On the Comprehension/Production Dilemma in Child Language

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1 The Dilemma

That children's linguistic ability in production lags dramatically behind their ability in comprehension poses a long-standing conceptual dilemma for generative studies of language acquisition. Do children's productions reflect their competence in basically the same way as is assumed for adults, or is children's competence/performance gap dramatically greater?

The latter hypothesis, invoking severe performance difficulties to account for the impoverishment of production relative to comprehension, has several problems. Gross formulations of the hypothesis, essentially claiming that children don't produce, say, a particular segment because their motor control hasn't yet mastered it, can run afoul of the fact that children who systematically avoid a given structure in their linguistic productions can often easily imitate it (e.g., Menn and Matthei 1992:220). More problematic still for this hypothesis are children like those studied by Smith (1973:149): they produce, for instance, [pʌdəl] and [θɪk], but for *puzzle* and *sick*—*puddle* and *thick* are produced [pʌgəl] and [fɪk].[1] Even subtle formulations of the hypothesis would seem to entail that generative grammar has little to say about production—in particular, no means of explaining the broad generalization that the additional restrictions manifest in child output align remarkably well with the crosslinguistically observed restrictions on adult outputs: the same configurations that are marked (in the sense of disfavored) in adult languages tend also to be avoided in child language (Jakobson 1941/1968, Stampe 1979). Where constraints defining linguistic markedness are shared across adult and child language production, and where child productions reveal a grammatical character formally parallel to adult grammars, it would be attractive to have a viable hypothesis according to which grammar has a central role to play in explaining child production.

My topic, therefore, is the other horn of the dilemma. The alternative hypothesis, that the additional limitations manifest in child output are to be explained by a grammar, leads immediately to the extremely unattractive (perhaps, indeed, incoherent) conclusion that the child must have two grammars. It is obvious that the same grammar could not simultaneously yield impoverished productions and relatively rich comprehension.

My purpose here is to prove that this obvious conclusion is incorrect. To provide a minimalist demonstration of this conceptual point,

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[1] Thanks to Joe Pater and Linda Lombardi for pointing me to the examples from Menn and Matthei 1992 and from Smith 1973, respectively.

I will present a grammar that simultaneously displays two properties. On the one hand, the grammar leads every word to be produced as the structurally optimal form, perhaps *ba*. On the other hand, the same grammar allows correct comprehension of an unbounded class of words rich in phonemic distinctions and prosodic structure.[2]

This grammar is formulated in the Optimality Theory (OT) framework (Prince and Smolensky 1991, 1993). The result presented here contributes to the OT acquisition literature a general explanation for an assumption central to much of that literature: even children with extremely limited phonological production have underlying forms that relatively closely approximate the adult form (Demuth, in press, Pater and Paradis, in press, Bernhardt and Stemberger 1995, Gnanadesikan 1995, Levelt 1995; see also Smith 1973). I will show how one and the same child grammar can permit the acquisition of a rich set of underlying forms that can be effectively used during comprehension, even though during production most of the underlying distinctions are neutralized to the unmarked structure.

The primary example grammar I will present is a phonological one; the conclusion, however, concerns OT grammars in general, and I include a brief syntactic example as well.

2 The Proposal

The resolution I propose to the comprehension/production dilemma is this: there is only one child grammar, and it is an OT grammar. An OT grammar is to be understood now as a means of evaluating the relative Harmony (unmarkedness) of structural descriptions via a language-particular ranking of universal constraints. These structural descriptions contain two important substructures; the *input form* and the *overt form* (in phonology, the underlying and surface forms, respectively). This OT grammar can be deployed in multiple ways. In ''production,'' what is fixed is an input; what competes are structures that share this particular underlying form. The overt expression of a given input is the overt form contained within the maximum-Harmony or optimal structural description of that input. In ''comprehension,'' on the other hand, what is fixed is a surface form, and what competes are structures that share this given overt form. ''Comprehension'' of a given surface form is determined by the maximum-Harmony structural description containing that surface form. Only one grammar is used in the two processes: one constraint ranking, one means of evaluating the relative Harmony of structures. What differs between ''produc-

[2] In keeping with the minimalist theme, I do not treat the complexities of deriving underlying forms in the face of surface phonological alternations. The proposal developed here actually handles this additional layer of difficulty as well, if, following independently motivated proposals in the OT phonology literature, optimization is carried out at the level of the morphological paradigm rather than the individual form: see Tesar and Smolensky 1996.

tion'' and ''comprehension'' is only *which structures compete:* structures that share the same underlying form in the former case, structures that share the same surface form in the latter case.

As we now see, changing the competition in this way can have dramatic effects on what wins. In ''comprehension,'' it is possible for adult surface forms to be analyzed faithfully: no distinctions are lost. In ''production,'' it is possible for the same grammar to lead to massive loss of distinctions.[3]

In OT terms, this situation at first seems paradoxical: it would appear that faithful ''comprehension'' requires that FAITHFULNESS constraints be high-ranked, whereas massive neutralization during ''production'' requires that FAITHFULNESS constraints be low-ranked. Once the differences in competition are taken into account, however, this apparent paradox dissolves, resolved by prototypical OT constraint-ranking effects.

It should be clear that the topic here is not the full performance connotations of ''comprehension'' and ''production,'' but rather formal functions of a purely grammatical character, functions that pair underlying and surface forms with the mediation of structural descriptions. The grammatical mapping relevant for ''production'' has been the focus of OT work to date: given an underlying form, which structural description is it paired with, and what is its surface form? Of course, ''production'' in the full performance sense involves considerably more than just this grammatical mapping. Correspondingly, the grammatical mapping relevant for ''comprehension'' takes a given overt form, and specifies what structural description it is paired with, and what input is parsed by that structural description. This input contains morphologically structured underlying forms in phonology, and predicate/argument and operator/variable structures in syntax; such information is crucial to ''comprehension,'' but of course many other factors play important roles in that process as well.

[3] It seems likely that accounting for reorganization of perception and comprehension during acquisition will involve additional principles. But under reasonable assumptions, the current proposal need not immediately lead to the conclusion that comprehension is inherently errorless. For example, the loss of the ability to lexically discriminate using features that are noncontrastive in a native language might be consistent with the account presented here, under the additional grammatical assumption that underlying representations are unspecified for predictable material (which follows from one version of Lexicon Optimization discussed in Prince and Smolensky 1993), and the further extra-grammatical assumption that if a type of linguistic information is not encoded in underlying forms by the end of the critical period for native language acquisition, that type of information cannot later be reliably stored in lexical entries. The proposal made here would then entail that a Korean native speaker acquiring English late, when hearing *bear/bail,* will assign the structures [$_\sigma$ beːr]/[$_\sigma$ beːl] but will be unable to reliably distinguish the morphemes in comprehension, because recognition requires matching the assigned structures to stored lexical entries, and the lexical entries for the two items are identical, being unspecified for the *r/l* distinction. (Thanks to Bob Frank for suggestions along these lines.)

Under study here are functions that assign structural descriptions or grammatical parses. The point is that two different parsing functions are of interest, one relevant to ''production'' and the other to ''comprehension.'' What differentiates the functions relevant to language processing in these two directions is simply what information is given: underlying or surface form. With the understanding that ''comprehension'' and ''production'' will serve only to distinguish these two competence-theoretic functions, and for want of equally transparent alternative terminology, I henceforth retain the terms but drop the shudder quotes.

3 The Demonstration

The grammar we now investigate is none other than the initial state as loosely proposed in the OT acquisition literature: a hierarchy in which FAITHFULNESS constraints are outranked by markedness-defining structural constraints (Demuth, in press, Bernhardt and Stemberger 1995, Gnanadesikan 1995, Levelt 1995; for an explanation of this initial state based on general OT principles, see Smolensky 1996). In the phonological case, the latter constraints include NOCODA, ''syllables do not have codas'' (Prince and Smolensky 1991), which determines that closed syllables are marked relative to open ones; *DORS ''segments do not have the feature [dorsal],'' which determines that dorsal segments (like [k]) are marked (relative to coronal segments like [t], which violate *COR, universally lower-ranked than *DORS; Prince and Smolensky 1993, Smolensky 1993); and so on. The details do not matter here: what is crucial is that there is some structure, say, [$_\sigma$ ta], which is unmarked relative to other structures (e.g., [$_\sigma$ kæt]). With respect to the structural constraints, which I will encapsulate as STRUCH for *Structural Harmony*, [$_\sigma$ ta] is more harmonic than [$_\sigma$ kæt].

Potentially conflicting with STRUCH are the FAITHFULNESS constraints encapsulated as FAITH(FULNESS): these demand faithful parsing of the input, and unless the input happens to be /ta/, the demands of FAITH and those of STRUCH conflict. In the initial grammar, STRUCH dominates FAITH, so regardless of the input, only the most unmarked structures are produced: [$_\sigma$ ta]. This is shown in tableau 1; ''*'' marks constraint violation, ''*!'' a fatal violation. Candidates (a) and (b) are alternative parses of the input /kæt/: (b) is a faithful parse, pronounced [kæt], whereas (a) is pronounced [ta]. In (a) the first two input segments are unparsed and hence unpronounced; and the segment [a] is inserted in the output in violation of FILL, the FAITHFULNESS constraint demanding that syllable positions be filled with underlying material.[4] Parse (a) is favored by STRUCH (we assume), and since in this grammar STRUCH dominates FAITH, this is decisive: (a) is optimal (indicated by ''☞''), so underlying /kæt/ surfaces as [ta].

[4] What matters about structure (a) is that it is unfaithful and less structurally marked than (b); only this affects the outcome of competition with (b), so virtually all the details are irrelevant.

Tableau 1
Production: /kæt/ → ?

Candidates			Grammar	
Input	Surface form	Structure	StrucH: NoCoda, *Dors, ...	Faith: Parse, Fill, ...
a. ☞ /kæt/	[ta]	σ ⟨k æ⟩ t [a] /k æ t / [t a]		*
b. /kæt/	[kæt]	σ k æ t /k æ t/ [k æ t]	*!	

What may be less obvious is that the same grammar can be used for comprehension, and that the result is quite different (see tableau 2). I propose that the way a child hearing /kæt/ uses the grammar to analyze this surface form is exactly analogous to the way a child uses the grammar to produce /kæt/. What is *given* is the surface form, so the competing structures now are all those that are *pronounced* [kæt]: tableau 1's winning structure (a) is out of the running altogether. What the faithful parse (b) competes with now are structures like (c), an unfaithful parse of /skæti/ that is pronounced [kæt]. The violations of StrucH incurred by (b) (e.g., NoCoda), which were fatal in comparison with (a), are no longer fatal in comparison with (c), which shares the same structural violations: all structures pronounced [kæt] violate NoCoda, *Dors, and so on. By standard OT principles, the decision between (b) and (c) is thus passed to low-ranked Faith, which decisively rules in favor of (b) (here, the fatal violation is marked "¡*" and the winner "➻", in anticipation of tableau 3). What we have is McCarthy and Prince's (1994) *emergence of the unmarked*, with a twist: here, Faithfulness constraints have a chance to express themselves when higher-ranked structural constraints are not decisive, the reverse of the pattern extensively documented by McCarthy and Prince.

Tableau 2
Comprehension: [kæt] → ?

	Candidates			Grammar	
	Input	Surface form	Structure	STRUCH: NOCODA, *DORS, ...	FAITH: PARSE, FILL, ...
b. ➸	/kæt/	[kæt]	σ (k æ t) /k æ t/ [k æ t]	*	
c.	/skæti/	[kæt]	σ (⟨s⟩ k æ t ⟨i⟩) /s k æ t i/ [k æ t]	*	¡*

The contrast between production and comprehension is shown in tableau 3, which combines tableaux 1 and 2. FAITHFULNESS, too low-ranked to be active in production, operates decisively in comprehension, despite its low rank. Hearing [kæt], the child analyzes it faithfully as structure (b)—complete with marked segmental structure and marked syllable structure, entirely absent from her productions. This allows her to recognize the underlying form /kæt/ if it is a familiar lexical item, or to enter it into her lexicon, if it is not. (This is a version of Prince and Smolensky's (1993) principle of Lexicon Optimization; see also Itô, Mester, and Padgett 1995 for discussion.)

The proposed relation between production and comprehension can be summarized slightly more formally as follows. Let the universal set of all possible structural descriptions generated by the OT generator of candidates, Gen, be the set UGen: this set consists of all the candidate parses Gen (/ι/) for all universally possible inputs /ι/. Then:

(1) *Production and comprehension functions defined*

$$f_{\text{prod}}(/\iota/) = \textit{H-max}\{s \in \textit{UGen} \mid /\iota/ = \textit{Input}(s)\}$$

$$f_{\text{comp}}([o]) = \textit{H-max}\{s \in \textit{UGen} \mid [o] = \textit{OvertForm}(s)\}$$

The function associated with production takes an input /ι/ and assigns to it the structural description that has the maximum Harmony among the set of all those structures *s* the input part of which is /ι/ (this set is just Gen(/ι/), in fact). The function associated with comprehension

Tableau 3

Vive la différence

Candidates			Grammar		Functions using grammar	
Input	Surface form	Structure	STRUCH: NOCODA, *DORS, ...	FAITH: PARSE, FILL, ...	Production: /kæt/ → ?	Comprehension: [kæt] → ?
a. /kæt/	[ta]	σ ⟨k æ⟩ t [a] /k æ t / [t a]		*	☞	
b. /kæt/	[kæt]	σ k æ t /k æ t/ [k æ t]	*!			☜
c. /skæti/	[kæt]	σ ⟨s⟩ k æ t ⟨i⟩ /s k æ t i/ [k æ t]	*	¡*		

is exactly the same, except that it operates on an overt form [o] and considers only those structural descriptions *s* the overt part of which is [o].

4 An Illustration from Syntax

To better indicate the generality of the current proposal, I briefly present another illustration, based on the approach to *wh*-questions developed by Legendre et al. (1995) and Legendre, Smolensky, and Wilson (in press). Tableau 4 shows a sample grammar fragment loosely modeled on a stage of acquisition described by Thornton (1995), when English-learning children produce *medial wh*-phrases, obligatorily with nonreferential *wh*-phrases (candidate (a): *who do you think* ***who*** *the cat chased*) and optionally with referential (discourse-linked) *wh*-phrases (candidates (a′), (b′): *which mouse do you think* (***who***) *the cat*

Tableau 4

A stage in the acquisition of *wh*-questions (data from Thornton 1995:140)

Candidates		Grammar				Functions using grammar	
PF	Structure	MinLink$^{[-ref]}$	*e	MinLink$^{[+ref]}$	Fill	Production: Index → ?	Comprehension: (adult) PF → ?
who do you think **who** the cat chased	a. who$_i$ ... **wh$_i$** ... t$_i$				*	☞	
who do you think the cat chased	b. who$_i$ ... **e$_i$** ... t$_i$		*!				☜
	c. who$_i$ ... ... t$_i$	¡*!					
which mouse do you think **who** the cat chased	a′. [which mouse]$_i$ ... **wh$_i$** ... t$_i$				*	☞	
which mouse do you think the cat chased	b′. [which mouse]$_i$ ... **e$_i$** ... t$_i$		¡*!				
	c′. [which mouse]$_i$ ... ... t$_i$			*		☞	☜

chased). The role of phonology's input/underlying form is now played by what Legendre, Smolensky, and Wilson call an *Index:* a predicate-argument structure containing variables with given logical scopes. Candidates (a–c) have the same Index, as do (a′–c′), the difference is only that the *wh*-variable in the latter is referential whereas that in the former is not. The competing outputs include cyclic structures ((a), (b); (a′), (b′)) with overt ((a), (a′)) and empty ((b), (b′)) intermediate traces, as well as noncyclic structures ((c), (c′)). The constraints are as follows (see Legendre, Smolensky, and Wilson, in press, for details): *e, forbidding empty intermediate traces; FILL, forbidding a chain from having more than one overt member; and MINLINK, which uses OT optimization to force minimal links by forbidding a chain link to cross a barrier. The MINLINK constraints distinguish chains by referentiality, nonreferential chains violating universally higher-ranked MINLINK$^{[-\text{ref}]}$. Encapsulating the subtleties of MINLINK, the tableau simply registers that MINLINK favors cyclic chains: candidates (c) and (c′) respectively violate MINLINK$^{[-\text{ref}]}$ and MINLINK$^{[+\text{ref}]}$. The indicated grammar gives the child production pattern reported by Thornton (1995) (the two lowest constraints are separated by a dashed vertical line indicating equal ranking: this yields two optimal candidates, and hence optionality).

In comprehension of the adult pronounced form *Who do you think the cat chased?*, candidate (a) does not compete, since it has the wrong pronunciation: the winner in this nonreferential case is now (b). Even though the child never *produces* empty intermediate traces, her grammar provides an articulated theory of their distribution in adult forms. (The point here is the existence, not the correctness, of such a theory.) Her parse of the nonreferential adult PF contains an empty intermediate trace: she gives this chain a cyclic analysis. In contrast, a referential chain is analyzed as noncyclic: in comprehension of *Which mouse do you think the cat chased?* (a′) is not a competitor; (c′) wins, because it lacks an empty intermediate trace.

5 On the Role of Comprehension in Acquisition

The technique proposed above for the use of OT grammars in comprehension is crucial for acquisition theory in other ways. In Tesar and Smolensky 1996, this technique is dubbed *robust interpretive parsing* and is a central component of an OT learning algorithm. This algorithm starts with an initial grammar: as above, FAITHFULNESS constraints are dominated by structural constraints. The algorithm takes overt phonetic forms as primary data and performs robust interpretive parsing, as above, to assign these data full structural descriptions. Since these descriptions are based on an incorrect grammar, they are not initially correct, but they are used for the next step just the same. The full structural descriptions assigned to the overt data are then used in the Error-Driven version (Tesar, in press) of the Constraint Demotion ranking algorithm (Tesar and Smolensky 1993): whenever the structural description that has just been assigned to the overt data (comprehension) is less harmonic than the current grammar's output (production), relevant constraints are demoted to make the comprehension parse the more harmonic. This yields a new grammar, which the algorithm uses to repeat the whole process, reassigning structural descriptions to the primary data and then reranking constraints accordingly. The cycle is iterated repeatedly.

Crucial to this learning procedure and to the arguments presented above is the *robustness* of the proposed comprehension process: even when the input item being parsed is ungrammatical (suboptimal) according to a learner's grammar, that grammar can nonetheless be effectively used to parse it. This is what allows a child whose grammar only produces *ta* to correctly parse an unbounded number of phonetic strings, and what enables the learning algorithm to bootstrap a bad grammar into a better one, parsing data that it cannot generate and using these parses as targets for revising the grammar.

Robust interpretive parsing is essentially an application of Prince and Smolensky's (1993) principle of *Lexicon Optimization,* which states that if a learner must choose between alternative underlying forms that generate the correct phonetic form, the one to choose is the one that yields the maximally harmonic structural description for that phonetic form. The difference is that here the principle applies *even when the grammar is incorrect*—even when *no* underlying form will generate the correct phonetic form, because of inadequacies in the grammar. Robust interpretive parsing simply restricts competition to those candidates with the target phonetic form and picks the one with greatest Harmony according to the current grammar.

6 Conclusion

A fundamental claim of Optimality Theory is that a grammar is an evaluator of structural descriptions that combines universal constraints—criteria of markedness—to yield a language-particular formal definition of the relative Harmony—unmarkedness—of structures. Because structural descriptions contain both input and overt forms, optimizing Harmony is a principle that defines two related functions from a single grammar. Given either a fixed input or a fixed overt form, optimization assigns a structural description that respectively serves the abstract function of production or comprehension, now considered as part of competence theory. When a child's grammar deviates from the adult grammar, structures that are never produced using the grammar can nonetheless be correctly analyzed, using the same grammar, in comprehension of the adult language.

If grammars are procedures for the sequential derivation of surface forms from underlying forms, grammatically relating production and comprehension is quite difficult. In addition, child grammars become more complex than adult grammars: the least complex derivations are those with output most faithful to input, and the least marked outputs require the most complex derivations to generate. If grammars are parallel optimizations over structural descriptions containing both input and surface forms, however, a grammatical relation between comprehension and production is completely natural; furthermore, an initial grammar with low-ranked FAITHFULNESS gives child language production its highly "unfaithful" character, with no increase in grammatical complexity (see also Burzio 1995, Gnanadesikan 1995). If grammars are sets of parameterized inviolable constraints, it is difficult to see how, with a single grammar, children could display one set of parameter settings in their productions, while correctly processing adult forms requiring different settings. If grammars are hierarchies of ranked violable constraints, on the other hand, we expect that children will sometimes correctly process structures they do not produce, because the differences in competitor sets allow constraint interactions masked in production to emerge as decisive in comprehension.

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