonological word (not the artificially demarcated words in phonetic transcriptions) be treated as the basic unit of speech. D. Jones listed a variety of examples of words and phrases differing only in placement of juncture. These were examples of the plump eye -- plum pie variety. Trubetzkoy first realized the theoretical implications of junctural phenomena, which he treated under the heading Grenzsignale, or "boundary signals." Trubetzkoy considered such phenomena to be non-phonemic (cf. Lehiste (1960)).

IV.1. Sapir

Sapir is not usually mentioned in the literature on juncture, since he did not address that problem directly, but it is clear from his Language (1921) that he was fully aware
of the problem of identifying word boundaries. His argument for the psychological validity of the phoneme parallels his attempt to establish the word as a psychologically real unit, an attempt which has implications for the Juncture Controversy (cf. Sapir 1921:33-35). No objective [ie., phonetic] criteria can identify a word, Sapir argues, but linguistic informants have no difficulty isolating word-size chunks of speech in slow speech. He concludes that the word has psychological unity and integrity. "Cutting into" it disturbs its meaning. A word is an "integral whole, a miniature bit of art," which has "psychological validity" and a "definitely plastic unity". A word "makes sense"; it is "a completely satisfying bit of meaning." Sapir's claims about the psychological reality of words are unconvincing, but by maintaining the integrity of the whole word, he is able to sidestep many of the difficulties concerning juncture. Simply put, if the word is a psychologically real, atomic unit, then the native speaker already knows where the boundaries are:

Added to the "feel" of the word are frequently, but by no means invariably, certain external phonetic characteristics....Such features as accent, cadence, and the treatment of consonants and vowels within the body of a word are often useful as aids in the external demarcation of the word, but they must by no means be interpreted, as is sometimes done, as themselves responsible for its psychological existence. They at best but strengthen a feeling of unity that is already present on other grounds.
Juncture need not be audible phonetically because the native speaker already knows how the word is bounded--by its "feel."

Sapir's imprecise formulation of the psychological reality of words raises as many questions as it answers. He is disappointingly vague about just what "other grounds" constitute our knowledge of word boundaries. One can interpret Sapir as denying the validity of the biuniqueness principle (which had not yet, however, been formulated as such), and thus siding with Pike in allowing phonemic representations access to grammatical information. There is no indication in his statement that Sapir considers juncture to be a segmental phoneme, as Moulton would later propose (1947), but he does not seem to rule it out entirely, either. In any case, the quotation from Language demonstrates Sapir's astonishing insight into the problems associated with phonemic analysis--particularly when one considers that it appeared a full 26 years before Moulton's famous essay on German phonemics and juncture.

IV.2. Bloomfield

Bloomfield very briefly discusses the problem of word juncture in terms of the onset of stress, i.e., "the point at which the increase of loudness sets in." (1933:113) He notes that the onset of stress corresponds to the beginning of a
word in English, German, and Scandinavian, and that German also marks the onset of stress [word-initially before vowels] with a glottal stop. Lehiste has pointed out that Bloomfield printed spaces between words in his phonemic transcription, apparently to indicate predictable phonetic boundary markers (such as the glottal stop in German). However, he did not account for the presence of these spaces.

In addition, Bloomfield discussed what he called "transitions," i.e., the manner in which the vocal organs change from one phoneme to another (cf. Bloomfield 1933:118-9). This is a concept which, in slightly altered terms, was adapted by Trager and Bloch (1941), Moulton (1947), and Hockett (1958). Bloomfield notes that "in passing from silence to a stressed vowel, we usually make a gradual onset of the voice, while the North German first closes the glottis and then begins full voicing, so as to produce a (non-distinctive) glottal stop." This is the notorious glottal stop which Moulton (1947) accounts for by means of a phoneme of open juncture. He notes that transitional changes are phonemic in some languages, but not in others. Bloomfield distinguishes between close and open transition between consonants in examples like Engl. grab-bag (close) and Fr. cette table (open), and he explains that affricates in English, like all consonant groups, have close transition.
IV.3. Swadesh

Swadesh was also aware of the nondistinctive phonetic effects of junctural phenomena, notably the word-initial [?] of German (Swadesh 1934. In Joos 1957:34):

The limits of the word are often marked in special ways. Phonemes may have a special variant for the beginning or end of words. Thus the aspirate stops of Chitimacha are unaspirated at the end of the word; at the beginning of the word they are more fully aspirated than at the beginning of a medial or final syllable. Again, the limits of the word may be indicated by some non-phonemic element like the word accent of Latin or Polish, the initial glottal stop in German, or the aspiration that follows a final vowel in Nitinat. Such elements are not phonemes, but mechanical signs at the limits of the word units.

Swadesh was particularly insightful to recognize that word-boundaries are associated with phonetic effects like stress, aspiration, and the appearance of [?]. If such junctural phenomena are not phonemes, however, but merely "mechanical signs," by which I take Swadesh to mean predictable phonetic effects, then Swadesh's account still leaves unanswered the question of how word-boundaries are represented phonemically.

IV.4. Trager and Bloch; Trager and Smith

Trager and Bloch (1941) provided the first full treatment of juncture as part of a phonemic analysis of English. They
provided definitions of "open juncture" ("the transition from the pause preceding an isolated utterance to the first segmental phoneme, and from the last segmental phoneme to the following pause") and "close juncture" ("the transition from one segmental phoneme to the next within the utterance") (Trager and Bloch 1941:225). Trager and Bloch explained that open juncture is "the totality of phonetic features" at the beginnings or ends of words, and they note that it may be present either within words or at the boundaries of words. Trager and Smith (1951:38) also considered intonation and stress in conjunction with junctural phenomena.

IV.5. Orthography

The phonetic effects of juncture have been recognized for a long time. As mentioned, Bloomfield transcribed junctures by simply separating phonological segments with a space. Werner notes that the hyphen is used even in standard orthography in cases where the presence of juncture needs to be noted, e.g., Lehr-Ergebnis, co-op. Indeed, use of a hyphen to indicate juncture has enjoyed a vogue in recent years, particularly in so-called "postmodernist" writing influenced by the French social philosopher J. Derrida. The intrusive introduction of juncture is a means of rendering familiar words opaque and calling into play (in the sense of the language games discussed above) various segmentation
possibilities, suggesting a multiplicity of possible readings.

The Post-Bloomfieldians questioned the nature of boundaries, particularly the segment boundary called "juncture." The issue which they raised is a fundamental one for any phonological theory: how does the speaker know where phonemes, morphemes, or words begin and end? In general, context can be invoked to disambiguate utterances such as [waitšu:s] (why choose or white shoes). Context aside, it was extremely important to linguists during the Decade of the Phoneme to iron out the theoretical issues raised by examples of this sort, which raise a host of troubling questions: are boundaries always marked phonetically? If not, can phonemic analysis legitimately refer to grammatical information such as morphology and syntax to locate boundaries? Or must the analysis restrict itself to phonetic data, as Hockett and Moulton claimed? Is there a phoneme of juncture to demarcate word and syllable boundaries, and if so, is it to be represented on the phonetic, phonemic, or suprasegmental levels? Or are the posited segments and boundaries of phonological analysis, in the end, nothing more than an intricate fiction?
V. Juncture and The "Biuniqueness" Condition

The Juncture Controversy involves two related issues: first, the ontological nature of juncture (whether conceived of as subphonemic, phonemic, or suprasegmental), and second, the biuniqueness condition.

V.1. The "Biuniqueness" Condition.

The "biuniqueness" condition (the term was first used by Harris in 1944) may be formulated as an injunction: phonemic analysis may not refer to "higher" linguistic levels such as morphology, syntax, or semantics. Note that if the biuniqueness condition holds, then its converse must also hold: a phonemic representation must be convertible into phonetic form. Hockett (1942) states that one of the main criteria for grammatical classification is recognition of segments (e.g., morpheme, word, 'construction') "and of the borders between them." However, he insists that no grammatical information be used to identify phonological elements. In other words, only phonetic signals are valid evidence of the existence of particular segments and "borders" in conducting phonological analysis. Hockett's formulation dictum has since become famous: "There is no circularity; no grammatical fact of any kind is used in making phonological analysis" (Hockett 1942:107). Logically, phonological
analysis of a language must precede grammatical analysis; moreover, "the line of demarcation between the two must be sharp." The biuniqueness condition is sometimes formulated as an proscription against "mixing" levels; since grammatical analysis is itself based on phonemic analysis, the linguist cannot legitimately refer to higher levels of structure. In fact, mixing levels was considered acceptable as a field procedure, but only in order to choose from among several competing phonemic analyses.

Hockett's insistence on the independence of phonological analysis from grammatical analysis was rooted in a Bloomfieldian opposition to mentalism. Joos characterizes Hockett's (1949) paper as only apparently "'radical'--that is, private or even irresponsible. It was neither; it was, with all credit to Hockett's originality...and to his skill and personal way of putting the case, simply what Bloomfieldian phonemics was pretty sure to develop into through those years of discussion" (Joos 1957:108). For Hockett, as for the Bloomfieldians in general, grammatical analysis might proceed by hunches and trial-and-error, but phonological analysis must rest on a solid phonetic basis.

The biuniqueness condition became a methodological litmus test for the Post-Bloomfieldians as represented in Joos (1957). In a comment to Bloch's "Phonemic Overlapping"
(1941), in which Bloch argues for maintaining the biuniqueness condition, Joos writes: "the ghost of the slain dragon [ie., violation of the biuniqueness condition] continued to plague the community of linguists under such names as 'grammatical prerequisites to phonemic analysis' and has not been completely exorcised to this day." The "plague" to which Joos referred was the work of Kenneth Pike, the principle postwar proponent of using grammatical information for phonemic analysis.

V.2. Pike

Pike argued against the biuniqueness condition in two important articles. The first, from 1947, was skewered by Joos above; the second, from 1952, was entitled "More on Grammatical Prerequisites." In these two articles, Pike argued that some phonemic analyses might actually require access to information about the grammatical structure of the language:

"...[M]any of the phonological facts are inextricably interwoven with grammatical facts and structural relationships....one must inevitably utilize--however unintentionally--facts which are linked so closely to grammatical phenomena that an attempt to separate completely a phonological analysis from a grammatical one proves impossible."

Also: "Grammatical analysis of an initial kind is prerequisite to phonemic analysis" (Pike 1947. In Makkai 1972:153-4).
Pike's examples involve grammatical boundaries which condition the appearance of various allophones.

V.3. Juncture

Opposition to using grammatical information in phonological analysis went to the heart of the juncture debate. Harris (1951) argued that juncture phonemes are zero phonemes without any phonetic realization, and junctural phonetic phenomena are considered to be allophones of phonemes in the new environment created by the presence of juncture." This was an argument which was reminiscent of Moulton (1947). Hockett strongly disagreed with positing zero allophones of a phoneme. He argued (1955) that juncture phonemes must be realized phonetically; such phonemes are bundles of all the heterogenous phonetic features associated with boundaries. Today, 47 years after the publication of "A System of Descriptive Phonology," Hockett still insists that phonological analysis be independent of grammatical analysis:

"Zellig Harris's notion of a "zero" phoneme that conditions allophones in the flanking phonemes was an early and, in my opinion, totally incorrect bowdlerization of my juncture proposal. Only that which is audible (under good hearing conditions, that is) can be phonologically relevant. For the same reason, Moulton's proposal of a phoneme that can be actualized sometimes as zero, however tempting, is wrong. When it ain't there IT AIN'T THERE" (personal communication, Dec. 1989; emphasis Hockett's).
V.4. Hockett

C.F. Hockett was involved in every aspect of the debate on the phoneme and the phonemic status of open juncture. In Hockett (1949) he claimed that juncture phonemes have "allo-junctures" which have no phonetic properties in common, although they nevertheless have the "structural" property in common of belonging to a class of phenomena. Moreover, "it is always possible to phonemicize without junctures, though perhaps only sometimes possible to phonemicize in a way that gives us juncture phonemes." (Hockett 1949:36, quoted in Lehiste 1960:10).

Hockett (1955) accounts for junctural phenomena in terms of syllable structure. A syllable is comprised of onset, peak, and coda; an "interlude" is simultaneously coda-like and onset-like. Open internal juncture can be described as a coda-onset sequence, as opposed to an interlude. Hockett (1958) accounts for contrasts like night rate -- nitrate -- Nye Trait in terms of transition between phonemes. He notes that there are two types of transition between successive vowel and consonant phonemes, "sharp" and "muddy." Sharp transition is the only kind of transition found across a boundary between macrosegments. Hockett identifies the juncture phoneme /+/- as "a sharp transition within a macrosegment" (Hockett 1955:55). In other words, juncture
divides macrosegments into smaller units. Hockett discusses the distribution of the juncture phoneme in some detail. For example, he notes that when two adjacent vowels within a macrosegment both bear stress, they must be separated by */*, as in 'see+eight', 'try+ours'. There is no contrast in type of transition between an unstressed vowel and a following consonant. Transition contrasts between successive unstressed vowels are rare. He also points out that juncture does not always coincide with the spaces between words in English orthography. In examples like 'Juneau Alaska', the phoneme of juncture is lacking; even some single morphemes like 'Cato' or 'N.A.T.O', on the other hand, are pronounced as if they were two words separated by */*.

Hockett defines juncture in purely phonetic terms. Internal open juncture is phonemic, but in the Bloomfieldian sense of the phoneme, and it can be realized in a wide variety of ways. As Hockett argues, however, this is a strength of the juncture phoneme rather than a weakness (quoted in Lehiste 1960:11):

Juncture phonemes achieve their power precisely because of their phonetic heterogeneity....It takes longer to describe all the allophones of a juncture, but once the juncture has been described it constitutes a powerful tool.

Lehiste (1960:13) succinctly summarizes the variety of theories of what juncture is and how it is realized which were
current at the end of the Decade of the Phoneme:

a) the internal open juncture is a segmental phoneme (Moulton, Harris); b) the juncture is a suprasegmental phoneme (Hockett, 1942, Haugen, Joos); c) juncture is a phoneme sui generis, a "junctural" phoneme (Trager-Bloch, Bloch-Trager, Trager-Smith, Hockett, 1955, Hill); d) juncture is a non-phonemic modification of sounds at grammatical boundaries (Pike, 1947 and 1952); e) juncture is a contrastive emic feature of higher-layered units in the manifestation mode, but not an eme in its own right (Pike, 1955). The phonetic manifestation of juncture includes a) the totality of phonetic features that characterize the segmental and suprasegmental phonemes at the beginning and at the end of an isolated utterance (Trager-Bloch, 1941); b) a pause of indeterminate duration, a brief pause, or, in free variation, zero (Moulton); c) the internal open juncture has no phonetic features of its own (Harris); d) the internal open juncture is a "morphologically determined displacement of syllable timing" (Haugen); e) the internal open juncture is a coda-onset sequence, where coda and onset refer to syllable margins (Hockett, 1955); f) juncture is a feature of timing, definable in terms of prolongation of the segmental sound preceding the juncture (Joos, Stockwell, Hill).

She concludes, with Joos, that "The semantics of the word 'juncture' is confusing and fateful" (Joos 1957, quoted in Lehiste 1960:13).
VI. Juncture in German

VI.1. Some Phonetic Effects

The posited phoneme of juncture has been applied to synchronic German description most thoroughly in the work of Moulton, according to O. Werner (1972:62). Werner notes that concept of juncture developed from the (American Structuralist) urge to systematically describe all phonetic distinctions which were associated with a difference in meaning, i.e., which produced semantically distinct minimal pairs. Perceptible phonetic differences in pairs like Kuhchen -- Kuchen, braucht, um -- Brauchtum, den Bau erkennen -- den Bauer kennen seemed to require that the phonemic inventory of German include a glottal stop, [ç] and [x], both aspirated and unaspirated versions of [t], etc. Moreover, some phonetic differences (e.g., Eichen 'a small egg' -- Eichen 'oaks') were perceptible (at least in careful speech), but more difficult to describe. The apparent semantic contrasts exemplified above were resolved by the introduction of a suprasegmental phoneme of juncture. Phonetic signals which appeared to contrast in the same environment could then arguably be shown to occur as allophones in quite different environments. For example, [ç] and [x] could be described as allophones of a single phoneme /x/ which were realized in different positions relative to the juncture marker, an example to be discussed further below.
As Werner notes, juncture, which was associated with langue, might or might not be realized in parole. For instance, juncture was associated with an optional (or potential) pause. Note that grammatically significant pauses are indicated (orthographically) by punctuation and capitalization, as in the following example (Werner 1972:63): Er dachte, sie wird kommen -- Er, dachte sie, wird kommen. On the basis of such apparent contrasts, attempts have even been made to analyze a contrastive pause as a phoneme (Weinrich 1961, cited in Werner 1972:63). As Werner comments dryly, "Die Notwendigkeit, die taxonomisch gewonnenen suprasegmentalen Merkmale im syntaktischen Rahmen zu analysieren, zeigt sich aber hier deutlich" (Werner 1972:64).

VI.2. [x] and [ç]

German [x] and [ç] appear to be in complementary distribution, except for a few tantalizing examples, mostly involving the diminutive, -chen. Benware (1986:47–8) notes that the often-repeated examples Tauchen and Kuhchen, which Moulton cites, are perceived as odd by native speakers. However, dictionaries do cite Frauchen 'little woman' and Grauchen 'little donkey', so the problem of the distribution of [ç] persists, even in the absence of exact minimal pairs. If [ç] and [x] appear in analogous environments (after back vowels), then the two phones cannot be in complementary distribution. When morphological information about German is
brought bear on the analysis, Benware claims, the problem is easily resolved: only [ç] appears morpheme-initially; [x] appears elsewhere. This rule applies not only to the examples with -chen, but also word-initially in Charisma, Chemie, Cherub, Chiasmus, China, and Chirurg, Benware claims. Unfortunately, the data are insufficiently accommodating to Benware's analysis. At least one native informant produces [x] - [k] in each of the above examples except Chirurg, where she accepts only [ç]. She accepts both [x] and [ç] in China. Benware's rule ( /x/ --- [ç] immediately preceding a morpheme boundary) fails to account for cases, like Chirurg, where the realization of a particular sound is morphologically conditioned.

VI.3. Moulton (1947)

In his famous phonemic analysis of German, Moulton (1947) addressed the problem of whether [x] and [ç] are allophones in complementary distribution or separate phonemes. According to Lehiste (1960:8), Moulton had three options: First, he could apply the so-called "commutation test" for functional difference and, on the basis of such contrasts as Kuhchen 'little cow' [ç] vs. Kuchen 'cake' [x], decide that [ç] and [x] are indeed separate phonemes. Alternatively, he could interpret the German data by noting that brief pauses commonly occur at syntactic boundaries, whereas short pauses may or may
not occur at morpheme boundaries. In other words, he could use his knowledge of the grammatical structure of German (morphology and syntax) to demarcate morphemes, much as Sapir would use the "feel" or meaning of a word.

Moulton rejected both of these approaches. Instead, he concluded that [x] and [ç] are in complementary distribution with each other, with [x] occurring only after central and back vowels or semivowels and [ç] occurring only after front vowels and semivowels, and after consonants, e.g., [na:x] 'after', [bu:x] 'book'; but [ne:çst] 'next', [çElç] 'elk'. Now, however, Moulton had to account for the contrast of [x] and [ç] in pairs such as Tauchen 'diving' [x] / Tauchen 'little rope' [ç].

Moulton proposed a segmental phoneme of open juncture as a member of the phonemic system of German. This phoneme was realized in a variety of ways:

1) as a pause at the beginning or end of a word,
2) as a pause in free-variation with a zero-allophone within a word, and
3) as aspiration on a voiceless stop, a glottal stop, or [ç] following a central or back vowel or semivowel (Moulton 1947. In Joos 1957:213)

Moulton, like Hockett, insisted on accounting for the German data without using grammatical knowledge: "For a number
of reasons I believe that this should not be done....I believe that the phonemes of a language should be analyzed without reference to syntax or morphology (Moulton 1947. In Joos 1957:214, fn.14). His proposal of a phoneme of open juncture which is realized in a variety of ways (including zero) is an ingenious solution, since it accounts for a variety of predictable phonetic facts in the data and has the added advantage of economy; the addition of a phoneme of open juncture /+/ allows Moulton to avoid positing phonemes of aspirated voiceless stops, [ʔ], and /ç/. An analysis which makes use of a phoneme of open juncture thus allows Moulton to save the general observation that [ç] appears following a central or back vowel or semivowel, and that [x] and [ç] are in complementary distribution. Moreover, the presence of internal open juncture accounts for the apparent exception in the case of the -chen morpheme.

VI.4. Bloch

Bloch strongly questioned the existence of a phoneme of open juncture in "A Set of Postulates" (1948). Bloch writes:

There is nothing in our assumptions to cover juncture....The so-called juncture phonemes of English and German...are not phonemes at all in our sense of the definition: they are not...classes of segments or spans containing a given feature, but rather fictions created ad hoc to account for the difference between certain sets of phonetically different segments.
As this quotation illustrates, the hypothesized existence of a phoneme of juncture depends to a great extent on one's definition of the phoneme in the first place. Bloch, with a relatively limited conception of the phoneme as a class of segments, concludes that juncture is an ad hoc fiction created by the analyst. As Lehnste notes, however, Bloch's pronouncement is not to be taken as censure; he writes approvingly of Moulton's analysis involving the use of a zero-allophone of juncture. For Bloch, a phoneme of juncture is merely a fiction, but it is a useful fiction.

VI.5 Leopold

Leopold, while (ironically?) praising Moulton's "brilliant" analysis of German, strongly rejects his conclusion that [x] and [ç] are allophones in complementary distribution. Moreover, Leopold accuses Moulton of analytical trickery for positing a zero allophone of open juncture which is not perceptible in the data. "To say that /x/ shows the allophone [ç] after open juncture in its zero form, means that there is no observable sign of open juncture. It amounts to saying that we must assume open juncture when /x/ shows the allophone [ç]. This is a vicious circle" (Leopold 1948. In Joos 1957:215). Leopold does not object to the use of a phoneme of open juncture per se, since he notes that a pause is an observable phonetic fact. He does, however, insist that
a phonemic analysis be based on phonetic data alone, rather than on a non-observable intuition like "potential pause." Recall that in Moulton's analysis, internal open juncture could be realized as zero.

Moreover, he accuses Moulton of violating the biuniqueness condition by smuggling grammatical information into his analysis. Leopold maintains (in Joos 1957:216) that Moulton's internal open juncture actually "amounts to recognition of a boundary in word-formation. But he [Moulton] does not admit it, because of his conviction that a phonemic analysis should be based on phonetic facts," without reference to higher levels. "Apparently, this is where the crux of the matter lies," Leopold writes. "Is it permissible to introduce considerations of word-formation into phonemic disquisitions? If so, the alternative of assuming two allophones of ch is tenable. If not, it becomes necessary to return to the separation of /ç/ and /x/ into two phonemes..." 

VI.6. Moulton (1962)

Moulton devotes a chapter to juncture in his contrastive grammar of English and German (1962). Moulton claims that audible phonetic signals, such as the presence of a glottal stop, strong stress, or aspiration, can provide the listener or analyst with "clues" to the structure of utterances in
English and German. He describes a situation in which a given string of phonological segments is ambiguous in regard to constituent structure, though not in constituent order. A string of this sort is what I have called a "boundary placement paradox" below. In order to disambiguate the phonological structure of the string, the speaker has two options: 1) to name one part of the string, thereby indicating the appropriate segmentation pattern, or 2) to separate the segments with "a clear syllable break" or pause (of indeterminate length). The speaker always has the option of pausing where there are breaks between segments, even though she may or may not pause in any particular situation. Such breaks are called "junctures." For Moulton, juncture is identified with a potential, permissible, or actual pause. Moreover, Moulton considers juncture to be marked explicitly in the phonological representation of a lexical item. However, he recognizes that the presence or absence of phonological juncture may be a function of register, speech tempo, and other intangible psychological factors, including "the need which the speaker feels for using it."

VI.6.1. "Open" and "Close" Juncture

Moulton proposes two types of juncture: "open" and "close" (1962:139). Where segments are contiguous, but no pause is possible, the segments are said to be in "close"
juncture. One characteristic of close juncture is that, unlike open juncture, it does not inhibit assimilation of contiguous phonemes. As a result, close juncture is more common than open juncture in informal, "sloppy" speech "where there is no need to emphasize the grammatical boundary between the two words" or segments. "Open" juncture is more common in carefully articulated speech. Open juncture is associated with (i.e., "very frequently marks") the boundary between two morphemes, whether they be independent words, constituents of a compound, or a stem and an affix. However, Moulton notes that open juncture may also occur where no grammatical boundary exists, e.g., within borrowed words. Open juncture indicates the organization of grammatical elements; moreover, it is often realized by predictable phonetic effects. References to "juncture" alone refer to Moulton's "open" juncture.

VI.6.2. The Phonetic Realization of Juncture in German

Although Moulton clearly conceives of open juncture as a segmental phoneme, on par with any of the other phonemes of English or German, he is noticeably vague about whether it is a constituent of the speaker's phonological system or merely an artefact of the analysis. Juncture is realized heterogeneously in different environments. Moreover, a wide variety of phonetic signals may provide evidence for the
presence of a phoneme of open juncture.

VI.6.3. Pause

For instance, as mentioned above, open juncture may be realized as a pause. Moulton apparently considers a phonetic pause sufficient evidence for the existence of a phoneme of open juncture, as in the case of a morphologically complex word. Significantly, he also equates open juncture, a segmental phoneme, with boundary markers of segments much larger than the phoneme. For instance, he associates juncture with the terminals of any stress pattern, whether falling, rising, or holding. The boundaries of macro-segments, which are delimited by the length of an intonational pattern, are "probably always" marked by open juncture, he writes. For example, the following sentence has a juncture at the holding terminal following Krauss:

\[ \begin{array}{ccc|ccc} 2 & 3 & 3 & 2 & 3 & 1 \\ \end{array} \]

Der alte Herr Krauss + vergess seine Fahrkarte.

In addition, junctures must be posited at the extreme ends of the utterance, for the pause preceding the utterance of Der and after the falling terminal at the end.
VI.6.4. Stress

Another indication of the presence of open juncture is the onset of strong stress. In /kauflaks/, for example, alternative segmentation patterns yield the meanings Kau Flachs! 'chew flax!' and 'Kauf Lachs! 'buy lox!'. Moulton claims that, in the absence of a disambiguating pause, only the position of the onset of strong stress differentiates these utterances from one another (he ignores the disambiguating function of context). In this case, the strong stress appears on the phoneme which begins the new word, either /f/ in the case of Flachs or /l/ in the case of Lachs. In other words, the placement of strong stress indicates whether the /f/ is syllabified as the coda of the first syllable or the onset of the second syllable (cf. Moulton 1962:140).

Moulton notes that secondary stress is usually accompanied by open juncture in German, more frequently than in English (cf. Moulton 1962:140-1). Weak stress, on the other hand, usually indicates the presence of close juncture. The examples which Moulton gives, however, suggest that, in the case of weak stress at least, juncture may be optional. However, there are still other phonetic signals of open juncture.
VI.6.5. The Glottal Stop

Vowels preceded by a phoneme of open juncture (i.e., including those vowels in word-initial position) are often realized with a preceding glottal stop. Moulton notes that glottalized allophones of vowels are "far less common" in the southern German-speaking area than in the North (1962:143). In normal conversational German, word-initial vowels are pronounced in close juncture, without an accompanying glottal stop, when the vowel is 1) unstressed and 2) part of the same macro-segment or "stress group," as delimited by a single intonational pattern. This generalization does not apply when the vowel-initial word receives contrastive or emphatic stress, however, in which case the vowel is realized with a glottal stop. The association of strong stress and open juncture has already been discussed above.

VI.6.6. Phonetic [r]

Certain dialects of English, notably Australian English and the English spoken around Boston, may reveal a phonetic [r] whenever two vowels stand in close juncture. The presence of such an [r], like the glottalized vowel allophone in German, is closely correlated with speech tempo and register. The presence of open juncture, e.g., in careful speech, inhibits the speaker's production of phonetic [r].
In at least one dialect of Australian English, [r] appears before vowels at word-boundaries only in "presto" speech. A phrase like "Cuba is" is realized optionally with "r-full" and "r-less" variants, depending on the presence of close or open juncture respectively. Note that in citation form, "Cuba" is produced in the "r-less" variety. One informant reported that she could never catch herself saying intervocalic [r], since the phenomenon seemed to disappear whenever she focussed her attention on it. Apparently, concentrating on her speech was sufficient to cause her to insert open junctures at word boundaries, effectively removing the conditions necessary for the phonetic [r] to be produced.

As described above, standard German normally employs a glottal stop as a signal of open juncture between vowels; when the vowels are in close juncture, the glottal stop is absent. In addition, a synchronic analysis of German will find that certain classes of compound morphemes indicate close juncture between contiguous vowels precisely as in Australian English, namely with the presence of a phonetic [r]. In both so-called "wo-compounds" and "da-compounds," the contiguous elements may be linked by a phonetic [r]. Such compounds are formed by linking either wo- or da- to a preposition, e.g., wodurch, damit. When the preposition begins with a vowel, however, German speakers must insert an [r] between the compound parts, rather than a glottal stop, as might have been expected:
woran       daran
worin       darin
woraus      daraus
woruber     daruber
worunter    darunter

The fact that the [r] discussed here is a remnant of earlier forms (still perceptible in English where, here, there, etc.) does not detract from this synchronic analysis; it remains true that [r] functions to delimit and separate morphemes which stand in close juncture in wo- and da-compounds.

VI.7. Juncture and Constituent Structure

Moulton does not mention that the presence of juncture appears to correspond not only to the presence of intonational terminals, but also to the constituent structure of the sentence; it seems no coincidence that it is a Noun Phrase which in the preceding example is bounded on both ends by markers of juncture. Moreover, other junctures could be placed within the sentence, e.g., between the verb (vergass) and its object (seine Fahrkarte), in which case seine would be pronounced with initial [z] rather than [s]. Or, indeed, juncture could be marked at the morpheme boundary within the compound word: fahr+karte. Placement of boundaries to the left and the right of sentence constituents such as Noun, Verb Phrase, etc., corresponds to the definition of the phonological word in the sense of Chomsky and Halle (1968).
For Halle and Chomsky, syntactic structure is intimately related to the placement of boundaries. Wurzel (1966:252) provides an example which equates sentence constituents with boundary markers. Consider the sentence Bärbel arbeitet mit den Kindern. In SPE notation, simple word boundaries are marked by #: "phonological words" are indicated by the presence of ## before and after the word:

```
## ## Bärbel ## arbeitet ## mit ## den ## Kindern ## ## ## 
```

This sentence can be represented in a phrase structure tree as in Figure 4:
According to Wurzel, a Chomsky and Halle analysis would reveal the sentence to contain three phonological words, Bärbel, arbeitet, and mit den Kindern. As Wurzel shows, Chomsky and Halle basically form "phonological words" by attaching articles, prepositions, conjunctions, and "non-adjectival" adverbs to neighboring lexical categories. The SPE approach explains otherwise inexplicable phonological phenomena, Wurzel claims. For instance, assimilation and reduction of phonemes across word boundaries can be explained by a rule which applies only to a segment bounded by a single #, but not to a "phonological word" bounded by # #. Wurzel cites as examples contracted prepositions (im, zur, ausn, vors, zun [i.e., zu den]). Moreover, he claims that phonological word boundaries can explain reduction which occurs diachronically. A rule which operated only within the phonological word would account for the observation that the string mit den Kindern can be reduced, but not arbeitet mit. The application of a rule
which is limited to the domain of a phonological word can also explain the reduction of, for example, placenames over time.
VII. The Integrity of the Segment

VII.1 Segments as Gestalten

Speakers of language appear to have a Gestalt sense of a segment as a unitary whole. A word, for example, has what may be called "integrity" as a segment. Phonologists in particular must recognize and account for the fact that speakers treat a segment as a unitary whole or Gestalt as evidenced by phonological processes which operate over limited domains. If the integrity of a segment is disturbed—if it is broken up or cut into, to use Sapir's terms—then its identity as a segment vanishes. As Sapir wrote, segments have "psychological reality." Linguists from various schools account for the integrity of segments in different ways. Recall that Sapir had no qualms about using psychological terms to explain the speaker's unconscious recognition of the unity of the segment, regardless of whether that segment was phoneme- or word-sized. This view of the segment requires that constituents of the segment not be realized simultaneously, a restriction which may be too strict in the case of the phoneme. Although there is evidence that individual phonetic features can behave like segments, undergoing, e.g., metathesis, phonologists (since Jacobson) have often conceived of the phoneme as a bundle of simultaneously realized features. "Cutting into" a phoneme,
in this case, might destroy its integrity as a unit, but need not produce a string of smaller segments. In this sense the phoneme may be considered the atomic segment of language.

VII.2 The Gestalt Approach: Hockett

Unlike Sapir, Hockett (1958) insistently avoids a psychologistic definition of the word; instead, he defines it in terms of a discovery procedure. For Hockett, a word is any segment which is bounded by a potential pause (1958:166-7). Words may be identified either in slow speech, in which all potential pauses are realized, or by isolating the segment in other contexts. Moulton's analysis of the German phonemic system also uses a "potential" pause which may or may not be realized in a given situation.

Hockett (1987) now adopts a more psychological definition of the word. Explicitly adopting a Gestalt approach, he echoes Sapir's when he writes, "A listener need not hear some phonetic feature precisely at a boundary in order to know the location of a boundary. We infer the places where words abut from the recognition of the words as wholes" (personal communication, Dec. 1989). Juncture may be audible; however, because of a Gestalt sense of the unity of a word as a whole, a speaker is able to figure out "where words abut" without audible phonetic cues. The speaker's ability to know a word
when she sees one, i.e., to recognize words as wholes, may be related to the cognitive ability to recognize visual *gestalten* such as a person's face. As N.I. Trubetzkoy wrote (cited in Benware 1986:120): "Phonemes must not be thought of as building blocks from which individual words are put together. Rather, every word is a phonetic whole, a 'gestalt', and which is recognized by the listener as a *gestalt*, just as a familiar person is recognized on the street by his form as a whole."

Perhaps more important, a *gestalt*-based interpretation of the integrity of the segment may help explain the remarkable speed with which it is possible to recognize that a given segment is not a word, or that a given face has never been encountered before. The process by which humans do this is not understood, but based on the speed at which it is accomplished, it must involve parallel processing of information. In other words, it is demonstrably unnecessary to compare a nonsense word with all other words in one's linguistic system in order to determine that it is novel.

In Hockett's *Gestalt*-oriented view, interpretation of actual utterances involves identification of segmental wholes already present in the listener's linguistic system, rather than reconstruction of a segment from one or more of its pieces. The process is more like pattern-matching than it is like cloning. The speaker aims at a particular word shape, a phonological target, but produces only a slurred, muddy
approximation of that target which Hockett calls "Slurvian" (1987). There are no separately detectable phonemes in the speech stream. Moreover, a listener need not recognize phonemes, but only words as wholes. As Hockett writes (1987:51), "...a word is a RECOGNITION UNIT, a PERCEPTUAL GESTALT. If you hear someone say I drove downtown yesterday you recognize each of the four successive stretches of speech-sound as a familiar hunk....You do not take the sound of Idroved or rovedow or townyes as a unit because there are no such units." In context, a tiny amount of phonetic material may suffice to uniquely identify the speaker's target word.

VII.3. Modes of Listening

Hockett (1987) distinguishes at least three "modes" of listening, although there are probably infinite variations on the two modes. There is, for instance, a mode of listening called "sentry listening," in which the listener half-listens to what is said, just in case something important comes up, but does not really listen for comprehension. Other modes of listening include listening for "word shape" and "word identity." The former requires unusually clear pronunciation, or "clarity norm articulation," on the part of the speaker. It is the kind of listening which is employed by phoneticians, foreign language learners, and the slightly deaf. Hockett recalls that it was such slow, careful speech that led to the
development of the phonemic principle in the first place. In clarity norm articulation, words are carefully kept apart by discrete differences. The second mode of listening might be called "Gestalt Hearing." The kind of listening most often performed, it involves listening for the identity of a word, i.e., the recognition that the speaker intends word A, and not words B, C, etc. As in Gestalt studies of vision, the listener fills in the gaps where phonetic information has been obscured by noise and makes predictions based on the context and previous experience.

The mind does not passively parse the speech stream which it receives, but actively predicts potential matches to the words which the speech stream indexes. The process is not foolproof, and errors often result. Hockett, for example, reported two cases in which his poor hearing resulted in faulty segmentation of the speech stream. In the first instance, he understood "Tops Bread," when what had actually been said was "Top Spread." In the second case, he understood, "This is going to be a short stay." In fact, the speaker had said, "This is going to be a shorts day." These and similar mistakes of hearing support Hockett's claim that words are perceived as Gestalt shapes. Significantly, such mistakes of hearing do not usually produce phonological nonsense, but only semantic nonsense. Listening is an active process which involves pattern recognition and matching.
Segmentation mistakes such as these recall the language games discussed above; in both cases, the listener is faced with the task of parsing an utterance which gives ambiguous clues to its structure.

VII.4. **Gestalt** and Boundary

The **Gestalt** integrity of the word is relevant to the question of word boundaries. Pike insisted that grammatical boundaries were pertinent to phonological analysis; Hockett, as has been seen, insisted that boundaries could be phonologically relevant only when audible. On numerous occasions, Hockett has claimed that Pike was right, but "for the wrong reasons" (personal communication, Dec. 1989). Boundaries between words are computed from the context; they are inferred from the presence of adjoining **Gestalts**. Words, Hockett now claims, are appropriately defined as "perceptual recognition units," rather than, e.g., "minimal free forms."

VII.5. The Segment in Generative Phonology

What I have referred to as the integrity of the word is recognized by a variety of theoretical approaches. One method used in generative phonology, following Chomsky and Halle (1968) is to demarcate the boundaries of the "simple word" with the symbol "#" and the "phonological word" with # #.
Benware (1986) adopts this approach in his analysis of German syllabification, as does Wurzel (1970). These generative phonologists use the symbol #, which marks the beginning and the end of a segment, to somehow represent the speaker's sense that a word functions as a whole, i.e., has "integrity" as a segment.

In addition, the presence of word boundary is used to constrain the operation of certain phonological processes or rules. Wurzel claims that certain diachronic developments in German are the result of the application of rules within the phonological word. Simple word boundaries allow reduction to occur, while other types of boundary, e.g., phonological word boundaries, block phonological reduction. As an example of processes operating within the domain of the phonological word, Wurzel cites the reduction of place names like Mebach and Zermatt, which are derived from Middle High German ze dem ezbache and ze (de)r matte, respectively. The "phonological word" in the sense of Chomsky and Halle (1968), identified as it is by mechanical symbol manipulation, is an attempt to formalize the identity and "integrity" of the phonological segment; unfortunately, the SPE approach ignores the "integrity" of segments slightly larger or smaller than the "phonological word" and neglects the extent to which speakers can manipulate boundaries to create phonological units of any size. The difference between the generative approach, in
which the word's margins are marked with a special symbol, and Sapir's claim that the word has "psychological reality" as a unit, seems more a matter of style than of substance.

VII.6. A Typology of Segments

Kenstowicz and Kisseberth (1979) show that grammatical structure can determine whether or not a phonological rule applies. This is another way of saying that the application of a rule can be blocked or inhibited by a boundary marker. In addition, boundaries can condition (provide the necessary environment for) the application of a phonological rule. Kenstowicz and Kisseberth propose marking boundaries on different levels. Rules which apply to the morphemic level, the word level, the phrase level, etc., are to be restricted by boundaries marked on the relevant level.

Kenstowicz and Kisseberth maintain that a reasonable phonological theory must constrain the "appeal to boundaries" as conditioning factors for the application of rules in order to avoid trivial, ad hoc analyses. "An adequate theory of boundaries would delimit the number of distinct boundary types (e.g., morpheme boundary, stem boundary, word boundary, and phrase boundary) and the positions in the string of sounds which these boundaries occupy" (1979:415). They cite the critique (of Moulton) in Chomsky, Halle, and Lukoff (1956), in
which an analysis of nasal assimilation conditioned by the presence of a morpheme boundary is rejected as absurd.

The limited domain of phonological rules provides evidence that boundaries do delimit segments of different sizes, mirroring grammatical organization. For example, Kenstowicz and Kisseberth cite a rule which is conditioned by the presence of a morpheme boundary. Briefly, a voiceless occlusive in the Quicha language Puyo Pongo becomes voiced after a nasal, as long as the nasal and the occlusive belong to different morphemes. No voicing occurs if they belong to the same morpheme. In general, phonological rules apply across morpheme boundaries, a principle which was raised to a constraint in SPE phonology (Kenstowicz and Kisseberth 1979:408). Counterexamples, in which a rule applies across a morpheme boundary, are not difficult to find, however.

A particularly salient boundary type demarcates words. Generally speaking, phonological rules "tend to apply within words, not across words" (Kenstowicz and Kisseberth 1979:407) In Yawelmani, for example, a word boundary blocks the application of a vowel harmony rule which rounds /a/ to [ɔ] if an /o/ occurs in the immediately preceding syllable. Vowel harmony occurs across the domain of the word, but not beyond. In another commonly cited example, word-initial vowels are accented in Czech, whereas word-internal vowels are not.
Following Hockett (1987), I suggest that the high salience of the word boundary may result from the integrity of the word as a *Gestalt* unit.

Kenstowicz and Kisseberth cite several examples of phrase-level rules, i.e., rules which apply across a word boundary, from Cairene Arabic and Polish. They also note that speakers organize (or "chunk") phonological material in ways which can correlated with register. In French, for instance, *liaison* occurs more frequently in informal situations than in formal ones. Words which are in the same phrasal category are also more likely to be linked by *liaison*. Final consonants, which are frequently pronounced in careful speech, serve a disambiguating demarcative function in French, much like the glottal stop which appears in careful German speech before vowels. For example, *un marchand de draps anglais* can mean either 'a merchant of English cloth' and 'an English cloth merchant', depending on whether the final consonant of *draps* is pronounced. They claim that quite different representations underly the two possible pronunciations; in this example, *liaison* occurs only between sister nodes as represented in a phrase structure tree diagram.

There is also evidence that some phrase-level rules must have access to information about the grammatical category of a word, Kenstowicz and Kisseberth claim. They cite work on
Modern Greek which identifies four different rules of vowel deletion: one rule applies only between a subject and a following verb; another applies only between an adjective and a following noun; another between a verb and a following adverb; another between a pronominal clitic and a following verb.

I can see no compelling reason to avoid analytical segment boundaries wherever it results in a gain of economy or elegance, even if the resulting analysis does not correspond to the language structures in the speaker's mind. Moreover, as has been seen, junctural phenomena need not correspond to grammatical structures, as exemplified by 'Cato' and 'N.A.T.O.' Kenstowicz and Kisseberth conclude that the use of boundaries in phonological analysis raises many questions, including: 1) whether there is an upper limit to the number of boundaries, 2) what phonetic facts constitute sufficient evidence for postulating the presence of a boundary, 3) what phonological behavior is attributable to the presence of boundary rather than to the identity or integrity of a segment. It should be recalled that the structuralist phonologists asked the same questions over forty years ago.
VIII. Language Games

VIII.1. Segment Metathesis

VIII.1.1. "Pig Latin"

An awareness of the role played by segmentation or boundary placement in language parsing is not limited to trained linguists. There are a large number of language games and secret codes which transpose segments of various sizes or modify phonological material at boundary points. An obvious example of such a game is "Pig Latin." One version of "Pig Latin" requires the speaker to identify word-initial syllable onsets (not word-initial consonants), move them to the following word boundary, add [e:y], and resyllabify the string: [e:spre:y] 'spray'; [Ur?+c:e:y] 'church'; [e:sis+tme:y] 'tmesis'; [ale:y] or [al+?ey] 'all'.

VIII.1.2. "Egg Latin" and Sumsen

In a variety of "Pig Latin," called "Egg Latin," the speaker must identify every consonant phoneme or cluster in an utterance. The nonsense-syllable [Eg] is then attached to the consonant to form a syllable. Certain vowels are reduced, although the rules governing vowel reduction are not clear. The following examples will illustrate "Egg Latin":
English                  Egg Latin
'Genie' [jiːniː]         [jEg@nEgiː]
'butter' [bətər]        [bEg@tEgiːrEgi]       [?EgIÆgiː] or [?Eg+g1Egiː]
'ugly' [ˈʌgliː]         [?EgIÆgiː]
'into' [ɪntuː]          [?EgInEgtEguː]

There is a German version of Egg Latin, called **Sumsen**, in which the speaker inserts [zUṃ] after every word. For example, *Peter fährt in die Stadt* is pronounced *Petersum fährtsum insum diesum Stadtsum*. Following a voiceless consonant, the [z] of [zUṃ] often assimilates to [s], as in *heisssum* \(\Rightarrow\) [haisUṃ].

VIII.1.3. Spoonerisms

"Spoonерisms" represent a variation on "Pig Latin" in which segments are metathesized. As in the code games described above, the relevant segment is generally the syllable onset, whether a single sound or a cluster of consonants. Since spoonerisms are quite well understood, a single example, which is allegedly genuine, will suffice. Instead of his intended "Show her ladyship to her seat," Rev. Spooner demanded that his servants "Sew her shadylip to her sheet" (Jeffers and Lehiste 1979:7). It is noteworthy that metathesis may affect segments larger than the speech sound, including syllables or words, particularly in slips of the tongue.
VIII.2. The Boundary Placement Paradox

There is a series of language games and tricks which are directly related to proper segmentation of the speech stream. In general, these games are based on what might be called a "boundary placement paradox." In a boundary placement paradox, a given string of phonological segments has more than one meaning, depending on how that string is segmented. The effect of placing a boundary marker at one point in the string is to foreground one meaning, whereas placement of the boundary at another point reveals another of the possible meanings. The effect is analogous to the optical illusion called a Necker cube, in which a two-dimensional representation of a cube appears to have a face which is either in the foreground or the background of the picture, as in Figure 3:

![Figure 3. A Necker Cube](image)

VIII.2.1. Iced Ink

Like the Necker cube, a "boundary placement paradox" may
involve a sudden and unexpected transition from one state to another. One trick which employs the "boundary placement paradox" is the "I Stink" joke, which runs according to the following script:

Attacker: "What do you get when you have tea and you put ice in it?"
Victim: "Iced tea."
Attacker: "What do you get when you have ink and you put ice in it?"
Victim: "Iced ink."
Attacker: [uproarious laughter]

The joke succeeds because of the phonetic similarity of "iced ink" and "I stink" [ʔaist+iːn]k. The Attacker maliciously interprets the innocent Victim's response to reveal a possible meaning by resegmenting the Victim's utterance in an unexpected way. The iced tea example will be discussed further below. The savvy Victim can avoid the shame of inadvertently saying "I stink" by marking the word-boundary between "iced" and "ink" entirely unambiguous. In order to save face, the Victim can opt to break the phonological phrase in two, producing an utterance with a pause at the point of juncture, strong stress on both segments, and a glottal stop at the onset of "ink."

VIII.2.2. Puns

Other language games which, like the "I Stink" trick, rely on the placement of boundary to succeed, include puns of
the most egregious sort. For instance, I recently chanced to overhear a student joke, "What Philip [a university professor] really needs is some Acadamia nuts." This joke, like the iced ink -- I stink joke, relies on the phonetic similarity of a "boundary placement paradox" (some Acadamia nuts -- some Macadamia nuts) at normal speaking tempo for its punch.

VIII.2.3. Nursery Rhymes

German speakers have a rhyming game, "Drei Japaneser," which requires them to identify the vowels of an utterance. The text of the rhyme is as follows:

Drei Japaneser mit dem Kontrabass
Stehen auf der Strasse und verzapfen [= erzählen] was.
Da kommt ein Schutzmann und fragt, 'Was ist das?'
Drei Japaneser mit dem Kontrabass.

The poem is then repeated several times, but with each vowel now replaced: "Dra Japanasar mit dam Kantrabass...," "Dry Jypynysyr mit dym Kyntrybyss...," and so on. Only mit retains its original vowel.

In addition to distinguishing vowels from consonants, some nursery rhymes also exploit the ambiguous phonological structure of utterances, as in the case of "I Scream, You Scream, We All Scream for Ice Cream," a classic segmentation illusion. There is also a children's song, "Mares Eat Oats,"
which goes like this:

"Mares Eat Oats"

Mares eat oats,
and does eat oats,
and little lambs eat ivy.
A kid'll eat ivy, too—wouldn't you?

"Mares Eat Oats," sometimes written "Mairsy Dotes," is particularly interesting because it represents an extended version of the segmentation problem which, in most discussions of juncture, is limited to a lexical contrast. If it is done right, a recitation of "Mares Eat Oats" is incomprehensible at first. The listener tries in vain to figure out the meaning of "mairsy," "dotes," "dosey," etc. Only in quite careful speech does a disambiguating segmentation pattern become obvious. Thereafter, the listener who knows the pattern of boundary placement can always identify the segments (and the meaning) of the song, even in cases where phonetic clues about where segments begin and end are absent.

German speakers play a series of games which are precisely analogous to "Mares Eat Oats." Upon hearing a recitation of "Mares Eat Oats" for the first time, one Swiss German speaker instantly produced the following utterance: [dikura:nt@ bIsi: fi:laufi ro:rUm]. As above, the listener is left wondering just what Kurante, bisi, vielauf, and Rohrum might mean. In careful speech, however, the sentence can be
disambiguated as Die Kuh rannte, bis sie fiel auf ihr Ohr um. The proper pattern of segmentation is marked by the appearance of a glottal stop before auf and Ohr, a trilled [r], and a voiced sibilant [z] in sie, as well as strong stress on each word. Similarly, [vasErg@lt@ kupfErg@lt@] turns out to mean Wassergelte [= gefäss], Kupfergelte.

Naturally, the 'sophisticated' listener of such nursery rhymes does not memorize the positions at which junctures occur in games such as these, but uses her knowledge of grammar, semantics and word identity to parse future repetitions of the rhyme. "Mares Eat Oats" and similar games illustrate the sense in which one may be said to "hear grammar": lacking sufficient phonetic information, the speaker uses knowledge of grammatical structure to correctly segment and interpret the speech stream.

Language games like the ones described prove that speakers are quite good at recognizing segments of various sizes. Moreover, they are surprisingly good at "chunking" phonological information in packages of different sizes, as appropriate to the situation. One final game ought to be mentioned. German children sing a nonsense song, one version of which goes like this:

Auf der Mauer, auf der Lauer, sitzt eine kleine Wanze. Auf der Mauer, auf der Lauer, sitzt eine kleine Wanze.
Sieh einmal die Wanze an, wie die Wanze tanzen kann. Auf der Mauer, auf der Lauer, sitzt eine kleine Wanze.

The second verse repeats the third line, but this time Wanze and tanzen are shortened to Wanz and tanz, respectively. The final verse ends, "Sieh einmal die W [vU] an, wie die W [vU] t [tU] kann, Auf der Mauer, auf der Lauer, sitzt eine kleine Wanze. This song, which can presumably be sung by pre-literate children, is important in that it demonstrates the speaker's ability to recognize and manipulate sequential segments the size of a phoneme. Note the similarity of this German song to the English song "Bingo was his Name-o."

Games and rhymes such as these may help young language users acquire awareness of boundaries and facility in segmentation. They foreground the problem of segmentation in a surprisingly overt way. Significantly, these games, tricks, rhymes, and jokes "work" because the potential exists for a variety of segmentation patterns in parsing a given stream of speech. For the linguist, these games do more than demonstrate the sensitivity of children to boundary placement and ambiguous segmentation patterns. They also reveal the facility with which speakers can manipulate the placement of segment boundaries. Once she has learned the "Mares Eat Oats" game with segments clearly marked, a speaker has no difficulty removing all phonetic cues to segment structure again.
IX. The Segment and Boundary Approach

IX.1. Hockett

C.F. Hockett has been an important figure in the juncture debate and a major proponent of "the segment and boundary approach" to phonological theory. Hockett introduced the term "juncture" into linguistics around 1938, first into discussion and slightly later into print. His first published article (originally entitled "Phonemics and the Word," but later called "A System of Descriptive Phonology" at the suggestion of Bernard Bloch) was about juncture (personal communication, Dec. 1989).

Hockett (1942) notes that the beginnings and endings of utterances are characterized in some languages by special phonetic features, e.g., "typical intonations, stresses, quantities, or other features of sonority." Furthermore, the same features may be found within utterances, optionally accompanied by a pause. Where a junctural feature functions to distinguish meanings, it must be regarded as a distinctive phoneme. "Junctural phones are not matters of grammatical segmentation, though a junctural situation may define phonological segments which are of grammatical significance."

Hockett gives several English examples of
nearly-identical phoneme sequences which are nevertheless distinct in meaning, indicating the presence of juncture by the use of a hyphen. He also details a host of examples from a variety of languages which he claims contain a segmental phoneme of juncture. Czech, he claims, appears to have three junctural phones, a pause, loud stress, and the point of onset of stress, which is transcribed with a space. For Early Latin, Hockett writes, stress assignment can be predicted "if certain borders are assumed." The location of these "borders" (which I have called "boundaries"), is known from grammatical information about the language, although insufficient data make it impossible to tell whether or not boundaries could be located without recourse to supra-phonological information. In Potawatomi, as in German and English, the absence of a consonant in phrase-initial position and in certain phrase-internal positions may be distinctive. In these languages, juncture may be realized as hiatus, the point of sharp syllable division, or the point at which stress begins. Hockett's analysis of Delaware employs a junctural phoneme /#/ which occurs word-initially and intervocally; this phoneme is realized as hiatus. Before a stop, the phoneme is realized as a short pause, which occurs as lengthened closure at the point of articulation of the following stop: e.g., /#/p/ is realized phonetically as [p]. Hockett claims that this analysis is superior to one which would require many more phonemes, namely the series of long consonants. Finally,
Hockett suggests that hiatus in Sanskrit might best be analyzed as a phone of juncture.

Hockett (1958) devotes a chapter to the problem of juncture and transitions between phonemes in English. He proposes two types of "transition" from one sound to the next, "sharp" and "muddy." Between macrosegments (i.e., "across a boundary between macrosegments," identified by the presence of a terminal contour), only "sharp" transitions can occur. However, both "sharp" and "muddy" transitions can occur within a macrosegment. For example, Night rate is two macrosegments; therefore, there must be a sharp transition between [t] and [r]. In order to account for the difference between nitrate and Nye trait, Hockett proposes a phoneme of sharp transition, to be written /+. When /+ is absent, transition from one phoneme to the next is always muddy. When a macrosegment is divided by juncture, the segments which remain are called "microsegments." The addition of a junctural phoneme to the inventory of English phonemes allows the examples above to be distinguished from one another:

a) night rate /naj+trejt/
b) nitrate /najtrejt/
c) Nye trait /naj+trejt/

Either the position of juncture (as in a and c) or the absence of juncture (as in b) may be distinctive.
Juncture always coincides with the boundary between macrosegments, i.e., between successive vowels which both bear heavy stress:

| free+Danny | freed+Annie   |
| see+Mable  | seem+able    |
| see+zoos   | seize+ooze   |
| (Mr.+)A.+Benson | (Mr.+)Abe+Empson |
| see+stakes | cease+taking |
| try+spinning | brass+pin |
| try+skinning | ace+king |
| Bea+struck | cease+trucking |
| full+stop | false+top |
| Mick+stays | mix+ties |
| {one+}twelfth+soda | (three+){twelfths}+odor |
| six+thanks | sixth+ankle |

Whenever a stressed vowel is preceded by a consonant or consonant cluster, juncture must disambiguate the segmentation of the utterance. The following examples show that this is true even when the first vowel does not bear strong stress (i.e., is not a separate macrosegment):

| it+sprays  | it's+praise  |
| it+swings | it's+wings  |
| a power (+play) | up+our (+way) |
| Sarah Ball | (a) cherub+always... |
| a tall (+man) | (at+all (+costs)) |
| Sarah falls | (a) seraph+always... |
| a vanguard | of+anger |
| (a) mama things | (a) mammoth+ink (+well) |
| (a) puma seize | pumice+eases |
| he zones... | he's+only... |
| I mauled... | I'm+always... |
| a nice (+man) | an+ice (+man) |
| it+sings | it's+English |

The reduction of it is to s yields the following contrasts:
Between an unstressed vowel and a following consonant there is no contrast in type of transition; only muddy transitions occur. For instance, get a board and get aboard are not audibly distinct. Not even in extremely slow speech, in which junctures are inserted at grammatical boundaries, and every possible pause is realized, are there sufficient phonetic clues for the listener to disambiguate the phonological structure of the utterance.

Between a consonant and a following unstressed vowel, transition is normally muddy, as in the previous case. Hockett cites a single example, however, as evidence that a potential contrast between "sharp" and "muddy" transition exists: in Rosa+la+Platte, the /l/ is syllable initial; in personal+appeal, on the other hand, /l/ is in syllable-final position.

Successive unstressed vowels are normally not separated by the presence of juncture, as long as at least one consonant intervenes, e.g., a cherub is always... When no consonant intervenes transition is always sharp (/+/ is always present): the idea alarms me.
Secondary stress works just like primary stress in conditioning the presence of juncture, except that two successive vowels bearing secondary stress must have intervening juncture; if one of the vowels bears secondary stress, and the other bears primary stress, then the presence of juncture is distinctive: *(the) tin tax /tin+taeks/ -- syntax /sintaeks/.*

Hockett notes that juncture need not coincide with orthographic word boundaries or morpheme boundaries. For example, *Juneau Alaska* has two words, but may be transcribed without /+/. Hockett fails to note that a speaker may opt to insert juncture at the word boundary (in which case *Alaska* would be realized with a glottal stop). However, his main point (that orthographic word boundaries and phonological juncture boundaries do not necessarily coincide) is clearly true, as he illustrates with additional examples, e.g.:

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pirate savannah /pajr@ts@vaen@/
pirates of Anna /pajr@ts@v+aen@/
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Juncture need not coincide with morpheme boundaries, either. For instance, *N.A.T.O.*, *Plato*, and *Cato* are often pronounced with aspirated [t], indicating the presence of juncture following the stressed vowel. In my own speech, however, these words are pronounced with close juncture, as a single
phonological word, without aspiration on the [t].

Finally, Hockett cites several examples which demonstrate that juncture may be optionally omitted from an utterance, particularly in fast speech.

IX.2. Generative Phonology

In Generative linguistic theory, the phonemic system of a language is closely related to the morphemic system. In Chomsky and Halle (1968), there was no place for segments of phoneme or syllable size. However, as Pulleyblank (1989) indicates, the approach to phonological representation proposed in SPE was a linear one, consisting of strings of feature matrices. For generativist phonologists influenced by SPE, unlike previous phonologists, phonological structure was identified with boundaries at higher levels, specifically boundaries of the morpheme and the word.

IX.2.1. Chomsky, Halle, Lukoff (1956)

Chomsky, Halle, Lukoff (1956) attempt to construct a transcription which meets the three following requirements: 1) phonemically distinct utterances have distinct representations, 2) the elements of transcription are segmental phonemes (defined here as bundles of distinctive
features, i.e., as physical entities), junctures, and a single accent element, and 3) junctures appear only at morpheme boundaries. Note that, unlike phonemes, junctures do not represent anything physical, and have no physical features in common. They are introduced solely for the convenience of the analyst, in order to reduce the number of phonetic features which must be considered phonemic, just as in Moulton (1947). Like Smith and Trager, Hockett, and Moulton before them, Chomsky, Halle, and Lukoff recognize two types of juncture, which they call "internal" (= "open") and "external" (= "close"). Chomsky, Halle, and Lukoff are willing to posit junctures only where phonetic effects can be discerned, and then only when those phonetic effects correlate with a morpheme boundary.

Chomsky, Halle, and Lukoff emphasize the need to restrict junctures in phonological analysis. If unrestricted use of boundaries were permitted in phonological analysis, they argue, then new environments could be created ad hoc to account for almost any phonological phenomena. They specifically criticize Moulton's (1962) analysis of nasals, although the argument is here applied to English, rather than German. It would be possible, they say, to say that English possesses only a single nasal consonant /N/. [n], [m], and [ŋ] could then be predicted on the basis of environments which contrast only in the presence of (invisible) juncture:
\( /N/ \rightarrow \text{[n]}; \quad /-N/ \rightarrow \text{[m]}; \quad /N-/ \rightarrow \text{[ng]} \).  

As they point out, given enough kinds of juncture, one could conceivably develop a transcription which recognized only a single phoneme symbol, preceded and/or followed by several juncture symbols. "Needless to say, such solutions are entirely unacceptable and must be ruled out a priori," they write (Chomsky, Halle, and Lukoff 1956:67). They propose to eliminate "unacceptable" analyses by requiring junctures to appear only at morpheme boundaries.

**IX.2.2. Kiparsky and Bierwisch**

As discussed above, however, it is not always possible to equate juncture with a morpheme boundary; consider, for example, the contrast between *Ei+chen* 'little egg' and *Ei-er* 'eggs', where "+" marks a juncture and "-" marks a morpheme boundary. Because of such examples, generative phonologists had to account for the presence of juncture by means of special transformational rules. Generative phonologists identified a wide range of deep-structure boundary signals which were realized variously in the surface structure of an utterance. Kiparsky (1966) and Bierwisch (1966), for example, mark boundaries for morphemes, stems, words, and sentences in deep structure. The various boundaries are ultimately used to determine, through a series of transformations, intonation or the presence of a pause (cf. Werner 1972:64; Wurzel 1970:254).
Each type of boundary is distinguished by its own symbol. Bierwisch creates a complex boundary structure, organized hierarchically by numbers attached to each boundary marker. The operation of rules is constrained by the level of the boundary hierarchy being operated upon.

IX.2.3. Wurzel

Like Kiparsky and Bierwisch, Wurzel (Wurzel 1966:249-66) discusses Grenzfragen, or "Questions of Boundedness" within the framework of generative phonological theory outlined in Chomsky and Halle's Sound Pattern of English (1968). According to Wurzel, SPE assumed as a language universal that every language has two phonologically relevant boundaries, a morpheme boundary and a word boundary. Morpheme boundaries are considered a part of the underlying lexical representation. Word-boundaries, however, are located automatically by a rule which Chomsky and Halle claim is universal: the word-boundary marker # is attached to the beginning and end of any string which is governed by either a lexical category (e.g., Noun, Verb, Adjective) or a category like Sentence, NP, VP, etc. Chomsky and Halle admit the possibility that further, language-specific rules might insert word boundary markers in additional positions, such as within words, as well. A "phonological word" is by definition any string which is delimited on both sides by at least two word
boundaries: # #. According to Wurzel, the phonological word as defined permits a variety of phonological regularities in a range of languages to be described adequately. For example, the attachment of an article or preposition to the following word in Hebrew and Arabic, which is also indicated orthographically, can be adequately described using the Chomsky/Halle system (cf. Wurzel 1966:249). However, Wurzel notes that difficulties exist in applying the word-boundary placement rule to languages other than English, and he proposes that a better solution would be to expand the inventory of boundary markers. For instance, Wurzel argues that stems should be marked with a stem-boundary marker. He notes, furthermore, that pronouns and clitics in German need to be somehow included within the phonological word.

According to Wurzel, Bierwisch's complex system of hierarchically organized boundary markers successfully identifies phonological words and phrases and thus represents a significant improvement over the Chomsky/Halle model. However, he notes that Bierwisch's model produces the desired output by identifying phonological words, but unfortunately also destroys the internal boundary structure of a phrase. Since phonological rules operate on both "simple" word boundaries (#) as well as "true" phonological word boundaries (# #), Wurzel argues, the internal structure of boundaries in a phonological word must be preserved. Wurzel attempts to
correct some of the disadvantages of the Chomsky/Halle and Bierwisch models, specifically by modifying them to permit derived nouns, verbs, and adjectives, as well as compounds, to attach to neighboring strings as clitics. In the end, however, Wurzel's approach does not seem to achieve an improvement over other methods of describing and delimiting the phonological word.

IX.3. Multi-dimensional Phonology

IX.3.1. Halle and Clements

Conducting phonological analysis using such a wide range of symbols can be unwieldy. As Halle and Clements write (1983:15): "Until quite recently linguists assumed that the only way of delimiting sequences within the word was by means of junctures or boundary markers of various kinds. One problem with this device is that it introduces all sorts of additional symbols into the representation that, if taken seriously, make the statement of phonological rules very cumbersome." They note further that syllable and morpheme boundaries need not coincide. As a result of these considerations, Halle and Clements propose to treat a phonological representation as a three-dimensional object. A phonological representation is composed of a consonant-vowel "skeleton" or "core" surrounded by several autosegmental tiers
which contain information about the phonetic properties of the consonant-vowel skeleton. This "nonlinear" representation obviously differs markedly from a segmental one in which bounded segments are "strung together in a single line" like railroad cars or beads. In the nonlinear approach, a word may be simultaneously organized into morphemes, syllables, and so on. Halle and Clements argue that placing each constituent of a word on its own level of "tier" is "a much more perspicuous way of dealing with the problem" of representing linguistic knowledge than a linear representation which makes use of segments and boundary markers is.

IX.3.2. Goldsmith (1976)

Goldsmith (1976) presents arguments in favor of "autosegmental" or nonlinear phonological representation and against the segment and boundary approach, or what he calls "the absolute slicing hypothesis." Speech, he claims, is like the music of an orchestra, with many instruments (i.e., articulatory organs) playing simultaneously. Goldsmith examines contour-valued features, arguing that a dynamic feature like rising tone can best be explained as "the concatenation of two level tones," rather than an "atomic unit" itself. He proposes to represent a rising tone on a separate tonal tier (as a low tone followed by a high tone), but linked to one or more vowels. In addition, Goldsmith
suggests that his autosegmental approach is supported by "stability." "Stability" refers to the phenomenon by which a feature persists even when the segment which appeared to carry that feature disappears. Goldsmith presents evidence that, when a vowel which bears tone is deleted, the tone need not be deleted along with it, but can "spread" or attach to a neighboring vowel. Goldsmith argues that these (and other) phenomena can best be explained by recourse to a multi-dimensional model of phonological structure.

IX.3.3. Pulleyblank (1989)

Pulleyblank (1989) stresses the creative aspects of speech production; noting that the pronunciation of a word depends to a great extent on neighboring words, he concludes that speech must be more than the matching of a phonetic shape with a stored mental representation. Like Goldsmith, he presents evidence which argues against linear theories of phonology, in particular that of Chomsky and Halle in SPE (1968). The SPE approach, like the structuralist approaches which preceded it, treated a phonological representation as a string of matrices (each constituted by a set of binary feature specifications). However, as Pulleyblank writes, "A large body of work over the last 15 or so years has demonstrated the inadequacy of such linear representations." Pulleyblank summarizes some of that work. Citing evidence
very much like Goldsmith's (1976), including contour tones and
the behavior of geminates, he concludes that a multi-
dimensional representation which allows for a variety of tiers
(a syllabic tier, a segmental level, and additional feature
tiers such as root, laryngeal, place, etc.) provides a model
of phonological organization which is superior to linear
approaches.

The arguments advanced by Goldsmith and Pulleyblank are
only partially correct. It seems clear that phonological
phenomena such as gemination, contour tones, spreading of
features, compensatory lengthening, etc., can be quite clearly
represented using a multi-dimensional notation. Such a
notation, however, does not seem to be a major advance over
erlier, linear models of linguistic structure. In fact, non-
linear models continue to employ the concepts of segment and
boundary. The argument that contour tones are comprised of
"the concatenation of two level tones" (Goldsmith) on a higher
tier is especially telling. Non-linear models of phonological
structure may be better than linear models at representing a
variety of simultaneously occurring events in speech, but they
represent no major conceptual advance over hierarchically
demarcated segments. As I have argued above, the creation of
tiers simply disguises the complexity of the linear
representation in a multiplicity of levels.
IX.3.4. Firth and the London School

A more original approach to phonological representation was advanced by the London School of "prosodic analysis" as practiced by Firth and his followers. The London School emphasized the linguist's analysis of speech data, whereas I have stressed the speaker's ability to indicate linguistic organization with phonetic cues. The following sketch of the London School is based largely on Firth (1948) and Robins (1957).

Firth analyzes segment boundaries of various kinds in terms of what he calls "prosodies": "The use of spaces between words duly delimited and identified is, like a punctuation mark or "accent," a prosodic symbol," he writes; and "...any phonetic features characteristic of and peculiar to such positions or junctions [sic] can just as profitably and perhaps more profitably be stated as prosodies of the sentence or word. Penultimate stress or junctional geminations are also obvious prosodic features in syntagmatic junction" (Firth 1948, in Makkai 1972:253). A "prosody" is an analytic concept the domain of which is by definition larger than a single segment. There are prosodies of units as small as consonant-clusters and as large as whole utterances, though larger prosodies (eg., of discourse units) are not ruled out. Moreover, there are prosodies corresponding to grammatical
units, including the syllable, the morpheme, the word, and the phrase. London School phonological analysis also employs the concept of "phonematic units," which are the minimal segments of the phonetic material under analysis and which constitute the vowel and consonant "skeleton" of phonological structure. Phonematic units are serially related within larger constituents.

Robins illustrates the range and variety of prosodies used in Henderson's prosodic analysis of Siamese (Henderson 1949, cited in Robins 1957, in Makkai 1972:267). In Henderson's analysis, a prosody of intonation governs the sentence; phrases are governed by prosodies of length, stress, and tone relations between component syllables; syllables are governed by the former prosodies, as well as palatalization and labiovelarization; parts of syllables are governed by prosodies of aspiration, retroflexion, plosion, an unexploded closure; and "phonematic consonant and vowel units" are organized in classes like velar, dental, bilabial, nasal, front, back, rounded, unrounded. Firthian prosodic analysis, as exemplified by Henderson's analysis, represents "a radical critique" of linear phonological theory based on segments and boundaries, according to Selkirk (1982:381, fn. 26), in that Henderson "rejected the segment entirely as a unit of representation, replacing it with the syllable...."
Although American phonemic analysis ultimately recognized a variety of "levels" (phonetic, phonemic, suprasegmental, morphophonemic, etc.), phonological representations were essentially linear, one-dimensional strings; phonemes were identified by semantic contrast tests. Moreover, a major tenet of American structuralism was the insistence that phonological analysis be conducted without reference to grammatical levels. In contrast, the London school represented utterances in terms of multi-dimensional "layers" of prosodies operating simultaneously over domains of various sizes, from a few consonants to whole utterances, and closely associated with grammatical constituents. As Firth writes, "On the perception side, it is improbable that we listen to auditory fractions corresponding to uni-directional phonematic units in any linear sense" (Firth 1948, in Makkai 1972:263).

Note that some prosodic features, e.g., intonation, are realized over the whole length of a segment, in this case the phonological phrase or sentence. Pharyngealization is realized over the domain of the syllable in Cairene Arabic (cf. Kenstowicz and Kisseberth 1979:259-61). Other features, however, are realized at a single point, where they may function to demarcate and delimit segments. Henderson's analysis of Siamese includes evidence that plosion, aspiration, affrication, and other articulatory features are limited to consonants in syllable-initial position. Such
"prosodies of syllable initiality" allow the analyst to "mark off and bind together as a functional unit" a given segment, in this case the syllable.

In Firthian terms, the glottal stop which is associated with syllable-initial vowels in German (in open juncture) would be precisely such a prosody. Not only syllables, but also word-sized segments may be demarcated (or bounded) by prosodies of this sort. For example, in English the presence of strong stress is diagnostic of a single phonological word. A form like green house, which bears two strong stresses, behaves phonologically as two words, whereas greenhouse bears a single strong stress. In other words, strong stress is a prosody of the word in English. Czech and Hungarian, on the other hand, treat strong stress as prosodic of the syllable; in this case the presence of strong stress helps demarcate the limits or boundaries of the word. Similarly, word boundaries between a final consonant and an initial vowel (eg., an ocean, an aim) may be distinguished phonetically from word boundaries which fall between a vowel and an initial consonant (eg., a notion, a name) in extremely careful speech. In the former example, the phonetic difference, when perceptible, includes greater duration and laxer articulation of the word-final consonant. Thus, these phonetic features together represent a demarcating prosody of the word in English. The existence of French liaison in the same contexts means that French lacks
this (and perhaps any) prosody of the word (Robins 1957, in Makkai 1972:269).

Robins argues that prosodic analysis correctly emphasizes phonetic features at the intersection of phonology and grammar which more traditional phonological analyses might dismiss as unimportant, because predictable. Demarcative allophones like the predictable glottal stop in German or Sudanese, Robins writes, "...are frequently treated as differentially irrelevant since they are positionally determined, but they are, for just that reason, prosodically relevant and functional." The glottal stop can serve as a marker of boundary between syllables, morphemes, words, or phrases. Moreover, and this is the crucial point, a single appearance of a particular phonetic feature may demarcate segments on several levels simultaneously. As Robins writes, "The glottal stop in Sudanese is, in fact, an example of a phonetic feature which should be treated less as a member of a paradigm of consonants [as in traditional phonemic analysis] than as a marker of certain syntagmatic relations between one structure and another, at both the phonological and grammatical levels. It is the syntagmatic or structural dimension of language that phonemic analysis may be felt to neglect..." (Robins 1957, in Makkai 1972:270).

Hockett (1958) adopts an approach which is somewhat
reminiscent of the prosodies of the London School. Recall, for example, his claim that word-sized segments are demarcated by the presence of a (potential) pause, which may be revealed only in slow speech. Similarly, "macrosegments" are identified by the presence of a diagnostic phonetic clue, namely a terminal intonational contour: "Every macrosegment ends with a T[erminal]C[ontour], which therefore automatically marks the boundary between successive macrosegments in a single utterance" (Hockett 1958:28). Like Firth and his followers, Hockett believed that segments of various sizes were indicated by phonetic signals.

According to Robins (1957), demarcative prosodies of the London School variety represent a major advance over the Grenzsignale of Trubetzkoy and the Prague school because they are integrated into a complete phonological theory, rather than being partly phonemic (phonematisch) and partly nonphonemic (aphonematisch). Current phonological theory (cf. Pulleyblank 1989) has seized upon the multi-dimensionality of phonological representations and the role of the syllable at the interface between phonetics and phonology, areas first explored by London School prosodic analysis, and current approaches in autosegmental and nonlinear phonology clearly owes a debt to Firth. The syllable, in particular, deserves closer examination.
X. The Syllable

Speech sounds are organized into larger structures called syllables, a claim which is supported by the fact that many languages undergo phonological processes which can be most elegantly explained in terms of syllable-sized units. Tremendous disagreement exists, moreover, on the nature and internal structure of the syllable. Even linguists who are convinced of the need to represent syllable structure disagree about the syllable's proper place in phonological representation. The search for a phonetic definition of the syllable has been elusive, although some languages apparently indicate syllable boundaries by the presence of a phonetic signal. There are those who would place the syllable on the segmental level of a phonological representation, while others mark syllables on the suprasegmental level. Some linguists reject the notion of syllable as a segmental constituent altogether.

X.1. Kahn (1976)

Kahn (1976) presents arguments intended to show that aspiration of voiceless stops is conditioned by the presence of a syllable boundary in English (cf. Kenstowicz and Kisseberth 1979:256). English voiceless stops are aspirated in syllable-initial position, e.g., toll, pan, kin, but not
stole, span, or skin. Traditional phonological description might attempt to account for aspirated consonants by reference to the preceding segment [s] and the following strong stress, not recognizing the presence of a syllable boundary. However, the degree of stress on the following vowel is not relevant to the presence of aspiration, as the contrast of pan (with strong stress following aspirated [p]), Pacific (aspirated [p] with secondary stress) and specific (unaspirated [p], secondary stress) demonstrates.

A description of stop aspiration in English must account for the presence of aspiration in support and capon (where [p] begins the syllable) and the absence of aspiration in asparagus and aspen (where the syllable begins with [s]). If the syllable boundaries are identifiable, i.e., if sounds in the utterance are somehow organized into syllables, then a statement of the stop aspiration rule is extremely simple. "...[I]f phonological rules are permitted to refer to syllable structure, a relatively simple account of English aspiration is possible. If reference to syllable structures is not allowed, the statement of the distribution of aspiration becomes much more complex and would have to essentially incorporate the definition of syllable-initial position into the environment of the rule." (Kenstowicz and Kisseberth 1979:258-9). A traditional description which predicted the appearance of aspirated stops without reference to the
syllable would not only be more complicated; it would also incorrectly predict aspiration of medial voiceless stops in examples like *asparagus* and *aspen*, where the syllable beginning with [s].

X.1.1. Ambisyllabicity

Kahn is at some pains to explain forms such as *happy*, which at normal speech tempo is unaspirated. Aspiration predictably appears in slow speech, in which case [p] appears in syllable-initial position. Kahn concludes that the [p] of *happy* is "ambisyllabic" at normal speech rate; that is, it is simultaneously a member of both the preceding and following syllable. Other examples of ambisyllabic consonants include the medial consonants in *butter*, *coming*, and *college* (Selkirk 1982:354). The aspiration rule described above applies only to stops in syllable-initial position, but not to ambisyllabic stops. The presence of juncture in slow speech creates the necessary environment (syllable-initial position) for aspiration to occur. According to Kahn, consonants in syllable-initial or syllable-final position become ambisyllabic whenever followed by an unstressed vowel. For example, in slow speech, the [t] in *after* is aspirated. At normal tempo, the [f] becomes ambisyllabic, so the [t], no longer syllable initial, is realized without aspiration (cf. Kenstowicz and Kisseberth 1979:258).
X.2. Moulton

Moulton, noting that open juncture often correlates with a syllable break, considers the possibility of analyzing German phonology in terms of syllabic structure, rather than in terms of a segmental phoneme of juncture. However, he rejects the syllabic approach. Because German speakers usually have the option of pronouncing phonemes in close juncture, without a pause, competing analyses of the segmental phonemes into clear syllabic segments cannot be resolved. As Moulton writes, "...We need to allow for the fact that open juncture may or may not occur at a given point" (1962:143).

X.2.1. Consonant Clusters

Although he rejects the syllable as a unit of phonological analysis, Moulton is aware that analysis of juncture is closely related to constraints on possible consonant clusters. Every language constrains the number of consonants which can occur in close juncture. For example, a sequence of phonemes like /ngstr/ cannot occur with close juncture; the sequence must be broken up at some point by open juncture, e.g., Engl. angstrom. This amounts to a claim that strings of phonemes must be parsable into syllables. Moulton observes that no consonant may follow itself in close juncture in German. Where compounding places two of the same consonant
together, one of two results must occur. If the consonants are in close juncture, then the cluster is reduced by the loss of one of them; i.e., the long consonant is shortened. Alternatively, the consonants may be separated by open juncture, in which case "a clear break" between the two forms may be detected. This case amounts to the assignment of one consonant to the coda of a syllable, and one to the onset of the following syllable. Moulton cites examples such as pen+knife and An+nahme (Moulton 1962:141).

X.2.1.1. Assimilation of Nasals

In German, /n/ may stand in close juncture with a following stop only if the stop is made at the same place of articulation, i.e., /nt/ and /nd/ are allowed, but not */nb/ or */ng/, Moulton claims. Words such as un+bedacht and an+genehm must therefore be represented with open juncture. Open juncture in these positions is, however, dependent on the variables indicated above (tempo, register, speaker idiosyncracies, etc.); close juncture may bind /n/ to its following consonant. In such cases, however, the presence of close juncture (i.e., the lack of open juncture) allows the nasal to assimilate to the following consonant, becoming labial ([umb@daxt]) or velar ([ang@ne:m]).
X.2.1.2. Devoicing of Consonant Clusters.

German obstruent may stand in close juncture only if they are all voiceless. Moulton notes the following exceptions to this statement: clusters of voiceless consonants may be followed by /v/, e.g., guer, schwer, etc. Also, German contains a very few examples of /j/, which may be considered either a voiced obstruent cluster or an affricate, e.g., Dschungel (cf. Benware 1986:158). Moreover, there is a tendency among many German speakers to devoice these clusters: [kfEr], [tšUngg@l]. The constraint against contiguous voiced and voiceless obstruent in close juncture means that an example like saqbar will have two possible realizations. If /g/ and /b/ stand in close juncture, then the word is realized as [za:kpa:r], with [p]. In the case of /g+b/, however, the phonetic form realized is [za:k+ba:r] with [b].

X.2.1.3. Geminate Consonants

The presence or absence of juncture is a function of speech tempo and register. An idiomatic phrase such as Gott sei dank! is normally pronounced rapidly and as a single phonological unit, i.e., without open juncture at morpheme-boundaries. The absence of open juncture is indicated by the phonetic realization of sei with [s], instead of the [z] which appears in citation form. However, an
informant who normally produces [s] will say [z] in slower, more carefully articulated speech. Moulton cites a similar example (Moulton 1962:142). The phrase Wo bist du? is pronounced [vo+bIst+du:] in careful speech; the presence of open juncture is revealed by the voiced realization [d]. At a normal conversational tempo, however, the phrase is normally produced with close juncture, resulting in devoicing of the /d/. Recall that a voiceless-voiced cluster such as /td/ is not permitted in close juncture. Devoicing of /d/ produces /tt/ in close juncture, which is not permitted, either; therefore, the double consonant is reduced to [t]: [vobIstu:].

Reduction of geminate consonants which stand in close juncture is characteristic of English as well as German. Let us return now to an example given above, iced tea. For most (if not all) English speakers, iced tea is pronounced [aist]:, i.e., without the [t] which is realized in the citation form iced. One informant claimed that she never pronounced iced with final [t], i.e., [aist ti:], where a space indicates a pause, although "d" was present in writing. [t] is predictably not pronounced as geminate because iced [-t] stands in close juncture with tea [t-]. However, even this informant pronounces geminate or successive [t]'s in well-articulated speech, in which case the consonants /tt/ stand in open juncture, i.e., /t+t/. Most speakers are probably never called upon to articulate "iced tea" so
carefully; it may therefore literally be true that a speaker "never says" /t+t/ [ʔaist tiː:]. However, the speaker can and will indicate the presence of juncture with phonetic cue, in this case the realization of successive [t]'s. The other possible explanation for the appearance of [t] in slow speech is that iced [ʔaist] is a spelling pronunciation. However, this explanation can be rejected with confidence, for two reasons. First, "iced tea" competes orthographically with "ice tea," at least in the South, so there is no (orthographic) reason for a speaker to have a silent /d/ in her underlying representation. Second, geminate consonants which stand in close juncture in English are always reduced, not just in iced tea, but also in big guy [bIgai], (I) am mad [ʔ@maed], It took [ʔItUK]. Wherever /tt/ occurs, except in open juncture (eg., slow speech or contrastive stress), the cluster is reduced to [t].


X.3.1. Against the Syllable Boundary

Selkirk (1982) argues against the existence of syllable boundaries. The concept of the syllable boundary is part of what she calls the "non-hierarchical conception of the syllable," that is, the "commonplace view" that syllables are delimited segments in a representation which is composed of a
string of constituent sounds. Selkirk summarizes this approach in the following way: "...[P]honological representation consists of a strictly linear arrangement of phonemes and boundary or juncture elements....Syllables are therefore defined in terms of their boundaries."

Although it is "perhaps the most obviously available one within the theory of phonological representation which has been prevalent in work in phonology in the last five decades," the linear view of phonological representation as segmentable strings is inadequate, Selkirk believes. Not only do sub-syllabic constituents need to be recognized in order to account for attested phonological phenomena, but there is also evidence for a hierarchical, i.e., non-linear, organization of syllable constituents (cf. Selkirk 1982:353-5).

X.3.2. Against Ambisyllabiciry

Selkirk (1982) strongly rejects the notion of ambisyllabiciry, or "interlude," as proposed by Hockett (1958:86) and Kahn (1976). Her resistance to ambisyllabiciry is motivated by the desire to represent the syllable in terms of constituents organized hierarchically in a tree structure. Ambisyllabiciry would produce tree structures which were not well-formed, since a single node in the tree would be immediately dominated by two separate nodes, yielding
overlapping constituents; Hockett and Kahn claim precisely that constituents do overlap. Even if ambisyllabicity did exist, Selkirk argues, it would provide evidence against the segment and boundary approach to the syllable, since "a syllable boundary cannot be simultaneously before and after some segment of the string" (Selkirk 1982:355). As for the possibility of placing the boundary in the middle of an ambisyllabic segment, as proposed by Hyman (1977), Selkirk claims that such a proposal is "incoherent, given the theory of phonological representation in which it is concluded, and vitiates the whole boundary approach" (Selkirk 1982:381, fn. 28).

X.3.3. Critique of Kahn (1976)

Kahn (1976) associates the segmental string of speech sounds with a separate syllabic tier. For example, a string like "flounce" [flawns] would be assigned to a single syllable marker on the syllabic tier. Connections from the syllabic tier can be reassigned to the segmental tier by the operation of (re-) syllabification rules. The following example shows a case of ambisyllabicity in which the medial consonant of study is associated with two syllables simultaneously in Kahn's notation, where "S" stands for syllable, and a line indicates an association between the syllabic tier and the segmental tier:
The approach outlined above (Kahn 1976) is "autosegmental" to the extent that the phonological representation is multi-dimensional rather than linear. Kahn represents a phonological word as an association between a string or tier of segments and a separate syllabic tier. The difference between the traditional segmental approach and Kahn's autosegmental approach is significant, Selkirk writes: "...the autosegmental theory of the syllable is by no means merely a notational variant of the syllable boundary theory....One major difference is the possibility of representing ambisyllabicity" (1982:381, fn. 29). However, Kahn's approach suffers from the same shortcomings as the traditional linear segment/boundary view. Specifically, Selkirk objects that within Kahn's framework it is impossible to view the syllable as having an internal structure. Moreover, tones (and any other prosodic elements) cannot be arranged hierarchically with respect to syllables using Kahn's notation. Finally, since Kahn's notation allows
ambisyllabic, his phonological analyses are not representable in a well-formed tree; i.e., they do not permit well-formed bracketing.

X.3.4. The Syllable Template

Selkirk claims that syllabification in English depends on a template of the well-formed syllable. The template which she proposes contains hierarchically organized constituents, as in Figure 5. Parentheses indicate an optional element:

```
Syllable
  /
-/-(Onset)             Rhyme
  /
-/-(syl (+son))        /
  /
-/-(Peak)             -(Coda)
  /
-/-(+syl (+son))      /-
  /
+cons (-son)
```

Figure 5.

This general template of the well-formed English monosyllable is supplemented by others (such as a template which permits a combination of [s] plus an obstruent to function like a single obstruent). A phonological
representation is considered well-formed if it matches the structure indicated above (and does not violate a supplementary set of co-occurrence restrictions). In other words, a phonological representation is well-formed if it can be parsed according to the template.

X.3.5. Polysyllabic Utterances and Well-Formedness Conditions

Utterances are normally comprised of several syllables in succession, of course. All syllables in an utterance must meet well-formedness conditions represented in the above template (plus any supplementary templates). However, successive syllables may be resyllabified according to a set of "principles" which may differ cross-linguistically. These principles provide well-formedness conditions for poly-syllabic utterances. For instance, if a medial consonant or consonant cluster could be analyzed as either an onset or a coda according to the template above (e.g., prostrate, actress, arcane), a principle of "maximal syllable onset" syllabifies the consonant or cluster as an onset.

Such principles may not violate the restrictions inherent in the syllable well-formedness template above. The maximum onset principle provides for syllabification as in prostrate, ac.tress, ar.cane rather than as in pros.trate or prost.rate,
act.ress, and arc.ane. Syllabification principles are sensitive to syntactically or morphologically specified domains, which may differ cross-linguistically. For example, French allows a wider variety of syllable onsets for syllables in word-initial position than elsewhere. Thus, sl and pe are syllabified as an onset when they appear word-initially (eg., slave, psychologie), but are assigned to different syllables in other positions (eg., Is.lande, cap.sule).

X.3.6. Definition of the Word

In English, word boundaries always coincide with syllable boundaries. A string of phonological segments like /atktin/ is not a possible word in English, since it can not be syllabified in accordance with the template described above. Because she knows how to recognize a well-formed syllable, an English speaker quickly recognizes that there are no possible syllables which end in /tk/ or begin with /kt/. Thus, for Selkirk, a "word" is quite defined simply as a string of allowable syllables (Selkirk:1982:352).
XI. Boundaries and Diachrony

If it is true that segment boundaries can be manipulated by the speaker to distinguish from among a variety of possible phonological structures, it is equally true that boundaries can change over time. In fact, segments can be acquired, lost, or shuffled around over the course of a language's history. Examples of the addition or loss of phoneme-sized chunks of phonological material are manifold (cf., for example, Bynon 1977, Lehmann 1973, Jeffers and Lehiste 1979). It is worth stressing, however, that syllable-sized segments may be gained or lost, too. An epenthetic vowel (eg., [fil@m] 'film'; [ae@li:yt] 'athlete'), for example, will add a syllable to a word. Haplography is the loss of a syllable (eg., Early Latin nu:triti:x > Latin nu:tri:x; interpretative > interpretive) (Jeffers and Lehiste 1979:11). Segments larger than the syllable may also be lost; e.g., in the process known as "clipping": Examination > exam; laboratory > lab, etc.

X.1 Loss

Cliticization refers to the process by which two formerly separate segments which frequently co-occur become reanalyzed over time as a single morphological segment. This is what has happened in English in the case of negation. A proclitic
negation marker became reanalyzed as part of a new class of negating words:

n) either  
n) or  
n) one  
n) ever

English speakers for whom the previous words now represent unanalyzed segments are generally surprised to recognize the fossilized pattern of negation which these examples show, because what was formerly two morphemes has been reanalyzed as a single morpheme. The same process took place in German with the development of nicht from ne wixt.

X.2 Addition

If cliticization represents the loss of a boundary between segments, it should be noted that boundaries may be gained, too. For example, a boundary may be said to be gained in the case of a morpheme which is spun off from a word as a free form. Antilla calls this process "lexicalization" (cf. Antilla 1977:151). One commonly cited example is English marathon, a monomorphemic place name, which over time developed a boundary: mar+athon. The resulting pieces were then reanalyzed as a root, mar, followed by a suffix, -athon. The introduction of a juncture freed the new suffix, with the
result that today there are bikeathons, swimathons, chocathons, etc. Antilla cites a number of examples of original Greek compounds which have become lexicalized in English, including bus and teen (1977:151).

X.3 Movement

Boundaries of various kinds may be moved in words which occur together frequently, in a process which Antilla describes as "a shift in morpheme boundary along the chain of sound units" (Antilla 1972:150). Such examples always involve a reanalysis of boundary placement. For instance, the German plural ending is derived (by Latin rhotacism and Verner's law s > r) from an original s-stem. Bynon (1977:99-104) also cites a number of examples of language resegmentation over time. For example, the Modern English word apron comes from Middle English naperon, which itself derives from Old French naperon, the diminutive form of nape '(table) cloth'. It is apparently cognate with napkin and nappie 'diaper'. The Modern English form results from a resegmentation of a napron. The initial n was interpreted as belonging to the preceding indefinite article. Similarly, adder derives from Old English nae:dre, which is cognate with German Natter. Currently, English speakers appear to be engaged in a reanalysis of another, as illustrated by the expression "a whole nother." These examples illustrate reanalysis of the segmentation of a
phonological word. In both cases, the word boundary between the indefinite article and its accompanying noun was moved; i.e., two new contiguous segments had been formed from the same segmental phonemes, without changing the order in which those phonemes occurred.

Resegmentation may occur within words, too. For example, Modern English pea derives from Middle English pease, from Old English pese, plural pesen. By the time of Modern English, the s had been reanalyzed as the regular plural morpheme, yielding singular pea by analogy. The pease is still attested in "Peas Porridge Hot," although movement of the boundary between pea and s has changed the meaning of the nursery rhyme.

Bynon shows that the development of the present tense paradigm of the verb 'to be' from Proto Indo-European to Gothic involved speaker reanalysis and resegmentation of the inherited phonological shapes (cf. Bynon 1977:100). This resegmentation transformed the regular Proto Indo-European paradigm into an irregular one (first- and second-person plural endings represent an exception). Moreover, Old English and Old High German reveal a reduction in the number of segments in the verbal paradigm from the time of Indo-European (Bynon 1977:102-3).
Bynon's examples illustrate the crucial point about segmentation and the placement of boundaries: speech segmentation depends on a speaker's (conscious or unconscious) knowledge and analysis of her language. Phonological structures are not immutable forms waiting to be discovered by the linguist. Bynon's examples do more than show that boundaries move over time; they also illustrate the more important point that speakers can move them.

X.4 Metathesis

Jeffers and Lehiste discuss the reordering of segments (1979:7). When segments of syllable-size or larger are reordered, as with a slip of the tongue, the process is normally referred to as a "spoonerism," as described above. Spoonerisms are generally unsystematic, nonce occurrences of no significance to diachronic linguistics. However, metathesis, the reordering of segments, is a widely attested language change. Armenian provides a clear case of an historical metathesis which affected all clusters of a consonant followed by a liquid, in any position. Armenian *surb* is derived from an earlier form, *subhro-*. Jeffers and Lehiste point out that metathesis may occur with pieces of segments smaller than the phoneme, such as a unit of length or a feature like resonance. For example, they cite an instance of resonance metathesis in Gothic, where all sequences of V R
(where R is a resonant) were metathesized to RV (cf. Jeffers and Lehiste 1979:9). In addition, the Attic dialect of Ancient Greek underwent a metathesis of vowel quantity in which all sequences of a long vowel followed by a short vowel were reversed.

It is not necessary to describe such a change in terms of segment reordering if a non-linear representation is adopted. A syllable and boundary approach can also account for the Ancient Greek data. Expressed in terms of morae, this change can be described as resegmentation of a unit of length (m) from a vowel to its immediately following neighbor:

\[
\begin{array}{c}
\text{m} \\
\text{V}
\end{array}
\quad \text{m}
\quad \text{m}
\quad \text{m}
\quad \text{V}
\quad \text{V}
\quad \text{m}
\quad \text{m}
\quad \text{m}
\quad \text{V}
\quad \text{m}
\quad \text{m}
\quad \text{m}
\end{array}
\]

The migration of a mora to its neighbor is easily stated in segmental terms. In the following schematic diagram, "+" indicates a hypothetical mora boundary on the moraic tier:

\[
m \quad \text{m} + \text{m} \quad \Rightarrow \quad \text{m} + \text{m} \quad \text{m}
\]

Phonological change as it has traditionally been discussed may be regarded as the replacement of a phoneme-sized segment (a phoneme or allophone) with other
segments in the "phonological space" covered by the phonological system of a language (cf. Bynon 1977:80). Bynon cites an example from Moulton (1962) to demonstrate the real effects of this "phonological space. Moulton shows that, for a particular Swiss dialect, /a/ has central allophones if both /ae/ and /ɔ/ are present. Where /ae/ is absent, though, front allophones of /a/ are also present.
XII. Phonological Reduction

Clearly, the Gestalt theory of language outlined above has significant implications for phonological reduction and segmentation. An utterance like [jit] 'did you eat?' e.g., may contain enough phonetic material for the speaker to uniquely identify the morphemes intended by the speaker. The listener does not "expand" the initial [d] sound to /dId/, nor the [j] sound to /d+y/. The listener matches the utterance to segments which she already has in her linguistic system to figure out the speaker's intended meaning. Where too many matches (or none) occur, communication fails, and the speaker may have to repeat a proposition in a phonological form which is less ambiguous or provides enough information for the speaker to identify the meaning intended (Hockett's "clarity norm articulation." )

Phonological reduction thus obeys the cooperative Gricean principle of providing just enough information (not too much or too little). Speech which is too careful—i.e., speech which too precisely specifies meaningful segments in the listener's mind—may be perceived as uncooperative or too formal for a given context. Speech which omits too much phonological information, on the other hand, may be perceived as mushy. Such perceptions may influence or reinforce stereotypes and prejudices. Geographical or cultural
differences in the use of open juncture, for example, may contribute to common stereotypes among German speakers. In general, some phonemes which are obligatorily in open juncture in the North may stand in close juncture in the South, e.g., word-initial vowels are more likely to appear without an accompanying glottal stop in the South. As a result, the speech of southern Germany evidences more assimilation, fewer aspirated consonants, and greater vowel reduction, which together may be perceived as sloppy speech. North German speakers may be perceived as stuffy by southerners if they articulate more carefully than is normal in the South. It is perhaps no coincidence that Prussians are stereotyped as uptight but disciplined, in contrast to the gemütlich but lazy Bavarians. Significantly, both a similar phonological contrast and similar stereotypes exist between American and British English speakers.

XII.1 Conditions for the Loss of Juncture

Boundaries between segments are generally lost in informal speech, in "presto" speech, and when separate segments undergo "coalescence" and are reanalyzed as a single segment.
XII.1.1. Register

Benware compares two German texts, one formal and one informal, noting that phonological reduction is a function of register. He also identifies three major types of phonological reduction: loss of phonological segments, assimilation of phonetic features, and so-called "weak forms." Benware identifies phonological reduction by comparing the attested phonological shape of an utterance with its citation form in careful, decontextualized speech.

In general, assimilation refers to any situation in which two phonological segments become more similar. The assimilated segments need not necessarily be contiguous. Engl. 'orangutan' [or@ngg@taeng], to cite a classic example, is derived from Malay orang hutan 'man of the jungle'. The original segment [n] in hutan appears to have become velarized because of the influence of the [ng] in orang, even though the segments are separated by other phonological material. However, Benware notes that all assimilatory phenomena in the formal text involve progressive assimilation (ie., from left to right) between contiguous segments, e.g., wirken [vi@k@n] --> [vi@k@ŋ].

The informal text contains examples of both progressive assimilation, as above, and regressive assimilation (ie., from
right to left), e.g., /ha:βen/ --&gt; [ha:bm] --&gt; [ha:mm] (Benware does not cite this form) --&gt; [ha:m]; /mItgεge:βen/ is realized as [mIkLgεge:bm] (with /t/ assimilating to [k] before the velar stop). Both texts contain centralization of vowels, although centralization is much more frequent in the informal text. Benware also notes certain classes of words, which he calls "weak forms"—pronouns, articles, prepositions, conjunctions, and some adverbs—which are always realized without stress (except when emphatic or contrastive stress is present). Weak forms with tense or long vowels in citation form are shortened in the absence of strong stress. For example, the form /zί:/ 'sie' with strong stress contrasts with /zi/; /z6:/ contrasts with /zo/, etc.

Loss of a segment refers to elision, omission of a speech sound, or a loss of precision in the realization of a vowel (i.e., centralization). In general, loss of a segment may be considered an instance of total assimilation. There is a scale of phonological reduction with the full, stressed form of the vowel on one end and zero on the other:

\[ \begin{array}{cc}
\v' & \v & \emptyset & 0 \\
\end{array} \]

Extremely slow, stressed speech can produce phonological
shapes which never appear in speech at normal tempo, e.g. [ɔw] (potato), [h] (sehen), syllabic [n] (Japanese London [lo:n do:n], which is pronounced as four syllables). "Extra-full" forms such as these may result from the influence of orthography, as is clearly the case with sehen, a form which historically has never before been pronounced with intervocalic [h]. The speaker who produces such utterances is not opening a window onto her mental representation of a word, but merely sounding out a spelling. Other cases are less clear. In artificially slow speech, an English speaker who says [pəliːs] at normal tempo might pronounce police with an initial syllable [ɔw]. It is possible that this [ɔw] is a spelling pronunciation. On the other hand, [ɔw] may represent the full vowel as it is represented underlyingly in the speaker's phonological system. Arguably, the speaker produces the full vowel only when the segment is bounded on both sides by juncture and assigned full stress.

If we assume that the speaker produces a form approximating her underlying phonological representation in precisely articulated speech, rather than sounding out the spelling of a word, then an utterance like potato might be realized at any point along a scale of phonological reduction:
The phonetic representation in 1) has been broken up into separate "chunks" of phonological material in order to indicate that each syllable functions as a single macrosegment, receiving its own strong stress and bounded by a pause on both ends. Not every point on the cline from 1) to 5) has been indicated; between 1) and 2), for example, one could cite a form with three stressed syllables but where pauses which are potentially present are not in fact realized. If the assumption of an underlyingly "extra-full" vowel is not warranted, then the cline above remains essentially unchanged; however, the forms unattested in speech of normal tempo (ie., 1) above) would not be represented.

Martens (1965:95) cites a similar example of reduction from the full German form Guten Abend: [gu:tən ?a:bənt] --> [nabənt] --> [na:mt]. And Benware (1986:158) describes the reduction of den from its full form [den] as follows:

[den] --> [dEn] --> [dn] --> [n], [m], [ng].
In its final form, *den* has lost the feature indicating point of articulation; all that remains is a nasal which assimilates to the point of articulation of the following consonant (Benware omits [ɲ], e.g., [fYmʃ] 'funf').

The frequency of French *liaison* has also been correlated with register (cf. Kenstowicz and Kisseberth 1979:413-4). *Liaison* is more likely to occur in informal speech than in formal speech, while open juncture (which blocks *liaison*) is more frequent in formal French.

XII.1.2. "Presto" Speech

A range of patterns of reduction occur in "presto" speech. For instance, the glottal stop which may appear in citation form and careful speech is frequently absent from fast speech (cf. Benware 1986:120. Predictably, word boundaries are less frequent. The result is a nonce phonological word which may form the domain for the application of a phonological rule. For example, assimilation of neighboring consonants is normally blocked at the word boundary in slow speech. Consider the phrase, *Gott sei dank*. This utterance may be pronounced with either open or close juncture at normal speech tempo, at the speaker's option. In rapid speech, however, /s/ assimilates to the previous
voiceless consonant and is realized as [s]: gotts[s]eidank. Note that in slow speech, the presence of a boundary between /t/ and /s/ inhibits assimilation, and /s/ is predictably realized as [z] in word-initial position: gott+s[z]ei+dank.

XII.1.3. Coalescence

When compound words are reanalyzed by speakers as a single phonological unit, the process may be referred to as "coalescence." "Coalescence" may be an historical development, as in the case of incorporation of clitics, or a nonce formation related to register and speech tempo. According to Martens (1965:95), Sonnabend, when pronounced without the glottal stop, is perceived as a single unit, although it is clearly derived from compound parts which are free-standing lexical items. English greenhouse from (a) green house is a similar example.

XIII. Conclusions

I would like to return now to the question asked earlier: are boundaries real? The evidence that competent speakers organize or "chunk" information in various ways, depending on register, speech tempo, and other intangible factors, seems convincing. Whether this implies that boundaries or real, or that segments are, I regard as a moot point; segments and
boundaries are complementary analytical conceptions of the same phenomenon, which I call "chunking." Moreover, both linear and so-called "multi-dimensional" theories invoke segments and boundaries at some level. As I have argued, there is overwhelming evidence that speakers can control the size of the chunks they create. Linguistic knowledge implies the ability to manipulate boundaries and create segments of various sizes.

These segments, in turn, form the domain over which phonological rules can apply. The result is that some boundaries condition, whereas others block, the application of phonological rules. Some boundaries function to delimit segments. Language games, diachronic change, and constraints on the application of phonological rules provide evidence that speakers do, in fact, recognize and manipulate segments of diverse size. This realization has significant implications for phonological theories which are concerned with representing the speaker's linguistic knowledge appropriately.

Phonological chunks are often, although not always, indicated by audible phonetic signals which demarcate the beginning and end of a segment. These signals, clues to the structure of the phonological utterance, are used by the listener to identify segments and to parse the speech stream for grammatical organization. I have attempted to trace the
development of "juncture," a type of demarcative boundary, within the context of evolving phonemic theory in the 1930's - 1950's. The intensity of the debate over the nature and validity of a phoneme of open juncture (as proposed by Moulton (1947)) was indicative of the importance of the issues at stake for phonemic theory. Moulton and Leopold, and Hockett and Pike, argued vigorously about the question of "biuniqueness" and the "zero allophone" of juncture. The debate was also critical for practicing field linguists, since it highlighted questions about analytical methodology in the face of apparent contrasts such as Kuhchen [c] - Kuchen [x]. Many of the issues which were raised during the Decade of the Phoneme were never resolved, and they return in different forms today.

This thesis ultimately derives from the type of puzzle or game which I referred to as a "boundary placement paradox" above. When children play games like "Iced Ink," "Mares Eat Oats," or "I Scream for Ice Cream," they display extraordinary sophistication in manipulating segments and boundaries. The speaker must signal the intended structure by demarcating segments with phonetic clues. The crucial point, however, is that speakers can "package" the same phonological material in a variety of ways--even misleadingly, as in the language games described. This work has stressed the types of phonetic clues
which German and English speakers, in particular, have at their disposal for signalling phonological structure.

The listener, on the other hand, must parse an analog speech stream into meaningful, bounded segments which correspond to grammatical and semantic structures. In order to interpret the utterance as the speaker intended, the listener must be able to identify the segments and their boundaries. The problem is quite like that facing the descriptive or field linguist, with the crucial difference that the child already knows the language in question. Following Hockett (1987), I have proposed that listening is not a passive event, but rather an active process with several modes. One of these, listening for word identity, involves matching *Gestalten* in the listener's linguistic system with the speaker's imperfect production. Communication succeeds because segments have "integrity": they are recognizable as wholes.
References


