

Where Do Features Come From?
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THE SOURCE OF UNIVERSALS: FEATURES, SEGMENTS,
AND THE NATURE OF PHONOLOGICAL PRIMITIVES

I. Introduction

1. Goal: Frame a set of questions to be discussed over the next two days
Paying close attention to certain assumptions that I argue in some cases
predetermine the results of our empirical investigations

2. This conference highlights the fact that these issues are more complicated than
any simple answer assumes.

3. Some central questions

a. The nature of phonological primitives

- What are the primitives of human speech?
features?
segments?
prosodic structure?
- To what degree are phonological and phonetic systems language-specific and
to what degree are they common to all human languages?

b. What is the relationship between adult patterns and acquisition?

- How does the infant/small child learn the elements of his/her phonological
system?
- How does the process of language acquisition result in the knowledge of an
adult phonology?
- To what degree are mechanisms of linguistic learning and competence
specific to language and to what degree are they part of more general cognitive
mechanisms?

4. Structure of talk:

a. some terminological issues

- b. some assumptions to reconsider
- c. phonological primitives
- d. the relationship between adult phonology and acquisition

II. Some terminological issues¹

5. *phoneme*
segment

6. *feature*

"**feature** 3. *Linguistics* a. A property of linguistic units or forms: *Nasality is a phonological feature*. b. In generative linguistics, any of various abstract entities that combine to specify underlying phonological, morphological, semantic, and syntactic properties of linguistic forms and that act as the targets of linguistic rules and operations."

- phonological features
- phonetic features
- acoustic features
- articulatory features
- distinctive features

7. *universal*

"**universal** NOUN: 1. Logic. . . . b. A general or abstract concept or term considered absolute or axiomatic. 2. A general or widely held principle, concept, or notion. 3. A trait or pattern of behavior characteristic of all the members of a particular culture or of all humans."

NB: Ladefoged (p.c.): *terrestrials*
innate
"**innate** ADJECTIVE: 1. Possessed at birth; inborn. 2. Possessed as an essential characteristic; inherent. 3. Of or produced by the mind rather than learned through experience: *an innate knowledge of right and wrong.*"

¹ Definitions from *The American Heritage Dictionary of the English Language: 4th Edition* (2000), <http://www.bartleby.com/61/33/F0063300.html>, consulted 9/27/07

Does universal = innate?

“**universal grammar** NOUN: *abbr.* UG A system of grammatical rules and constraints believed to underlie all natural languages.”
language-independent vs. language-specific

III. Some foundational assumptions

8. Set of assumptions stemming from early generative theory, largely defined in terms of syntax, but also strongly influenced phonology either directly or indirectly
 9. Intwoven assumptions, e.g. Chomsky (1965) *Aspects of the Theory of Syntax*
 - the definition of the *ideal speaker/hearer* within a *homogeneous speech community*
 - the *separation of competence and performance*
 - the importance of *modularity* and the *avoidance of redundancy*
- See Cohn (2006) for discussion.
- **innate properties of human language**
 - **the direct role of the task of language acquisition as the source of language universals**

10. Since many of us are trained in approaches growing out of generative theory, or approaches that directly critique generative approaches, it is useful to think about how these foundational assumptions of early generative theory have shaped our theories and our approaches to linguistic investigation.

NB: In this broad sense, I understand Optimality Theory to be a theory of generative phonology.

11. Early generative linguistics as an approach to the study of language rejecting American Structuralist approaches, particularly with regard to the influences of behaviorist approaches to psychology.
 - The motivation for assuming a specific endowment for language, as well as assumptions about universals and their linkage to language acquisition arose from substantive and methodological gaps between linguistics and cognitive psychology in the late 50s and early 60s.

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- What were in a sense working assumptions have been taken as some to be foundational beliefs of the theory.
- These assumptions need to be reevaluated in light of what we have learned not only in linguistics, but also in the psychology and neurobiology of language over the past 40 or so years.

IV. The nature of phonological primitives

14. What are the primitives of human speech? And where do they come from?
15. Chomsky and Halle (1968) *The Sound Pattern of English* (SPE) account for the definition of possible speech sounds, as well as an explanation of *natural classes* and *markedness* by positing a small vocabulary of elements or parameters that we are endowed with, defined to be a universal set of *distinctive features*.

The total set of features is identical with the set of phonetic properties that can in principle be controlled in speech; they represent the phonetic capabilities of man, and we would assume, are therefore the same for all languages. (Chomsky and Halle, 1968, pp 294-295)

The significant linguistic universals are those that must be assumed to be available to the child learning a language as an a priori, innate endowment. (Chomsky and Halle 1968, p. 4)

- These phonetically defined properties are understood together to define the inventories and patterns in phonology. Much attention has been paid to delineating the proper set, in terms of observed natural classes and phonetic correlates.
16. Very successful enterprise in accounting for phonological structure, alternations, and commonalities across languages
 - Is this the right answer?
 - See also Gerken (2005), Pulleyblank (2006) among others for discussion.
 17. Extensive body of evidence of the language-specific nature of phonetics degree of vowel lengthening before voiced sounds (Chen 1970, Keating 1985) patterns of nasalization (Cohn 1990) vowel-to-vowel coarticulation (Beddor et al. 2002)
Now widely accepted view of *phonetic knowledge* (e.g. Kingston and Diehl 1994)

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18. Bradlow (1993, p. 2, p. 34) English vs. Spanish vowels

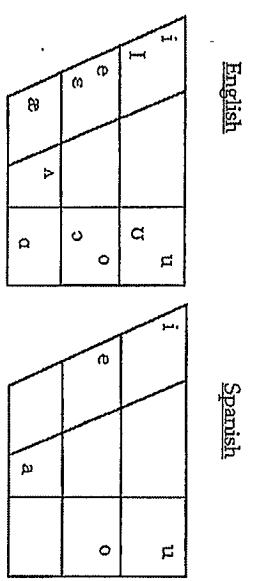


Figure 1.1. Charts of the English and Spanish monophthongs

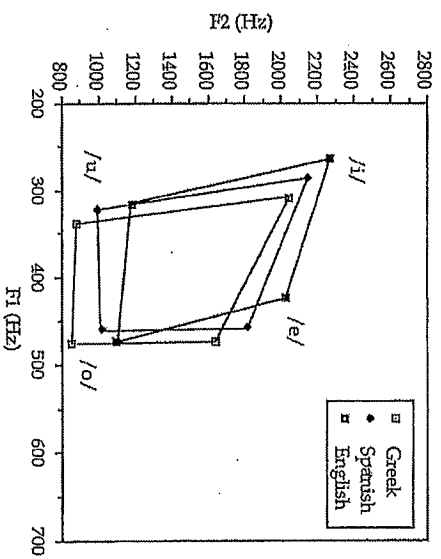


Figure 2.7. The /i/-/e/-/o/-/u/ areas in English, Spanish, and Greek.

19. Riehl (forthcoming, p. 284) timing structure of nasal-stop sequences

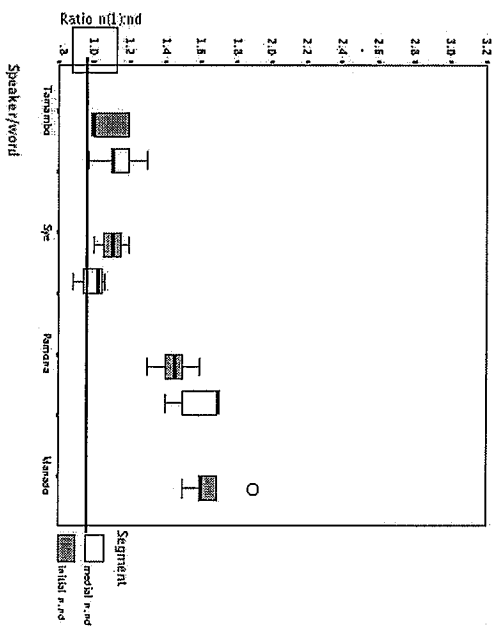


Figure 6.1 Average r:nd ratios across the speakers of each language, in both initial and medial position; $n=1$

20. Evidence from language-specific phonetics provides evidence that SPE view is not literally correct in the most simplistic sense.

There is not a universal set of phonetic elements (phones) equitable across languages defined by the set of distinctive features.

21. Definition of possible speech sounds

- Maddieson (1984) *Patterns of Sounds* identifies roughly 800 sounds occurring in a representative sample of 317 languages. These are quite well characterized in categories definable by distinctive feature theory. From this simple characterization, we have learned a lot about the typology of the sounds of the languages of the world.
- Pierrehumbert et al. (2000, p. 285) among others, rightly point out a problem: These categories are only definable in a roughly equivalent way. The categories are language-specific in the sense that "there are no languages in which the implementation of analogous phonemes is exactly the same."

22. The categories show more variation across languages and are fuzzier than predicted by the SPE distinctive feature set, which do not capture these differences.
- The evidence supports the view that experience contributes to the construction of adult categories.
 - In some technical sense then, distinctive feature theory is *wrong*. But does this mean that we should throw it out? No.
 - As we come to understand why formal systems are only approximately right, it becomes an interesting question why they do as well as they do. As we come to better understand *how* categories are acquired, we will come to better understand why categories are somewhat fuzzy.
23. In the broadest sense, as linguists, we strive to develop a *universal theory*, in that we aim to delineate the properties of possible human language.
- What is a possible human speech sound?
 - What are the representations of the set of possible speech sounds and the categories defined by them?
24. These goals predate generative linguistics, as seen, for example, in the long-standing interest in and accepted need for an international phonetic alphabet.
25. What *are* we endowed with that enables us to build up a system of phonological contrasts so successfully and so quickly?
- Why is it that the possible categories of contrasts across languages are quite limited and the systems show such surprising similarities across languages?
 - How do we explain evidence suggesting both language-independent and language-specific dimensions of language acquisition?
26. A partial answer comes from constraints imposed by the psycho-acoustics of the human ear and the nature of the human vocal tract.
- Quantal Theory (e.g. Stevens 1989)
- Dispersion Theory (e.g. Lindblom 1990)
- Articulatory Phonology (e.g. Browman and Goldstein 1992)
27. As stated by Fromkin (1977, p. 370), these are *necessary* but not *sufficient* constraints.
- How much of the definition of the sound system comes from the physical world vs. how much is intrinsic to the nature of the linguistic system?
 - Do the physical factors directly define the nature of the phonological system or whether their effects are indirect, mediated by the grammar.
 - Role of phonological principles and structural constraints intrinsic to the phonological system
- symmetry (Hayes 1999)
- economy (Clements 2003)
28. Possible answers
- the nature of “natural” classes (e.g. Mielke 2005)
 - learning of “natural” vs. “unnatural” classes (e.g. Seidl and Buckley 2005, Reperkamp and Dupoux in press)
29. The point is that unless we move away from a *literal interpretation* of feature theory as universal, we will not make progress on understanding the nature of the linguistic endowment, since the literal interpretation predetermines the answers.
30. Generative models have proven to be excellent *approximations* of adult grammars. This is a non-trivial result when we consider the complexity of linguistic systems across the languages of the world.
31. If we frame our discussion in terms of *right* and *wrong*, then we miss the opportunity to understand what is *almost right* about these models.
- We need to understand their limitations, while also understanding the insight they offer. It may be that feature theory is right at a particular level of granularity or it might be, as suggested by Pierrehumbert et al. (2000), that feature categories capture the end state, but not how the system is formed.
32. Why a model that captures an approximation of adult grammar might be on the right track.
- For communication to be successful, all we need is for individual grammars to approximate the individual grammars of those we are communicating with.

V. Relationship between adult phonology and acquisition

33. *language acquisition as the source of language universals*

Chomsky (1965, 27) defines the goal of universal grammar and the task of the child acquiring language as follows:

A theory of linguistic structure that aims for explanatory adequacy incorporates an account of linguistic universals, and it attributes tacit knowledge of these universals to the child. . . .

Language learning would be impossible unless this were the case. . . .

What are the initial assumptions concerning the nature of language that the child brings to language learning, and how detailed and specific is the innate schema (the general definition of "grammar") that gradually becomes more explicit and differentiated as the child learns the language?

Chomsky and Halle (1968, p. 4)

The significant linguistic universals are those that must be assumed to be available to the child learning a language as an a priori, innate endowment. That there must be a rich system of a priori properties—of essential linguistic universal—is fairly obvious from the following empirical observations. Every normal child acquires an extremely intricate and abstract grammar, the properties of which are much underdetermined by the available data. This takes place with great speed, under conditions that are far from ideal, and there is little significant variation among children who may differ greatly in intelligence and experience. The search for essential linguistic universals is, in effect, the study of the a priori *faculté de langage* that makes language acquisition possible under the given conditions of time and access to data.

34. Many would agree that the nature of phonological universals and the acquisition of phonology are two of the central questions that face the field of phonology.

• However, the equation of the task of the linguist and the task of the child acquiring language has major consequences for the definition of *language universals* and their relationship to *language acquisition*.

• This inextricable linkage is neither logically nor empirically warranted. (See Pierrehumbert et al. 2000; Vihman and Velleman 2000; Gerken 2005 for discussion.)

• How we learn ≠ what we know

Vihman and Velleman (2000, p. 307-309) point out that neither a model of "phonology all the way down" which models early acquisition in terms of adult categories and rules or constraints, nor a "phonetics all the way up" approach which assumes that "phonology" emerges gradually out of the phonetics offers an adequate account of the acquisition of a phonological system.

• Both language acquisition and linguistic universals need to be investigated and understood in their own right. Only then can we understand how they are interrelated.

35. What we know: properties of adult linguistic systems

36. How we learn:

Multiple stages that need to be accounted for (see Vihman and Velleman 2000, Beckman 2003, and Peperkamp 2003 for recent reviews)

early language-independent discrimination (6-8 months)

language-specific discrimination (10-12 months)

early word learning (14-16 months) – impedes discrimination of similar sounds

rapid vocabulary explosion

adult-like categories not fully formed for a number of years (Hazan and Barrett 2000)

37. An example: covert contrast in language acquisition (Cohn and Kishel 2003)

• What is the nature of phonological categories of preschool aged children?

• How should we model such systems?

Recently patterns of language acquisition have been modeled as conflicting constraints in OT, tension between markedness and faithfulness, e.g. cluster reduction (e.g. Pater and Barlow 2003). Crucially observed patterns are assumed to involve complete neutralization.

38. Phonological development of initial consonants and consonant clusters in a

pair of fraternal female twins acquiring American English.

- At age 4 years, 1 month, twin A had achieved a nearly adult phonology; while twin B evidenced a reduced inventory of surface contrasts, due to the multiple effects of substitution, deletion, and coalescence.

surface	intended target		
	direct	substitu-tion	deletion
[ʃ]	ʃ	θ	
[s]	s	ʃ	st, sm, sk
[fʷ]		ʃ, fr, θr	
[sw]	sw	sl, fr	skw, str, skr

Table 1: Surface realization of intended targets, twin B.

- The relative intelligibility of twin B's speech leads one to wonder whether covert contrasts exist (Macken and Barton, 1980, Scobbie et al. 2000) that is, low-level phonetic differences which provide cues to the intended target forms.

NB: At this stage, both twins perceived a full range of contrasts.

39. Acoustic study

full range of initial consonants and clusters of English (most real words) multiple repetitions for both twins measurements for duration, intensity, and spectral balance

[f]	[aɪ]	[ɪ]	[fʷ]	[aɪ]	[ɪ]
f	fight	fit	f	fly	flip
θ	thigh	thick	fr	fr	frizz
sp	spy	spit	θr	thrice	thrift
sm	smile	Smith	spr	spy	spring
			spl	splice	split
[s]	[aɪ]	[ɪ]	[sw]	[aɪ]	[ɪ]
s	sigh	sit	sw	swipe	swim
ʃ	shy	ship	sl	slide	slip
st	stey	stick	ʃr	shrine	shrimp
sn	snipe	snip	str	strip	script
sk	sky	skip	skw	skate	sketch
[l]	[aɪ]	[ɪ]	[sl]	[aɪ]	[ɪ]
l	light	lip	sl	slide	slip
[w]	[aɪ]	[ɪ]			
w	white	which			
r	ride	rip			

Table 2: Word list used for acoustic study.

- 40. Results: Differences were found for both duration and intensity between those cases which impressionistically exhibited complete neutralization.

41. Predictions for duration

Predictions:

- If complete neutralization: all surface [f]'s and [s]'s will be of comparable duration to /f/ and /s/.
- If incomplete neutralization: surface [f] or [s] from target clusters should be longer than from target single consonants, e.g. [s] from target /st/ or /sk/ should be longer than [s] from target /s/.

42. Results for duration:

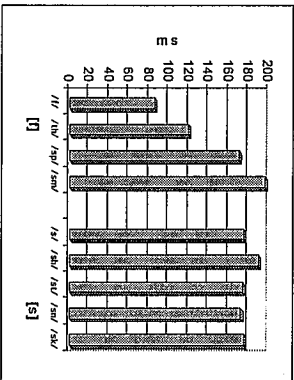


Figure 1: Average durations (in ms.) of surface [f] and [s] according to target sound, Twin B

- On the average, surface [s] is longer than surface [f] (mean duration for surface [s]: 177ms; mean duration for surface [f]: 140ms).
- This is consistent with results reported in the literature for adult fricative production (Jongman et al. 2000) although the differences found here are greater than those usually observed in adults.
- surface [f]: both target /sm/ and /sp/ are noticeably longer than for target /f/ or /θ/, in the range of surface [s] durations
- the realization of coalesced target forms is distinct from target single segments

- surface [s]: target /st, sn, sk/ have durations comparable to target /s/ and /ʃ/.
 - This suggests a difference in the realization of forms involving coalescence (/sp, sm/) and deletion (/st, sn, sk/).
43. Discussion:
- Results provide further evidence of the role of covert contrast in phonological acquisition.
 - Need for acoustic and articulatory data; impressionistic data is not sufficient
 - Children at this stage exhibit categories with many adult-like properties, but these categories can not be equated with adult categories.
 - Much more work is needed on the development of both production and perception of categories throughout childhood (see Hazan and Barrett 2000)
44. What is the relationship between the adult system and acquisition?
45. To answer this question, we have to separate our hypotheses/hunches/world views from the methodology
- Methodologically we need to argue from the null hypothesis, that is based on input along
 - but this does not mean the null hypothesis is right
46. Some promising directions
- early learning of categories (e.g. Maye et al. 2002, Weiker et al. 2007, Burns et al. 2007)
 - learning of “natural” vs. “unnatural” classes (e.g. Seidl and Buckley 2005, Peperkamp and Dupoux in press)
47. Both the complexity of the problem and the speed of learning and processing suggest that the right answer must involve both structural constraints and distributional information (Yang 2004)

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VI Conclusions

48. Need to move beyond assumptions from early generative theory about the nature of language universals and innateness
- Both language acquisition and linguistic universals need to be investigated and understood in their own right. Only then can we understand how they are interrelated.
 - Generative models have proven to be excellent *approximations* of adult grammars. This is a non-trivial result when we consider the complexity of linguistic systems across the languages of the world.
 - We need to understand the limitations generative models, while also understanding the insight they offer.
49. Because the very nature of language is so complex, an adequate model will be complex and we are most likely to properly characterize it through synthetic approaches, one that incorporates the roles of the input as well as structural constraints.
50. Our models need to enable us to accurately model adult grammar, not as epiphenomena, but as a system of knowledge, while also modeling acquisition, (as well as language use, and language change). And they need to give us insight into the ways in which the adult grammar grows out of these.

51. Looking forward to hearing about progress in these directions over the course of the conference.

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