Why this Article is not about the Acquisition of Phonology*

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0. Introduction

In order to understand what is going on when phonology is acquired we clearly need to understand what is being acquired. We need to understand what phonology is, and what aspects of it have to be learned. Advances in phonological theory, in particular the theory of Government Phonology (Kaye, Lowenstamm & Vergnaud, 1985, 1990, Charette, 1991) have deepened our understanding of the phonological component of the human linguistic system, its interfaces with other components and the extent and nature of cross-linguistic variation. This latter point is central to the issue of acquisition. I follow the general view that the human linguistic system (including its phonological component) consists of a fixed innate template (UG) which underdetermines a given linguistic system. This system is "fleshed out" by a vector of parameter settings which, along with UG, defines the linguistic system in question. In this view acquisition consists of parameter setting upon exposure to primary linguistic data. The computational model discussed in Dresher & Kaye, 1990 was based on these assumptions. One of the purposes of that study was to show that this model was at least plausible. At the time our understanding of the parameters of stress systems ("metrical phonology") was the most developed and it was for that reason that we chose to model them in our study. Today much more of the observed phonological diversity has been reduced to a small set of parameters and so much more ambitious models of phonological acquisition are possible. I will take it to be an obvious point that to the extent that phonological diversity can be shown to be rather small, the acquisition model can be correspondingly simplified.

One of the key moves for gaining an understanding of the acquisition of phonology (indeed of phonology itself) is the liberation of phonology from any notion of "phonetics". Here I take "phonetics" to mean considerations involving concepts of articulatory organs, air stream mechanisms and anything else involved in the production of speech sounds by humans. Aside from placing certain anatomical limitations on how human speech sounds can be produced (e.g. we can place the tip of our tongue behind our upper teeth but not on our left earlobe) knowledge of these anatomical facts has played no role in our knowledge of phonology nor in the functioning of phonology itself. Failure to grasp this point has muddied the waters considerably and led to the general lack of theoretical progress in mainstream phonological approaches that we can observe today. The phonetic view that I am rejecting is one that holds that the primitives of phonological representation are really "instructions to the articulatory system for the production of speech sounds". A child's acquisition of phonology in this view involves mastery of a precise set of phonetic features which constitute the end product of speech production and the starting point (i.e. the first conversion from signal to some form of cognitive representation) of speech recognition. I will show that there are very good reasons for rejecting this model.

Two alleged properties of linguistic systems have interesting implications for acquisition models.

(1) All linguistic systems are dynamic (they change through time)

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(2) The human ability to acquire linguistic systems tails off rapidly after puberty.

I will try to explain why (1) is true and why (2) is believed to be true (I will argue that it is false). The central claim involved here is quite simple:

(1) Humans possess a group recognition system.

(2) Human group recognition cues are expressed through vocalisms.

The human vocal channel is shared between two discrete systems:

(1) The human linguistic system

(2) The human group recognition system.

It is the existence of the group recognition system that explains the dynamic nature of the linguistic system. It is also the ability to acquire the group recognition system ("group stamping") that is extinguished shortly after puberty. Humans can and do acquire additional linguistic systems long into adulthood. Since the vocal channel is shared by at least two distinct systems (in addition to group recognition cues it contains information as to individual identity, age, sex, emotional state, etc.), the articulatory processes that go into the production of a given vocalism are not being employed exclusively for the linguistic system. From a linguistic perspective the signal produced may be viewed as containing nuggets of information relevant for linguistic cues and a large degree of "packaging" -- linguistically inert material that is used for non-linguistic purposes or perhaps for no purpose at all. It is therefore futile to analyse linguistic entities in terms of articulatory categories since these latter factors go into the production of the whole vocalism and not simply that part of the vocalism relevant to the linguistic system. We cannot say that the tongue is used for linguistics while the lips are used for group recognition and the vocal folds for personal identity signatures. Once these distinctions are understood and filtered out of purely linguistic analyses, then the linguistic (especially phonological) models are seen to be much simpler than earlier supposed and the acquisition models are correspondingly simpler as well. Let me now present some arguments for the existence of the human group recognition system and its essentially vocal characteristic.

1. The Human Group Recognition System

A. Humans are social primates.

All known human populations live in groups that exceed the nuclear family (one or more parents plus offspring). Social animals have means of distinguishing conspecific (i.e. members of the same species) group members versus non-group members. This distinction evokes differential behaviour (group members are treated differently from non-group members) typically with respect to altruistic/cooperative behaviour and mate selection. The human group recognition capacity goes beyond merely being able to distinguish co-group members from non-group members. Humans can also differentiate amongst other groups that are not their own.

B. All primates have recognition systems.

All primates studied to this point have been shown to have some form of recognition system. Typically this system is a "kin recognition" system whereby parents recognise their offspring and vice versa or siblings recognise each other. Humans can be expected to have (and do indeed have) ways of recognising kin.

C. Humans' "phonetic" ability far exceeds linguistic requirements.

The evidence is largely (entirely?) anecdotal. It is observed in all human groups that individuals can distinguish group members from non-group members. This is done even by young children (3 year olds if not younger). Children typically recognise

"outsiders" by their accent. Judgements about who speaks differently from us and who speaks the same are extremely accurate. Such judgements are often accompanied by irrational emotional responses. There is no known *linguistic* motivation for this ability. This ability extends to conspecifics who have not been encountered before.

D. In primates, group size correlates directly with neocortex size. [Robin Dunbar, *The Times Higher* Jan. 26 1996]. Among primates humans have the largest neocortex. Given Dunbar's claim, we would expect that human groups are larger than those for other primates. This increases the likelihood that humans are called upon to recognise co-group members that they have not seen before.

Human group size seems to depend more on ecological conditions than any biological limitations. Human groups appear to expand as conditions permit. Large groups imply that individuals may routinely encounter co-group members who are hitherto unknown to them. Nevertheless, appropriate group behaviour is called for. That human groups have no obvious upper bound will be important in our later discussion of the mechanism of recognition that is involved.

2. Modes of Group Recognition

Studies of the modes of recognition between mother and infant yield the following conclusions:

A. Infant - Mother Recognition (of mother by infants)

1. Vocal Stimuli 2 days [DeCasper & Fifer, 1980]
2. Olfactory Stimuli 3 days [Schaal *et al., 1980*]
3. Visual Stimuli 1 month [consensus]

It is noteworthy that vocal stimuli are employed very shortly after birth. I will claim that vocal stimuli are the leading cues for group recognition below.

B. Conspecific types of recognition (typically for kin recognition)

Research in the area of kin recognition has proposed the following types of recognition.

i. **Spatial location** The individual recognises kin not on the basis any cues presented by its conspecifics but rather on the basis of cues in the environment.

ii. **Association** Individuals learn during their development cues from the most familiar, or most commonly encountered, conspecific(s) in their environment. [Human infants learning to recognise parents' faces]

iii. **Phenotype matching** Recognition of kin is again based upon cues presented by conspecifics. In this case individuals match the cues of conspecifics and assimilate these to form a single template. [Probably the main type used in human group recognition].

iv. **Recognition genes** In this case the recognition of kin is encoded directly by an individual's genes and requires no experience. [n/a to human group recognition]

C. Remarks

From the remarks above we see that vocal stimuli are used by human infants very early on in life. Human experience shows that this trend continues throughout our lifespan. Olfactory stimuli experiments have shown that infants are capable of using this means of recognising their mother. It is doubtful that olfactory cues have any role in group recognition. (Could we recognise someone from Liverpool by their smell?) Visual

stimuli are obviously important for recognition of individuals. Their role is marginal at best for group recognition (unless the group is small enough for its members to be learned by rote). Only the grossest distinctions (skin pigment, etc.) are detectible visually and these kinds of differences are not typical of geographically contiguous groups.

The mechanism for human group recognition appears to be phenotype matching. The notion of template is crucial here. A template can be applied to any conspecific to determine group membership. It is unnecessary to have met the individual beforehand. This corresponds to the human ability to perform exactly this task. Humans (including young children) are able to distinguish group members from outsiders. This point is highlighted in the experience of bilingual children. The appear to possess an uncanny ability to distinguish native speakers of the languages they have learned. Often a bilingual child will refuse to speak, say, French, to an Anglophone, even if she speaks French fluently. This data is anecdotal but is commonly reported as typical in bilingual communities such as Montréal.

One must be careful to distinguish phenotype matching, in which a template is applied to an arbitrary conspecific, from association which can only be applied to conspecifics with whom the subject is already familiar. Vata speakers in the Ivory Coast can unerringly identify co-group members of the 5 villages that constitute their group home. The group is too large for all individuals to know each other personally. They can distinguish their own group from neighbouring populations whose linguistic systems are nearly identical. Their pronouncements tend to be very categorical on the subject: “They speak very differently from us.”

I conclude that humans possess a group recognition system and that in the main human group recognition uses phenotype matching applied to vocalisms. Since vocalisms are also used by the human linguistic system it would be expected that certain properties of group recognition systems may “spill over” into our linguistic systems. I will argue that sharing the vocal channel can offer an explanation for the dynamic nature of linguistic systems and for the claim that language acquisition is attenuated or disappears entirely following puberty.

3. The dynamic nature of linguistic systems

All linguistic systems change. The notion that somewhere in rural West Virginia there is a population speaking “Shakespearean English” is a myth. From the rain forest of the Amazon to West Africa to South East Asia, linguistic variation from one village to another is observed. There are no exceptions. There is no satisfactory explanation for this phenomenon. Appeals to articulatory explanations (tendency towards ease of articulation) seem to lead nowhere; they are either false or untestable. I would like to suggest that linguistic dynamism exists because the linguistic system shares the vocal channel with the group recognition system. The two systems are acquired together (at least for L1 acquisition) and the human group recognition system must be dynamic or else it could not serve its purpose (distinguishing group members from non-members). This consideration, that a dynamic property is vital for a group recognition system but unnecessary for a linguistic one (aside from a dynamic vocabulary of course), leads to a further speculation: the linguistic system was an outgrowth of the group recognition system and *not* from a primate communication system (which persists in activities like smiling, crying, etc. for which there is no acquisition issue). Let me offer an argument for the necessity of a dynamic group recognition system.

Consider a human group sharing a common group stamp. Over several generations

this group may expand, divide, incorporate other groups and so forth. Now suppose the group recognition system were static (unchanging). Eventually we might have several groups, all issuing from an original group but now living separately. Group membership will wax and wane through deaths, births, marriages, fissions, etc. As long as the group recognition system remained static there would be no way for members of these offspring groups to be distinguished from any of the other daughter groups issuing from the same original group. In whatever time it would take for two daughter groups to become distinct viable groups, the group recognition system would have to reflect this new situation. If 3 or 4 generations' separation is sufficient to establish distinct groups in human terms, then the group recognition system, to be effective, would have to change at that rhythm. This point is illustrated in the two figures below.

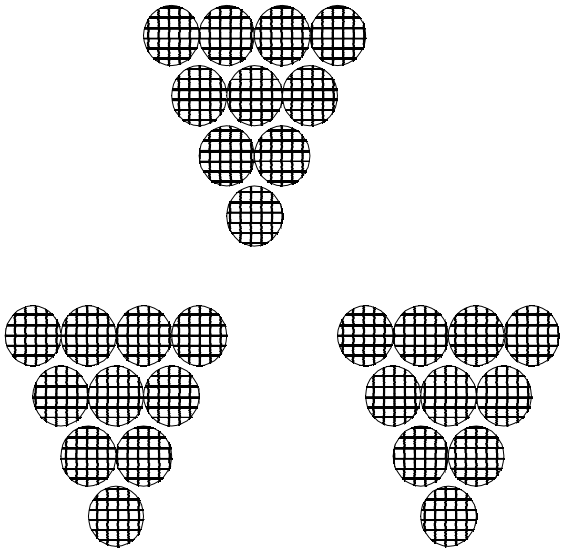

Figure 1 Stasis model

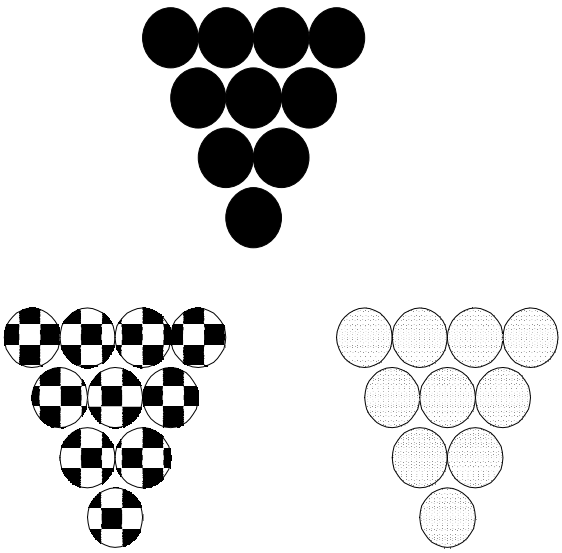

Figure 2 Dynamic model

The sets of circles represent human groups; the different patterns correspond to different group signs. The time dimension is represented along the vertical axis. Different rows are separated by several generations. In the static model group signs do not change through time and so when groups eventually split (or join) they are not distinguished by their group sign.

In the dynamic model group signs change through time in rhythm with the changes in group membership. Descendants of a single group my split into several groups, each with its own group sign. This could not happen in the static model.

Remember that the existence of human groups (as is true for any social animal) is not a question of taste or fashion. Human groups are the result of evolution. If human populations survive, it is due in large part to their social nature. If human social organisation is driven by evolution then its essential components, among them a device for determining group membership, are also driven by evolution. We would expect that recognitions systems (that is the specific signatures that characterise a given human group) would be as malleable as the human populations they identify. In sum, if 3 or 4 generations suffice to create distinct human groups then the group signatures must change in about the same time frame. This scenario seems to correspond reasonably well with the observed human condition.

4. Acquisition and Puberty

It is commonly believed that humans' ability to acquire another language is greatly reduced after puberty. I would like to suggest that this is not the case. In fact, it is difficult to imagine why humans would have such a property. It might seem adaptive to have a species where acquisition is possible through the lifetime of the individual. One could argue that the overhead required to maintain a functioning acquisition system is not worth the occasional benefits that might accrue to humans possessing this ability. The fact remains that it is not obvious why language acquisition should atrophy following puberty.

Armed with the idea that group recognition cues are being acquired along with linguistic systems, the situation becomes more comprehensible. It may be strange that language acquisition rarely takes place after puberty (if such were the case). It is quite natural that group stamping, the acquisition of group signatures, should stop around puberty.

There are at least two major reasons for distinguishing fellow group members from non-group members:

(i) mate selection

(ii) altruistic/cooperative behaviour

Consider mate selection. Human populations frequently mate with either members of the same group (endogamy) or members who are outside one's group or even members of a specific set of different groups (exogamy). Puberty means the development of sexual maturity. Mate selection may take place a few years after the onset of puberty. When mate selection takes place it is important that prospective partners give and receive "honest reads" about group membership. In other words, if human forms of mate selection are biologically adaptive (driven by evolution) and then it is important that signs on which selection is based are reliable. If post-pubescent humans were too plastic with respect to group stamping, then reliable group affiliation data would be lacking. A member of the opposite sex exuding your group signature might have acquired it rather recently. Such a state of affairs would defeat the whole point of mate selection by group since the group signature of a sexually mature potential partner might not be reliable. Better to freeze

group stamping by puberty so that group distinctions are more robust at mating time. In like manner, robust group marking in functioning adults is crucial for targeting altruistic/cooperative behaviour. Whatever form this group-dependent differential behaviour takes, adults would be far more able to dispense and receive it than children.

We can ask why group stamping persists up to puberty rather than being extinguished at, say, 5 years. There would appear to be benefits for plasticity on the part of children. Children are dependent on adults and the world is a cruel place. Calamities can occur: loss of parents, natural disasters, etc. which might throw children into different groups. It would be important for the children to be able to produce the appropriate group signs in order to evoke the kind of behaviour necessary for their survival.

Since the onsets of both the linguistic and group recognition systems are temporally quite close and because both systems share the vocal channel, they have been consistently confused in discussions of both language acquisition and phonology. Group stamping becomes more robust after puberty as we would expect. Language acquisition continues but is now separated from group stamping. This is known as "speaking with an accent". L2 learning under natural conditions (for example, immigration) can result in high degrees of linguistic proficiency. The group stamping is absent or imperfectly learned, hence detectable by group members except in very unusual cases. Differing parameter settings are frequently, even typically, learned in a natural L2 context. One's accent is always a give-away to one's non-native (i.e. non-co-group member) status. The connection between the acquisition of these two systems may explain the dynamic nature of linguistic systems and the belief that the language acquisition device shuts down after puberty. Now that we are sensitive to the distinction between the acquisition of group recognition cues and the acquisition of phonological parameter settings, we can proceed to the discussion of the salient features of this latter category.

5. Phonological Parameters

A. Constituent Structure

Much has been made of the alleged diversity of syllabic systems. This view is based on erroneous analyses induced by naive theories of phonological structure. It is commonly held that any word initial or word final consonant sequences are tautosyllabic. Thus, in English the word "string" is assumed to begin with an onset contain three members: s, t and r. These claims lack any empirical support (see Kaye, 1996 for arguments). In working on our computational model of stress acquisition (Dresher & Kaye, 1990) it became clear that stress systems only cared if constituents were branching or non-branching. This seemed to suggest that this exhausted the possibilities of structural divergence. An impressive body of empirical material now supports this view. Taking the most conservative view of phonological constituent structure (the most difficult for an acquisition model) we have three constituents: onset, nucleus and rhyme. The rhyme can be viewed as a projection of the nucleus in that the head of a rhyme is the nucleus and all nuclei are dominated by the rhyme constituent. It can be shown, given the assumptions of GP, that all constituents are maximally binary. Accordingly this gives us three parameters of constituent structure:

onsets - branching	[yes/no]
nuclei - branching	[yes/no]
rhymes - branching	[yes/no]

This gives us the possibility of 8 different systems. In fact, a positive value for the

branching onset parameter is a very exotic event. Branching onsets have only been attested in Indo-European languages. These languages also have branching rhymes. This can lead to a postulated dependency of branching onsets on branching rhymes (onsets may [not must] branch if a language allows branching rhymes). Be that as it may, these 3 parameters exhaust the diversity of phonological constituent structure.

B. Licensing Constraints

All human phonological segments consist of one or more of a set of 6 to 8 elements. These elements may be pronounced in isolation or in combination and are called "phonological expressions". Phonological expressions come in two flavours: headed or headless. A phonological expression may have up to a maximum of one head. It may contain zero or more non-heads, called operators. Current work in GP (again, we take a conservative approach) posits six elements: A, I, U, H, L, ? and an identity element.

In order to account for the diversity found in the various phonological systems we need to say something about the combinatorial possibilities of the elements. If nothing were said then we would expect all combinations in all languages. This is not the case and so acquisition of these systems is an issue. We use licensing constraints to limit various combinations of elements in a given system. For example the following licensing constraints define the English nuclear system.

(1) Branching nuclei are headed (i.e. all expressions associated [linked] to a branching nucleus are headed); non-branching nuclei are headless.

(2) U and I cannot combine.

(3) Nothing can license I (I cannot appear as an operator in a headed expression)

All expressions not explicitly excluded by the licensing constraints are licit. Limiting ourselves to the elements A, I and U and combining them freely (except where excluded by (1,2 and 3) above, we get the following system.

Non-branching Nuclei:

A	pat
I	pit
U	put
AI	pet
AU	pot
i	but

Branching Nuclei: (Heads are underlined)

<u>A</u>	part
<u>I</u>	Pete
<u>U</u>	boot
A<u>I</u>	bait
A<u>U</u>	boat
U<u>A</u>	bought

Now compare this situation with French. (Continental) French does not have branching nuclei.

(1) All expressions are headed.

(2) Nothing can license U.

A pas
I cri
U fou
AU faux
AI fé
IA fait
IU fût
AIU feu

There are some indications that the licensing constraints also define other aspects of the phonology. This possibility has been discussed in some detail by Charette & Göksel, 1996. They show that Turkish licensing constraints which define the Turkish nuclear system can also be used to explain why Turkish vowel harmony has the properties that it has. This has clear implications for the acquisition of phonology. Primary data involving nuclear systems and primary data concerning vowel harmony may feed into each other. In like fashion languages displaying so-called "ATR Harmony" (which is not a harmony at all but rather a case of head-licensing) appear to be exactly those languages that possess the licensing constraint that A cannot be a head. Progress in phonology is uncovering more and more connections of this sort and to the extent that these relationships are understood the content of the phonology that is acquired will be reduced. Taking an extreme view, it may turn out that the licensing constraints may be the ONLY items that are acquired with respect to segmental variation across systems.

Other uses of the headed/headless distinction involve parsing information. For example, in dialects of Brazilian Portuguese the distribution of headed/headless nuclei correlates with accent placement in the following way:

(i) all nuclei from the beginning of the word up to and including the tonic vowel are headed.

(ii) all post-tonic nuclei are headless.

In this way domain boundaries fall between a headless and a headed nuclear expression. Interestingly, Japanese pitch accent (Yoshida, 1995) works in a very similar way for very similar reasons: From the beginning of the word, all nuclei bear high tone up to and including the lexical accent. Post-accent nuclei are toneless. The first nucleus of the word is toneless unless it is lexically accented. The differences between Japanese and Brazilian Portuguese reduce to the differences between using headless/headed versus toneless/toned for marking accentual domains. These kinds of differences are fairly obvious and present no particular learnability problems.

Further differences in phonological systems involve other types of licensing properties. Charette, 1990 has discussed variations in government licensing. The number of possibilities is small and all are attested in linguistic systems. In some systems p-licensed nuclei do not grant government licences to their onsets (Wolof). In other cases p-licensed nuclei do government-license their onsets but only locally (English). Finally, other systems allow both local and non-local government licensing of onsets by p-licensed nuclei (Polish). These differences are manifested in the fact that "bes" is well formed in Wolof, English and Polish; "best" is well formed in English and Polish; and "betr" is well formed only in Polish. Once again the primary data for these distinctions are not at all exotic and the parameters are quite easy to fix. Other aspects of variation of ECP effects display similar sorts of behaviour and require no additional machinery or comment. To the extent that adequate theories of phonology exist, acquisition issues become easier to handle, if not entirely trivial. Phonological variation has been wildly exaggerated as a

result of poor theoretical design and testing and because of a number of wholly unjustified assumptions (e.g. phonology is related to phonetics).

6. The Phonology-Morphology Interface

Another source of confusion and complication for phonological acquisition is the question of the phonology-morphology interface. It is important to separate out lexical phenomena (those occurring at L-structure) from genuine phonological phenomena (those taking place in P-structure). Part of the central dogma of phonology since SPE is the assumption that any two forms that are both phonologically and morphologically similar must be derived (at least in part) from a common source. For example, it is commonly believed that forms such as "opaque-opacity" are related in a phonological way (i.e. some common form for "opaque" with or without the suffix "-ity"). This assumption then requires that a series of rules or constraints or rankings be put forth to "account for" this purported phonological behaviour. Constraints or rules such as "great vowel shift" or "velar softening" greatly expand the expressive power of phonological theory and accordingly render the acquisition model more problematic. In fact, there is not a shred of evidence in support of this position. It is assumed to be correct without question and the consequences fall where they may. If "opaque" and "opacity" are considered to be separate lexical entries and not related by a common source, then the need for all the phonological accoutrements associated with their derivation evaporates. For an acquisition point of view, you don't need to learn what doesn't exist!

Arguments for this position are presented in detail in Kaye, 1995. The only aspect of morphological structure that is visible to the phonology is a domain. Morphology is divided into two parts: analytic and non-analytic. Analytic morphology contains domains visible to the phonology; non-analytic morphology is invisible to the phonology. Its forms carry no phonological trace of internal structure. This is the difference between English weak verbal morphology (e.g. "peeped") versus strong verbal morphology (e.g. "kept"). The former case is analytic with both "peep" and "peeped" forming domains: [[peep]ed]. The latter case is non-analytic with a single domain: [kept]. Non-analytic morphology involves no phonological processes than those that would apply to morphologically simplex words. "kept" is treated exactly like "apt". Forms may differ arbitrarily in their analytic vs. non-analytic status. "kilOmeter" (stress on the "o") is a non-analytic form [kilometer] whereas kIlometer (stress on the "I") is analytic: [[kilo][meter]]. "altimeter" is analytic in British English but non-analytic in American English.

Failure to provide an adequate model for the phonology-morphology interface has led to much confusion about what exactly is a phonological process. This failure when coupled with unconstrained theories of phonology (anything can happen), led to excessively complex models such as "lexical phonology" with sets of rules levels and complex interactions between them. It is open to question whether any realistic acquisition model could be paired with this kind of theory.

7. Conclusion

In this paper I have tried to show that discussion of the acquisition of phonology is futile until we know what it is that is being acquired. Acquisition issues cannot be discussed in a theoretical vacuum. An acquisition model must be paired with a model of the component that is being acquired. It should be obvious by now that acquisition models will vary enormously according to the component model with which they are paired.

Acquisition models are interesting in themselves and also in that they provide at least some limitations on the sorts of theories of linguistic components that are being proposed. I would regard any linguistic theory with some suspicion if its paired acquisition model were unduly complex, not to say impossible.

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