Where is pragmatics in optimality theory?

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Abstract

Abstract This paper deals with the architectural issues of pragmatics within an overall account of natural language in optimality theory. It is argued that pragmatics can be seen as an optimisation problem described by its own constraint system which lies outside the constraint system that defines grammar (the production oriented OT models of syntax and phonology). Speaking and hearing both involve grammar and pragmatics, but in different ways. The paper argues against the popular view that grammar and interpretation should be mixed into a symmetric constraint system and connects the proposed architecture with the views that underlie the motor theory of understanding and the mirror neuron theory of the understanding of behaviour.

1. The Meaning of Production

Optimality theory [Prince and Smolensky, 1993] can be seen as a modern version of Jakobson's markedness theory. In the very concept of an optimisation problem, there is a concept of blocking: some regularity is broken because in the particular case there is a better solution. *Gooses* is ruled out by the "better" *geese* and all the theorist has to do is to explain why *geese* is better. These explanations take the form of a system of constraints, a set of demands on outputs relative to a given input that are linearly ordered by strength. The regularity will always exist, but stronger constraints prevent it from emerging in the particular case.

Though it is not particularly hard to come up with explanations of this kind in phonology and syntax, this is not the business of this paper. For successful treatments of phonology see [Prince and Smolensky, 1993] and most of the Rutgers Optimality Archive, for syntax an interesting collection is [Dekkers et al., 2000]. The starting point of this paper is the assumption ---really an assumption since many issues remain unresolved--- that comprehensive treatments in optimality theory of phonology, the lexicon and syntax are possible. That successful treatment would allow mapping any meaning to its optimal pronunciation by a function F defined by the constraint system. The inverse of F would be the interpretation function F^{-1} and would deal with semantics and pragmatics. Linguistics would be finished!

While this would be nice, there are some problems.

A first problem is the role of the context. A proposition like *Tim is happy* can be expressed in a number of ways depending on the context.

(1)   Yes.
                He is.
                So he is.
                He is however.
                He is too.
                He is happy.

...and happy.
Tim is happy.

The variation depends on the conversational setting (e.g. did the interlocutor ask: Is Tim happy?) on the degree of activation of Tim in the context and on the degree of activation of the predicate *be happy* and on the presence of reasons for thinking he might not be happy (*however*) or other happy people (*too*). Intonational variation is not included in the example, but would give rise to a whole range of further variation.

With this addition, F^{-1} will assign sets of pairs of contexts and meanings and since the interpreter presumably knows the context, the possible meanings of the utterance u in the context c can be defined as the set $\{m: u$ is optimal for m in $c\}$.

Even with this addition, there are problems. First of all, there exists semantic blocking next to the production blocking discussed before. These are examples like:

(2)   a. Katja and Henk$_i$ were surprised that the journal rejected each other's$_i$ papers.
            b. Katja and Henk$_i$ were surprised that the editors$_j$ rejected each other's$_{j/i}$ papers.

(3)   Poor Jones kicked the bucket. (non idiomatic)

(4)   Jones sat down on the bank (financial institution)

(5)   John has three cows. (the at least 3 reading)

(6)   How late is it?

In 2b *each other* cannot take the antecedent it takes in 2a, because the antecedent *the editors* is strongly preferred. In appropriate contexts, 3 will be interpreted in the idiomatic way with blocking of the literal context (this example is slightly problematic: it has been argued that this sort of idiom always evokes the literal meaning. The literal meaning is there in one sense, but it is not there as the intended meaning.) In 4 the difficulties of sitting down on financial institutions repress that meaning of *bank*. 6 is related to syntactic blocking. It seems that because this should have been said as *what time is it?*, it cannot have the meaning that according to compositional semantics it should have.

The problem with the interpretation function F^{-1} is that it is not given as an optimisation problem and that thereby it is unable to implement the idea that there are better interpretations that block the blocked interpretations.

[Hendriks and de Hoop, 2001] shows that it is fruitful to think of interpretation as an optimisation problem and that interestingly it needs to take account of all the formal factors involved in production: syntax, lexicon, intonation and context. It is hard to see how traditional accounts of semantics could deal with the problems that are dealt with in the paper.

A further problem comes from the proper application area of pragmatics. Pragmatics proper needs to deal with problems such as interpretation preferences given the context, stereotypicality effects, resolution of anaphora and presupposition and implicatures arising from relevance and other sources. These factors cannot be dealt with in production. The pragmatically dispreferred interpretations can

still be possible inputs in the context and so would be mapped by *F* to the utterance. The utterance however will not have the interpretation in the given context, though it may well have it in another context.

Take for example the familiar defaults about presupposition resolution and accommodation. The production constraint on the use of a trigger like *regret* should be limited to the requirement that the local context entails the complement, in 7 that Tim married Mary. The two interpretations 7b and 7c therefore seem to be alright if the context does not have the information that Tim married Mary. And in fact, in a context in which it is entailed that the speaker does not know that Tim married Mary (e.g. because it contains information that he did not) 7b is the right interpretation while in contexts in which the speaker could know this, 7c is the best interpretation. Restrictions on production alone cannot give this preference.

(7)   a. If Tim regrets marrying Mary, I would be surprised.
                 b. If Tim has married Mary and regrets it, I would be surprised.
                 c. Tim has married Mary and if he regrets it, I would be surprised.

The considerations above lead into a confusing situation. Suppose, following [Hendriks and de Hoop, 2001] that a constraint system SEM can be developed that defines a function *G* analogous to the function *F* that can be defined from the production OT constraint system, but this time from utterances in a context to interpretations. *F* and *G* must be related but how? There are two implications that seem plausible ways of relating the functions:

$u \in F(m,c) \rightarrow m \in G(u,c)$
$m \in G(u,c) \rightarrow u \in F(m,c)$

The presupposition example gives a counterexample to the first implication. But fortunately counterexamples of this kind can be ruled out by restricting *F* to *G*:

$F'(m,c) = \{u \in F(m,c): m \in G(u,c)\}$

(This seems a vindication of the pruning strategy proposed by [Blutner,2001]. It will however turn out in section 3 that pruning as practiced also cuts out perfectly healthy branches.)

In this restriction, the speaker is pictured as somebody who steps into the hearer's shoes and disallows possible utterances that will be misunderstood.

How about the second implication? Doubt is cast on the principle by the familiar fact that language users understand many utterances they would never produce, both at any stage of acquisition and afterwards. This can in the context of OT be dealt with: an OT constraint system does not just define the best utterance, but it also induces an ordering over the set of all possible utterances. All that needs to be done is to exploit this ordering in the following way.

$m \in G'(u,c)$ iff there is no $m' \in G(u,c)$ such that *u* is better for *m'* then for *m* in the production system.

In this definition it is the hearer who is charitable: no matter the quaintness of the speaker's way of expressing herself, the hearer makes the best of it.

G' and F' are improved versions of F and G and it can be shown that $F'^{-1} \subseteq G'$.

Can F' and G' be implemented by constraint systems? There are two proposals here. The first is known as bidirectional optimality theory and is quite popular, with Boersma, Blutner, De Hoop, Hendriks, Spenader, Bouma and De Swart coming out in favour of it. The idea is to have a single constraint system comprising the production systems and semantic constraints that computes both F' and G' by computing the best utterance for a meaning and by computing the best meaning for an utterance. There are two flavours of this idea, that are often not well distinguished. In the first flavour, the computation of the meanings or forms is conditioned by the computation in the other direction. In the strong version, m is optimal for u if m wins the competition for u and u wins the competition for m. It follows that m can only be optimal for u if u is optimal for m. (I will not discuss the weak version here.) In the second flavour, the constraint system itself is assumed to be symmetric: it has the property that u wins for m iff m wins for u.

I will come back to these proposals in section 4 after here presenting my own proposal, the motor theory of language understanding. In this theory, production OT is adopted without any changes. It is after all possible to give illuminating and correct descriptions of phonology and syntax by production constraint systems. These production systems -taken in conjunction- also define grammar: the relation between form and meaning in a context[1]. On top of that there is pragmatics: a separate optimisation problem in which it is decided which of the grammatical meanings of a given form is to be preferred.

The production systems are learnt by the users of languages and have emerged from language evolution. OT gives an account of] the plasticity in learning: next to the lexicon, it is only the ordering of the constraints, and so restricts the learning problem and the typological possibilities. The pragmatic system in contrast does not need to be learnt and has been exapted as is: it is the system with which humans and their ancestors make sense of intentional communicative behaviour directed at themselves and, as such, it predates language. Section 2 gives an brief introduction to this style of OT pragmatics.

A similar proposal has been made in the context of OT phonology by [Hale and Reiss, 1998] and it has a problem that my proposal has to face as well. There is no optimality theoretic account of how the production system is inverted. And this has repercussions for popular views of OT learning such as [Boersma, 1998] or [Tesar and Smolensky, 1998]. My original view was that this is just a question of computation and a solved one moreover. [Frank and Satta, 1998] and [Karttunen, 1998] get very close[2] to showing that OT phonology can be inverted by compiling the finite state transducers. One can similarly use one of the popular stochastic parsers ([Manning and Schuetze, 1999] to come up with reasonable candidate interpretations that can be checked against production. These technologies are there and can be used without any problem for OT learning. The only thing that matters is whether one's own production for the understanding can match the utterance or not.

It is however not at all obvious that not having an OT account of the inversion of production and having to rely on what appear to be engineering approaches in this area is such a problem. The first consideration is that in natural language parsing and even more strongly in speech perception one should have very serious doubts whether rule-based approaches are practically feasible at all and if they

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1 One can conceptually add pragmatics to grammar, as in the definition of F', but then grammar is no longer given by a OT production system alone. I prefer to call grammar, and pragmatics pragmatics and to refer to the integrated notion as speaking. This is not speaking as it is practised around us but an idealisation, the behaviour of undisturbed competent speakers.
2 The construction needs an upper bound on the number of errors that a given constraint can assign to a candidate. This is not pure OT, but it gets very close.

were, whether they are as learnable as the stochastic approaches that have become standard in these areas.

What is more, stochastic recognisers can be in principle be made to have the same bias as the pragmatic constraints I will discuss later: it is just a question of choosing the appropriate stochastic variable they should minimise. And getting them to be like that merely increases their similarity to what we seem to understand about the working of our brains: contextual activation and associative processes are central in their operation and central to perception. For the pragmatics of section 2, a case can be made that it is nothing else but context-driven perceptual bias in the distal perception of the speaker intention.

So there is a good case for not taking these stochastic parsers as just engineering tools that have to be used because there are no proper tools yet or not enough of them, but as approximate models of what goes on in human speech and language recognition. The OT production models and OT pragmatics can help in making them better approximations of what goes on in human language perception.

The second consideration comes from the discovery of mirror neurons. This research originally showed that in the F5 pre-motor cortex of rhesus monkeys there is a class of neurons that fire both when an action like grabbing an object or tearing it up is planned but also when the monkey perceives another organism do the same thing. What it shows in short is that the part of the brain that is responsible for planning the action plays a presumably important role in the perception of the same action. Presumably important, because otherwise the brain would not have evolved to create this activation pattern in perception. Meanwhile mirror neurons have been discovered in many other parts of the brain and in many other species, including humans. [Rizzolatti and Arbib, 1998] speculate that F5 is the precursor of Broca's area. Mirror neurons open the door for accounts of understanding behaviour of other organisms by reconstructing it as behaviour of oneself.

In speech recognition, Alvin Liberman (e.g. [Liberman and Mattingly, 1985]) is the author of the motor theory of speech perception. There is some debate about this theory in speech perception but Liberman's theory is rather minimal. It holds first of all that perception of speech is distal perception of the articulatory gestures that the speaker makes in producing the speech. Liberman came to this theory because he thought these were the real invariants in speech: the acoustic signal is too much spoilt by biological differences between people and by coarticulation. The debate on the motor theory of speech perception is about the proper invariants in the speech signal and there are arguments for thinking that Liberman was wrong or partly wrong. The second part of the theory was largely speculative when Liberman formulated it but is now abundantly confirmed. It is that the articulatory parts of the brain play a prominent role in speech perception. I am hardly a speech technologist, but it would seem to me that if it is correct to identify phonemes as bundles of articulatory features and if one tries to take the standard hidden Markov model speech perception seriously from a cognitive perpective, then what happens in that approach is distal perception of phonemes, by trying to maximise the probability of a certain phoneme as causing the signal multiplied with the probability of the phoneme in the context. The discussion about invariants is hardly relevant for taking Liberman's theory seriously in this respect. An important element of Liberman's argument is *parity*. The idea is that in a communication system it should be possible to explain how the sender and the receiver can converge on the same signal. In the case of speech, for the speaker the signal is a complex of articulatory gestures, for the hearer an acoustic signal. There must be some point at which the speaker and the hearer agree on the identity of the signal. Liberman's proposal is that the hearer reaches identity by recognising the articulatory gestures. The truth may be more in the middle, but reconstruction of the articulatory gestures is still part of reaching parity.

Another forerunner of these thoughts (around the same time as Liberman) is Grice. In [Grice, 1957], non-natural meaning is defined in terms of intention recognition. It follows from that definition that communication fails, if the hearer does not recognise the intention. But it seems a mystery what intention recognition is. I used to be quite puzzled by what this could be. It now seems quite obvious: the hearer should reconstruct the whole action of the speaker in producing the utterance as a possible action of one's own. If the reconstruction is successful, it is a recognition of the speaker's intention and a side effect would be the reconstruction of all the judgments that underlie the various choices the speaker made in producing the utterance.

The absence of an OT-based account for the reversal of production OT is therefore not a problem but an asset. It allows general perceptual mechanisms to take over and the motor theory of understanding makes it understandable how this could work: the perceptual mechanisms distinguish different possible states of the production system. It is therefore the simplest and most natural explanation of parity.

2 The OT Pragmatic System

This section gives a brief overview of the optimality theoretic pragmatic system on top of production OT. More elaborate treatments are [Zeevat, 2001], [Zeevat, 2007b] and [Zeevat, 2007c], while [Zeevat, 2007a] takes up the consequences for presupposition projection.

The pragmatic constraints can be seen as a definition of what is marked in interpretation. First of all, the interpretation of the utterance must be an explanation of the utterance. The speaker must understand from the interpretation why it was made and why it led to the particular signal that was produced. The interpreter can judge the quality of the explanation in this respect because the interpreter is also a speaker and knows the context and can consequently simulate the production. In the theory of this paper, production OT defines the rules of the process, starting at the maximally abstract level (the intention of the speaker) and going down to the level of the speech. Marked according to this constraint are any deviations from what is overtly given in the utterance. One of the predictions from this principle is therefore that non-literal interpretations only occur if literal interpretations do not succeed.

The second constraint is plausibility. It should not be the case that there is an equally good interpretation that is more plausible. In this notion of plausible there should be several layers. One level is purely linguistic: if there are ambiguities, the most likely interpretation should be chosen based on probabilities given in language use. The other side of plausibility is the probability of the message in the context. This can go from the context ruling it out entirely to its being surprising in the context and from there to it being expected or fully known. The last cases are the unmarked ones. The most unmarked is the most expected. FAITH however does not allow interpretations of an utterance in which there is no point to the utterance.

The third contraint *NEW enforces conservatism with respect to the context. If referents have to be assumed in the interpretation, one should always prefer the referents with the highest activation level possible. Fully new referents come last. Given that interpretations have referents of various kinds (objects, moments of times, events and states and maybe even topics) this forces maximisation of coreference. The unmarked case is that the utterance stays with the entities and topics that were under discussion.This fits with the idea that most unmarked rhetorical relation is the *restatement* relation as shown by [Jasinskaja, 2007].

The last constraint, relevance, prefers interpretations which help to achieve current goals of the

conversation or which settle questions that have been activated. From the perspective of this constraint what is unmarked makes sense with respect to the goals of the conversation. Digressions and attempts to address a new topic are special.

1. FAITH: there is no interpretation for the utterance for which the hearer ---putting herself in the position of the speaker---could have produced an utterance that is closer to the given utterance.

2. PLAUSIBLE: maximise plausibility (an interpretation is bad if there is a more plausible interpretation that is otherwise equally good)

3. *NEW: old referents are preferred over connected referents which are preferred over new referents.

4. RELEVANCE: let the interpretation decide any of the activated questions it seems to address.

The constraints must apply in this order. FAITH should be able to override any of the concerns of the other constraints. PLAUSIBLE is ---in its form of a consistency checker--- a well-known constraint on pronoun resolution and on relevance related implicatures, including presupposition accommodation. The placement of *NEW over RELEVANCE can be argued from presupposition accommodation: *NEW says that presupposition resolution is always preferred even if a more relevant reading can be reached by accommodating as in 8.

(8)   If John is rich, his wife must be happy
            If John is married, his wife must be happy.

While it would definitely help in settling the question whether John is married (achieved by a global accommodation), as in 8a, resolution is possible in 8b which makes accommodation impossible.

The system follows the architecture of relevance theoretic pragmatics: it can be interpreted as adding information to underspecified interpretations. The speaker however is monitoring the pragmatic effects her utterance may have and will change the utterance if unwanted effects are predicted.

The system can be used to interpret non-linguistic communication without any essential change.

As an example, consider the following situation. John stands by the road waving with his jacket at me. I should be asking myself first when I would be standing by the road waving my jacket at me? This is FAITH: it requires me to have an explanation. The possible answers should be weighed by plausibility and better answers should be selected over less plausible ones (PLAUSIBLE). I should then be wondering about the new elements in my explanation, can they be eliminated, can I connect them to already known things (*NEW). And if there are activated questions, can John be settling them by his waving (RELEVANCE)? If one supposes that we were looking for a lost cow, the proper explanation may be that John has seen it and that he is indicating where it is. The jacket waving then means: I found the cow. Here it is!

The first three constraints can also be understood as an OT account of explanation in general. FAITH should then be reinterpreted as the check that what is offered as an explanation would in fact have caused the explanandum. The other two constraints then maximise the plausibility of the explanation and minimise the new assumptions occurring in it.

This paper does not have space to apply the constraint system to the whole field of pragmatics and ---

anyway--- the relevant areas are covered in the papers referred to above. Only some examples will be given therefore. But the constraint system has the ambition to cover the whole of pragmatics and this appears to work: the same principles play a role in rhetorical structure, in presupposition resolution and accommodation, in implicature projection, and in pronoun resolution. This cannot be avoided within OT methodology: a constraint cannot just be switched off when one goes to a different area of pragmatics. The constraints are generalisations from assumptions in the standard Heim/Van der Sandt theory of presupposition projection ([Heim, 1983], [Van der Sandt, 1992]) and it was quite surprising that they turn out to have an explanatory value on rhetorical structure, pronoun resolution and implicatures, areas that these researchers on presupposition did not take into account in these papers.

Example 1: The pronoun "she".

The production system allows the pronoun only for singular referents with female agreement and a high level of activation. This high activation level can be due to the non-linguistic context, but more commonly to mention in the pivot or in the current sentence. The production system also prefers "she" if the conditions on its use are fulfilled. Production monitoring for the reference feature prevents "she" from being used for Mary after examples like:

(9)   Mary and Jane went to the cinema.

FAITH guarantees that the possible referents are highly activated, otherwise the use of "she" cannot be explained.

PLAUSIBLE can rule out antecedents.

*NEW's only role with respect to the pronoun is to guarantee that there is not a higher activated suitable antecedent.

RELEVANT can decide between equally ranked antecedents.

Example 2: "a new rucksack" as in 10.

(10)   Bill went to Spain. He bought a new rucksack.

The production system prefers the indefinite marker on the rucksack only if the conditions for definite marking are not fulfilled. One of these is that there is no unique description available and in particular that "new rucksack" is not a unique description of the referent. It allows "a new rucksack" only if the referent is a new rucksack.

FAITH reconstructs these considerations. The referent must be new to the context (otherwise there would be a definite alternative) and "rucksack" is not a unique description. Together this forces the construction of a new discourse referent for the rucksack.

*NEW prefers a connected discourse referent to a fully new one. Since rucksacks play a enabling role in traveling, the inference is reached that this is the rucksack Bill used in traveling to Spain. Since the rucksack cannot be used before it is acquired, this also forces the buying to be before the traveling. (The reasoning around the buying event is similar, and it is hard to say in which order the inference is actually reached).

RELEVANT is responsible for answering the question why Bill bought the rucksack and so for placing the buying in the preparatory phase of going to Spain. And for exhaustivity implicatures: he bought nothing else of the same
significance in his preparation.

Example 3: the particle and sentential conjunction "and"

(11)   Bill left. And Martha followed him.

As argued in[Jasinskaja and Zeevat, 2007] "and" is a strongly grammaticalised additive marker ("also" is less grammaticalised, "in addition to that" not at all). It imposes on its use in a clause that there is another clause belonging to the same topic which is distinct from it. The grammaticalisation makes it possible that this is not really so, but only according to a prominent view in the context. This covers the cases in which it is allowed. Monitoring must be assumed for the "additive" feature: same topic, different element and this would entail that "and" or a replacement is obligatory in certain cases.

FAITH reconstructs these considerations. In particular it forces the identification of the shared topic and of the other element, the assumption of distinctness between the identified element and the current one or identifies the view under which they are distinct.

"And" belongs to the particles which switch off *NEW through FAITH. But *NEW still forces a preference for the most activated antecedent for "and" and can thus be made responsible for the formation of the version of "and" in which it is a sentential conjunction.

3. **Speaking and Hearing**

A speaker is also a hearer and as such can bring in expectations about how she is going to be interpreted into the decisions about the form of what she is going to say. There is a proviso here: the formal possibilities for going to a different formulation should be there and sometimes they are not.

(12)   Welches Maedchen mag Peter?
             Which girl likes Peter/does Peter like?

In 12, the word order dimension has been exploited to mark the sentence as a question and to mark the **wh**-element by fronting the **wh**-NP. That means that unlike in (13), it cannot be used again for marking the subject. As a result, the sentence is ambiguous: Peter can be the subject or the object.

(13)   Peter mag Maria.
             Peter likes Maria.

In 13, there is a strong preference for canonical subject object order which marks Peter as the subject (case marking and agreement do not mark it in this case.) This means that the word order dimension is again fully used and not available for a third task to which it may be set: the marking of contrastive topics, as in 14 ("er" is the nominative of the male pronoun).

(14)   Maria mag er. (Aber nicht die Christina).
             He likes MARIA (but not Christina).

The strong preference in 13 can be explained as the speaker monitoring the hearer: the speaker checks whether the hearer can find out who likes who and if necessary adjusts the word order to subject before object. In 14, this is taken care of by the case marking and no adjustment of word order is necessary.

A formulation in which monitoring is absolute (the speaker refuses a formulation unless it is guaranteed that the hearer will understand it correctly, i.e. the version F' of F from section 1) will lead to problems. 12 will be disallowed unless *welches Maedchen* is the subject, 13 will be disallowed when *Maria* is the contrastive topic (assuming monitoring for the expression of the contrastive topic).

Monitoring seems to happen in this moderate way and with priority for certain features over others. It is about the phenomenon of optional marking and the explanation of why certain optional marking strategies are obligatory when they occur in a larger text.

$F \cap G^{-1}$ as proposed in section 1 is therefore too strong. It does not need to be so strong either in the current perspective. Interpretation outperforms speaking. If one can prevent confusion by marking one should do so. But if marking is impossible or hard, it is still more likely than not that the understanding will nevertheless be correct.

In interpretation there is no corresponding monitoring in the motor view: understanding is identical with finding the least marked reconstruction of speaking. Understanding is identical to what would be monitoring.

4. **Parity**

[Smolensky, 1996] is one of the earliest applications[3] of bidirectional or symmetric OT and it attempts an explanation of why young children can understand things they cannot produce yet. To borrow one (made up) example, the child will produce the name Kate as /ta/ but will understand /kaet/ as Kate[4] and /ta/ as "ta". The imperfect production is explained by the high ranking of markedness constraints with respect to faithfulness constraints. This will produce low marked forms in production, but since markedness constraints do not play a role in understanding, faithfulness will produce understandings that are similar to the adult case. Language learning then demotes the markedness constraints until the point where a symmetric system results.

[Hale and Reiss, 1998] is an attack on the whole line of reasoning of Smolensky's paper, but especially on the idea that production should be inverted and that symmetry of the constraint system will eventually result. To show this, a simple counterexample is given: the two German words *Rat* and *Rad* that share their pronunciation /rat/ due to FINAL DEVOICING, a constraint outranking FAITH(VOICE). In the production direction this gives a correct description of the phenomenon, but in the interpretation direction, the interpretation *Rad* for /rat/ will incur a FAITH(VOICE) error that the interpretation Rad does not get. The adult constraint system is therefore not symmetric and no degree of further learning will make it so. And one cannot prune it into symmetry by means of bidirectionality,

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3 The idea comes from OT learning: high markedness constraints and low faithfulness constraints produce a robust parser in the opposite direction and a learning mechanism based on it can demote the markedness constraints.
4 This is demonstrated presumably, by semantic understanding of the name: the child will look at Kate. I am forced to claim that stochastic understanding is in place already. The sound /kaet/ is associated with *Kate*. The imperfect rendering of *Kate* as /ta/ is a learning datum which will demote the markedness constraints. At this stage, classification by production cannot play a serious role yet.

since then *Rad* with its pronunciation /rat/ just disappears. Hale and Reiss have an important conceptual point. No ambiguity should ever be resolved by the inverse competition. This is not how ambiguities are resolved, they are solved by semantic considerations and not by phonology or syntax. Inverting production competitions will however just open the possibility that they will.

The Rat/Rad problem also establishes two negative conclusions about parity. Just running the inverse competition with the production constraints does not establish parity unless the system is symmetric. And bidirectional pruning also does not does not give parity on a correct but asymmetric system: it makes a correct production system incorrect.

The solution proposed by [Boersma, 2001] is the only proper one: add sufficiently many semantic constraints to make the constraint system symmetric without destroying the behaviour in the production direction.

Unfortunately, there is no theorem that says that this can always be done. Boersma's example is Dutch phonology taken as a finite relation between lexical items and surface forms. And for finite relations, one can prove that semantics can be done by a semantic OT constraint system such as the one proposed by Boersma. From this constraint system, one can then construct the symmetric system. But can this be generalised to the infinite case? And I am not sure either that Dutch phonology should be seen as a finite problem. It seems that a proper account of Dutch phonology should also predict that the phantasy pronunciation /tat/ is ambiguous between the phantasy words *tat* and *tad*.

So, the problem of there being a symmetric system incorporating any given correct production system is fully open. And full symmetry has the problems noted in section 3, if the pragmatics of section 2 is integrated.

While there is no theorem, there is also no counterexample to the claim that any correct production system can be inverted by another constraint system. But I have an argument against the claim that there always is. Languages like Dutch, English or German have acquired a vast functional inventory by a process that is called grammatical recruitment of originally lexical words. This would happen in the cultural evolution processes that shaped these languages and would require a functional explanation. The simplest explanation is that recruitment happens to improve the chance that one is understood properly: partial recruitment leads to improved understanding which leads to increased reproduction of the recruited item in its new role. Now how could this ever happen if the production system has a perfect OT inverse? Very much the same point can be made from the study of dialogue as in [Clark, 1996]. One of the clearest findings in that work is that there are powerful feedback mechanisms to monitor proper understanding and supply feedback. This would be fully unnecessary with full symmetry.

It would therefore seem that the motor theory of understanding is so far the only of the views considered in this paper that can account for parity in the adult system.

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