Unfaithful conduct: A competence-based explanation of asymmetries between production and comprehension

Petra Hendriks
University of Groningen

Abstract

Children’s production skills in their native language do not always develop in tandem with their comprehension skills. In some cases, children’s comprehension is adult-like, while their production is still poor. In other cases, the situation is the other way around and children’s production is adult-like, while their comprehension is still poor. Optimality Theory is able to provide a competence-based explanation for these asynchronies in children’s language development because optimization is direction-sensitive. As a result, an OT grammar may yield a different mapping between form and meaning in production than in comprehension. This paper explores which configurations of constraints predict such asymmetries between production and comprehension. It is argued that asymmetries arise from various configurations of constraints and are resolved by the OT learning mechanisms of constraint reranking and bidirectional optimization.

1. Introduction

In language acquisition research, it is commonly assumed that children’s mastery of the forms of their native language goes hand in hand with their mastery of the meanings associated with
these forms, or, if there is a mismatch, that children’s production of a form lags behind their comprehension of this form. However, several exceptions have been observed to this pattern, suggesting that adult-like production can also sometimes be ahead of adult-like comprehension. Such asymmetries between production and comprehension pose a major challenge to rule-based and usage-based grammars. If a child produces a form correctly and thus shows that it possesses the relevant linguistic knowledge, then why is the child not able to interpret this form correctly?

A well-known asymmetry between production and comprehension in child language is the asymmetry between young children’s initially poor pronunciation of words and their apparently correct comprehension of the same words. According to Smolensky (1996), this asymmetry can be given a straightforward explanation within the constraint-based grammar Optimal Theory (OT) (Prince & Smolensky, 1993/2004). This is because in OT production the input meaning is fixed and only forms for expressing this meaning compete. In OT comprehension, on the other hand, the input form is fixed and only meanings for this form compete. As a consequence of these different competitor sets in production and comprehension, optimization in phonological production may yield a different form-meaning pairing than optimization in phonological comprehension.

Several other asymmetries between production and comprehension in child language have been explained along similar lines, including cases where production precedes comprehension. This paper addresses the question what properties of the OT grammar allow for a competence-based explanation of mismatches between forms and meanings. A fundamental distinction in OT is the distinction between faithfulness constraints and markedness constraints. Whereas faithfulness constraints demand identity between input and output and can thus be said to promote symmetry, markedness constraints demand unmarked outputs and hence appear to promote asymmetry. This paper investigates what combinations
of constraints under what rankings are predicted to give rise to an asymmetry between production and comprehension. It is argued that asymmetries emerge from two fundamental properties of OT that are absent in rule-based linguistic frameworks: the violability of faithfulness constraints, which can be overruled by stronger constraints of the grammar, and the possibility of underspecification of form-meaning correspondences. As a consequence, OT grammars are inherently asymmetric.

One configuration of constraints giving rise to asymmetries was already identified by Smolensky (1996). Smolensky argues that initially markedness constraints on surface form are ranked too high in children’s grammar and dominate the relevant faithfulness constraints. This explanation of young children’s mispronunciation of words they already understand is presented in more detail in Section 2. Asymmetries between production and comprehension are not only observed in lexical acquisition, but also in the acquisition of syntax and semantics. Such asymmetries involve delayed production relative to comprehension, but can also involve cases where comprehension is delayed relative to production. Several of these latter asymmetries and the configurations of constraints giving rise to these asymmetries are discussed in next sections. The discussed asymmetries concern the relation between argument structure, on the one hand, and the way argument structure is signaled through word order or referential choice, on the other hand.

2. Optimization is direction-sensitive

Young children frequently produce non-adult-like reduced word forms, but at the same time seem perfectly capable of understanding the meanings of these words. For example, they may say *ta* when referring to a cat, while clearly understanding what the word *cat* refers to when it
is uttered by someone else. This mismatch between young children’s production skills and their comprehension skills has been attributed to performance factors such as children’s underdeveloped motor control. If children produce reduced forms due to underdeveloped motor control or some other performance reason, we would expect them to produce these reduced forms across the board. However, this does not seem to be the case. Instead, children seem to produce reduced forms in some cases but not in others, showing linguistic systematicity. For example, Smith (1973) discusses his son’s phonological acquisition and gives examples in which the child produces puzzle and sick as puddle and thick, but produces puddle and thick as puggle and fick. If the child is unable to produce puddle and thick in the latter case due to underdeveloped motor control, we would expect him to not be able to produce these same forms in the first case either. These examples pose a challenge for performance-based accounts of syllable reduction and suggest that the mismatch between production and comprehension requires a competence-based explanation instead.

Smolensky (1996) provides a competence-based explanation for this mismatch within the linguistic framework of OT. In Smolensky’s explanation, a crucial role is played by markedness constraints such as in (1).

(1) Markedness constraints (MARK):

   NoCODA: Syllables may not have codas.

   *DORS: No dorsal segments.

The markedness constraint NoCODA is violated by any syllable with a coda: a consonant following the vowel. The constraint *DORS is violated by any segment with a dorsal feature, such as [k]. As a result, these constraints encode a preference for syllables without a coda and without dorsal segments, which are cross-linguistically unmarked, over syllables with a coda
or dorsal segments, which are cross-linguistically marked. Importantly, as markedness constraints are output-oriented, this preference is independent of the input to be expressed. Hence, these markedness constraints promote reduction of syllables.

If the input contains a coda or a dorsal segment, the markedness constraints in (1) are in conflict with faithfulness constraints such as in (2).

(2) Faithfulness constraints (FAITH): \(^1\)

PARSE: Every element in the input must be expressed in the output.

FILL: Every element in the output must be present in the input.

These faithfulness constraints demand that the input to the grammar and the output of the grammar are maximally identical. The faithfulness constraint PARSE is violated by deletion of a segment in the output that is present in the input. The constraint FILL is violated by insertion of a segment in the output that is not present in the input. These constraints thus prohibit reduction of syllables, as any omission of a segment results in a constraint violation.

Suppose a child wishes to pronounce the word *cat*, which is stored in her mental lexicon as the underlying form /kæt/. Possible surface forms for this underlying form /kæt/ include the faithful surface form [kæt] and the reduced surface form [ta]. The reduced form [ta] clearly differs from the underlying form /kæt/. Whether the child chooses the reduced form [ta] or the faithful form [kæt] depends on the ranking of the constraints. If the markedness constraints outrank the faithfulness constraints, it is more important to satisfy the markedness constraints than it is to satisfy the faithfulness constraints. In that case, the less marked but reduced form [ta] is the preferred form. Alternatively, if the faithfulness constraints outrank the markedness constraints, it is more important to satisfy the faithfulness constraints. In that case, the child will choose the faithful non-reduced form [kæt].
Children’s production of reduced forms can thus be explained by a non-adult ranking of the constraints of the grammar. If in children’s grammar the markedness constraints outrank the faithfulness constraints, children are predicted to produce reduced forms. This is illustrated in Tableau 1.

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>MARK: NOCODA, *DORS</th>
<th>FAITH: PARSE, FILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>/kæt/</td>
<td>[kæt]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>* /kæt/</td>
<td>[ta]</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Tableau 1. Children’s non-adult-like production of the underlying form /kæt/

The input to optimization (the forms in the first column in the tableau) are fixed, while potential outputs for this input (the forms in the second column) compete. Because the markedness constraints NOCODA and *DORS are ranked highest, violation of these constraints by the candidate [kæt] is fatal. As a result, the reduced candidate [ta] is the optimal output. In the adult grammar (not illustrated here), the faithfulness constraints outrank the markedness constraints. This results in the faithful candidate [kæt] being the optimal output, as the violation of the faithfulness constraints by the reduced form [ta] is now fatal.

An important insight due to Smolensky (1996) is that the same constraints under the same ranking can give rise to a different result when applied in comprehension than when applied in production. In phonological production, illustrated above, optimization starts with an underlying form as the input and yields the optimal surface form for this underlying form.
as the output. In phonological comprehension (perception), optimization proceeds in the opposite direction. In this case, optimization starts with a surface form as the input and yields the optimal underlying form of this surface form as the output. Applying the same grammar (i.e., the same constraints under the same ranking) in the opposite direction of optimization gives rise to a different pairing of surface forms and underlying forms. Whereas the constraints predict children to produce non-adult-like surface forms in production (see Tableau 1), the same constraints under the same ranking predict children to interpret surface forms in an adult-like way (see Tableau 2).

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>MARK: NOCODA, *DORS</th>
<th>FAITH: PARSE, FILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>[kæt]</td>
<td>/kæt/</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>[kæt]</td>
<td>/ta/</td>
<td>*</td>
<td>*!</td>
</tr>
</tbody>
</table>

Tableau 2. Children’s adult-like comprehension of the surface form [kæt]

If a listener hears the word *cat*, which is pronounced as [kæt], he should select the optimal underlying form for this surface form. As [kæt] is the form that is heard, the listener should only consider possible underlying forms for this particular surface form. Alternative surface forms such as the reduced form [ta] are irrelevant. Because all output forms under consideration have the marked surface form [kæt] as the input, they all violate the markedness constraints NOCODA and *DORS. As a consequence, the candidate outputs are equally optimal as far as the markedness constraints are concerned. Hence, the effects of the
markedness constraints are neutralized and the lower ranked faithfulness constraints become
decisive. On the basis of these faithfulness constraints, the listener will select an underlying
form that is maximally faithful to the surface form. Thus, we see a variant of the “emergence
of the unmarked” (McCarthy & Prince, 1994), which I will refer to as the emergence of the
faithful correspondence. In effect, the listener will interpret the heard form [kæt] as the
faithful underlying form /kæt/, and not as the unmarked but less faithful form /ta/.

Because the constraints of the grammar can have a different effect when applied in the
opposite direction of optimization, an OT grammar is direction-sensitive. As a consequence,
the mapping between forms and meanings in production may be different from the mapping
between forms and meanings in comprehension. In children’s phonological production, the
underlying form /kæt/ is incorrectly mapped onto the reduced surface form [ta] as a result of
the dominant markedness constraints. In contrast, in their phonological perception, the surface
form [kæt] is correctly mapped onto the underlying form /kæt/ because the markedness
constraints are neutralized and do not play a role in the choice between underlying forms. The
result is an asymmetry between production and perception. Note that it is not the mere
presence of markedness constraints that results in asymmetries between production and
comprehension. Rather, asymmetries arise if these markedness constraints outrank conflicting
faithfulness constraints, that is, if markedness constraints outrank faithfulness constraints that
have an opposite effect. In the above example, the markedness constraints promote syllable
reduction, whereas the faithfulness constraints prohibit syllable reduction. If the markedness
constraints are ranked below the conflicting faithfulness constraints, as in the adult grammar,
no asymmetry emerges. In adult phonological production, the underlying form /kæt/ is paired
with the surface form [kæt], and in adult phonological perception, the surface form [kæt] is
paired with the underlying form /kæt/, resulting in symmetry.
This explanation for the production/comprehension asymmetry in children’s early words is attractive because it automatically follows from fundamental properties of OT. No additional assumptions need to be made. Furthermore, this explanation can be generalized to allow us to make predictions about other asymmetries in child language, including inverse asymmetries where production precedes comprehension. As Smolensky’s explanation is not dependent on the specifics of syllable structure or speech production and perception, it follows that in all situations where markedness constraints outrank conflicting faithfulness constraints in the grammar, asymmetries are expected to arise between production and comprehension. One such situation may be the acquisition of SVO word order in Dutch and English, as is discussed in the next section.

3. Direction-sensitive optimization also predicts inverse asymmetries

In their comprehension of reversible transitive sentences, preschoolers have been found to incorrectly assign higher priority to animacy than to word order. When hearing the sentence *The car is pushing the boy*, 2-year-olds would often act out the meaning of this sentence in an act out task by having the animate entity (the boy) push the inanimate entity (the car), instead of having the first noun phrase (the car) push the second noun phrase (the boy) (see Chapman & Miller, 1975, and Thal & Flores, 2001, for English, and Chan, Lieven, & Tomasello, 2009, for a comparison of English, German and Cantonese). Similarly, in a picture-selection task or preferential looking task they would often incorrectly point at, or more often look at, the picture of the boy pushing the car rather than the picture of the car pushing the boy (see Cannizzaro, 2012, for English and Dutch). At the same time, these children show adult-like
production of the same sentences by consistently placing the subject in front of the verb and placing the object after the verb (Chapman & Miller, 1975; Cannizzaro, 2012).

As has been argued by Hendriks, de Hoop and Lamers (2005), this remarkable pattern of correct production paired with incorrect comprehension can be explained as a result of a markedness constraint on prominence (proposed by de Hoop & Lamers, 2006) that is ranked too high:

(3) Markedness constraint on interpretation (MARK):

PROMINENCE: The subject outranks the object in prominence (here, animacy).

In contrast to the markedness constraints in Smolensky’s account of the acquisition of early words, the markedness constraint PROMINENCE in (3) does not constrain surface form, but instead constrains interpretation. PROMINENCE is violated by any interpretation according to which the semantic subject is equal in animacy to the semantic object or is lower in animacy than this semantic object. Thus, this constraint encodes a preference for meanings representing boys pushing cars over meanings representing cars pushing boys, irrespective of the form that is used to encode this meaning. As a consequence, if this constraint is decisive, the sentence *The car is pushing the boy* is interpreted as meaning that the boy is pushing the car.

The markedness constraint in (3) can be in conflict with the faithfulness constraint in (4) (also from de Hoop & Lamers, 2006):

(4) Faithfulness constraint (FAITH):

PRECEDENCE: The subject precedes the object.
The two constraints PROMINENCE and PRECEDENCE were proposed by de Hoop and Lamers (2006) as members of a family of Distinguishability constraints that help the listener to distinguish between the two arguments of a transitive relation. De Hoop and Lamers show that these constraints can account for German adults’ interpretation of transitive sentences as well as various processing effects observed in these sentences. In addition, these constraints have been argued to play a role in strategies of case marking (e.g., de Hoop & Malchukov, 2008).

The constraint PRECEDENCE is a faithfulness constraint. Faithfulness constraints in the domain of syntax and semantics are different from faithfulness constraints in the domain of phonology in that they do not demand that input and output are maximally identical. Obviously, this is impossible because one of them is a form and the other one is a meaning. Hence, identity is not possible. Instead, faithfulness constraints in syntax and semantics can perhaps be said to demand maximal correspondence between input and output. That is, if a particular property of meaning is present in the input, then a particular property of form must be present in the output, and vice versa. Note that this is a departure from earlier work in OT syntax, which stated that faithfulness constraints require the output to express all and only the properties of the input (e.g., Legendre, 2001).

The faithfulness constraint PRECEDENCE promotes such a correspondence between input and output. It demands that there is a correspondence between argument structure (meaning) and word order (form), in particular between the semantic subject and the semantic object of a semantic predicate and two linearly ordered noun phrases in the surface form of the sentence. It is violated by any (syntactic or semantic) representation according to which the semantic subject does not precede the semantic object in the surface form. In the formulation in (4), the constraint is violated in two situations: firstly in production when object-subject word order is produced, and secondly in comprehension when a sentence is
understood as expressing object-subject word order. The constraint PRECEDENCE thus restricts the mapping from semantic arguments to noun phrases and vice versa.  

In OT production, incorrectly ranking the markedness constraint above the faithfulness constraint nevertheless results in the adult choice of word order, as can be seen in Tableau 3.

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>MARK: PROMINENCE</th>
<th>FAITH: PRECEDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUSH(car, boy)</td>
<td>The car is pushing the boy</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>PUSH(car, boy)</td>
<td>The boy is pushing the car</td>
<td>*</td>
<td>*!</td>
</tr>
</tbody>
</table>

Tableau 3. Children’s adult-like production of the meaning ‘the car is pushing the boy’

To express the input meaning that the car is pushing the boy, represented as the predicate-argument structure PUSH(car, boy), a child can choose to place the semantic subject (car) first or to place the animate entity (boy) first, resulting in two different word orders. The input meaning violates the markedness constraint PROMINENCE because the semantic subject car is lower on the animacy hierarchy than the semantic object boy. However, as the input is fixed for all candidates, the markedness constraint does not distinguish between candidate outputs. Hence, the faithfulness constraint is decisive in choosing the optimal output form. SVO word order satisfies this faithfulness constraint, whereas OVS word order violates this constraint. Therefore, the optimal form is a sentence with the SVO word order *The car is pushing the boy* and not a sentence with the inverse OVS word order *The boy is pushing the car*. So even if the markedness constraint on prominence is incorrectly ranked above the faithfulness constraint
on word order, the correct word order is chosen due to the neutralization of the markedness constraint in production. Again, this illustrates the emergence of the faithful correspondence.

In OT comprehension, on the other hand, these same constraints in the non-adult constraint ranking result in a non-adult interpretation of the sentence *The car is pushing the boy*. This is shown in Tableau 4.

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>MARK: PROMINENCE</th>
<th>FAITH: PRECEDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The car is pushing the boy</td>
<td>PUSH(car, boy)</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>∼ The car is pushing the boy</td>
<td>PUSH(boy, car)</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Tableau 4. Children’s non-adult-like comprehension of the sentence *The car is pushing the boy*

The SVO interpretation PUSH(car, boy) violates the markedness constraint PROMINENCE, as the semantic subject *car* is lower on the animacy hierarchy than the semantic object *boy*, in contrast to what this constraint demands. The OVS interpretation PUSH(boy, car), on the other hand, satisfies this markedness constraint but violates the faithfulness constraint PRECEDENCE, as the noun phrase referring to the semantic subject *boy* does not precede the noun phrase referring to the semantic object *car* in the word order of the sentence. Because PROMINENCE is stronger than PRECEDENCE in the child’s grammar, the OVS interpretation satisfies the constraints of the child’s grammar best and hence is the optimal interpretation. In
contrast, if \textsc{precedence} is stronger than \textsc{prominence}, as is hypothesized for the adult grammar, the SVO interpretation is the optimal interpretation.

Whereas children’s constraint ranking correctly maps the meaning \textsc{push}(\text{car, boy}) onto the sentence \textit{The car is pushing the boy} in production, the same constraint ranking incorrectly maps the sentence \textit{The car is pushing the boy} onto the meaning \textsc{push}(\text{boy, car}) in comprehension. The result is an asymmetry between production and comprehension, with production being more advanced than comprehension. Thus, this situation is the inverse of the situation in Smolensky’s (1996) word pronunciation example, where comprehension is more advanced than production. This shows that a direction-sensitive OT grammar is able to explain asymmetries where comprehension precedes production (as in the word pronunciation asymmetry) as well as inverse asymmetries where production precedes comprehension (as in the word order asymmetry). In both cases, a markedness constraint is ranked too high relative to one or more conflicting faithfulness constraints. This allows us to formulate the general prediction that every time a markedness constraint is ranked too high in the child’s grammar relative to a conflicting faithfulness constraint, there will be a mismatch between production and comprehension. If the markedness constraint applies to surface forms, production is delayed compared to comprehension. If the markedness constraint applies to meanings (or underlying forms in phonology), comprehension is delayed compared to production.

4. Unfaithful correspondences arise from low-ranked faithfulness constraints

A variant of the pattern exemplified in Section 3, also showing the emergence of the faithful correspondence, is Schouwenaars, van Hout and Hendriks’ (in press) account of Dutch children’s asymmetry with \textit{which}-questions. Their account reveals that asymmetries in an OT
grammar are in fact not due to the high ranking of markedness constraints, but rather to the low ranking of the relevant faithfulness constraint.

Schouwenaars et al.’s account provides an explanation for why 7-year-old Dutch children interpret object questions such as *Welke boef hebben de pilooten gekieteld?* (literally: Which thief have the pilots tickled?) as subject questions, although these same children show adult-like production of object questions. In Dutch, a fronted *wh*-expression can be the subject or the object of the sentence. In contrast to English, in Dutch no structural cues such as the presence or absence of an auxiliary verb or word order are available to distinguish between a subject question such as *Which thief tickle the pilots?* and an object question such as *Which thief do the pilots tickle?* Also, there does not seem to be a clear bias in *which*-questions in Dutch towards one of the two interpretations (see Schouwenaars et al., in press). Therefore, to understand subject questions and object questions correctly, a Dutch listener must determine what is the semantic subject and what is the semantic object on the basis of other information than syntactic structure, such as agreement.

In the proposed OT account, agreement is formulated as a faithfulness constraint requiring agreement in number between the finite verb and the expression realizing the semantic subject:

(5) Faithfulness constraint (FAITH):

    AGREE: The subject and finite verb agree in number.

Schouwenaars et al. argue that children’s comprehension errors result from the fact that this constraint is ranked too low in children’s grammar. In particular, this constraint is ranked below two constraints on word order, one requiring the subject to be placed in first position in the sentence (which they call SUBJECT-FIRST but may in fact be the constraint PRECEDENCE
discussed above) and the other one requiring a wh-expression to be placed in first position in the sentence (this could be the constraint Op-SPEC introduced by Grimshaw, 1997: Operators are realized in SPEC position). The constraint requiring wh-expressions to be placed first is the strongest of these two constraints and rules out all question forms in which the wh-expression is left in situ. As a result, in production the optimal form must be selected from among those candidates in which the wh-expression occurs in first position. As Tableau 5 shows, because all relevant candidates violate PRECEDENCE, the constraint AGREE is decisive in production. Therefore, the form produced by children will be the form that satisfies the constraint AGREE, that is, the form in which the noun phrase expressing the semantic subject de piloten ‘the pilots’ agrees in number with the finite verb kietelen ‘tickle’.

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>FAITH: PRECEDENCE</th>
<th>FAITH: AGREE</th>
</tr>
</thead>
</table>
| TICKLE(the pilots, ?thief) | Welke boef kietelt de piloten?  
  which thief-SG tickle-SG  
  the pilots-PL | *                | *!            |
| ¬ TICKLE(the pilots, ?thief) | Welke boef kietelen de piloten?  
  which thief-SG tickle-PL  
  the pilots-PL | *                |             |
Tableau 5. Children’s adult-like production of an object *which*-question in Dutch

In Dutch children’s comprehension of object questions, on the other hand, there is a way to avoid a violation of PRECEDENCE, namely by violating the weaker constraint AGREE. Therefore, it is not the expression agreeing with the finite verb in number (the pilots) that is chosen as the semantic subject, but instead the expression mentioned first (which thief). This results in the subject question interpretation TICKLE(?thief, the pilots) as the optimal interpretation for an object question, rather than the object question interpretation TICKLE(the pilots, ?thief) that would be correct according to the adult constraint ranking. This is shown in Tableau 6.

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>FAITH: PRECEDENCE</th>
<th>FAITH: AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welke boef kietelen de piloten?</td>
<td>TICKLE(?thief, the pilots)</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welke boef kietelen de piloten?</td>
<td>TICKLE(the pilots, ?thief)</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Input: *Welke boef kietelen de piloten?*  
*which thief-SG tickle-PL*  
*the pilots-PL*
So the low-ranked faithfulness constraint AGREE is decisive in children’s production and gives rise to the emergence of a faithful correspondence between argument structure and verb inflection, but is overruled in their comprehension by a conflicting but stronger faithfulness constraint demanding faithfulness between argument structure and word order.

As we saw in Sections 2 and 3, the effects of markedness constraints are neutralized in the opposite direction of optimization because markedness constraints are output-oriented. As a result, markedness constraints on surface form are neutralized in comprehension and markedness constraints on meaning are neutralized in production. This section shows that also the effects of faithfulness constraints can sometimes be neutralized in the opposite direction of optimization. This can happen under the influence of a stronger markedness constraint that enforces a violation of this faithfulness constraint in one direction of optimization. As the markedness constraint is neutralized in the opposite direction of optimization, it allows the faithfulness constraint (in this case PRECEDENCE) to be satisfied in this direction of optimization, albeit at the cost of violating a conflicting but weaker faithfulness constraint (in this case AGREE).

Due to the neutralization of higher ranked markedness constraints in one direction of optimization, lower ranked faithfulness constraints can become decisive. This then leads to the emergence of a faithful correspondence between input and output in this direction of optimization, which is absent in the opposite direction of optimization. As a consequence of the different effects of this faithfulness constraint in production and comprehension, an asymmetry arises.
5. Underspecification in optimization predicts further asymmetries

The discussion of asymmetries between production and comprehension in the previous sections might suggest that asymmetries only emerge if a relevant faithfulness constraint is ranked too low and is dominated by conflicting constraints. However, in this section we will see that asymmetries can also sometimes emerge if the relevant faithfulness constraint dominates these conflicting constraints. In the particular configuration of constraints discussed in this section, an asymmetry is predicted to arise because the correspondence between forms and meanings is underspecified by the relevant faithfulness constraint.

This pattern is exemplified by children’s production and comprehension of object pronouns. Children’s comprehension of object pronouns in languages such as English and Dutch (but not in Romance languages) shows the well-attested Delay of Principle B Effect: until the age of 5 or 6, children allow an object pronoun such as him to incorrectly corefer with the local subject, in violation of Principle B of Binding Theory. That is, they show a guessing pattern in their comprehension. In addition to correctly allowing him in the sentence Bert is washing him to refer to a salient referent not mentioned in the sentence, they also incorrectly allow him to corefer with the subject of the clause Bert, giving rise to the interpretation that Bert is washing himself. Because these incorrect interpretations occur at an age at which the children are already capable of interpreting reflexives such as himself in accordance with Principle A of Binding Theory, this delay is referred to as the Delay of Principle B Effect. Surprisingly, the same children who incorrectly allow him to corefer with the local subject in their interpretation of object pronouns do not produce such errors in their own speech (De Villiers, Cahillane, & Altreuter, 2006; Matthews, Lieven, Theakston, & Tomasello, 2009; Spenader, Smits, & Hendriks, 2009). That is, they do not produce utterances
in which an object pronoun corefers with the local subject. The resulting pattern in their acquisition of object pronouns thus is that correct production precedes correct comprehension.

As shown by Hendriks and Spenader (2006), this stage in children’s grammar can be accounted for through the interaction between a faithfulness constraint and a markedness constraint. The relevant faithfulness constraint is a violable version of Principle A from Binding Theory (Chomsky, 1981):

(6) Faithfulness constraint (FAITH):

PRINCIPLE A: A reflexive must be bound (i.e., corefer with a c-commanding antecedent) in its local domain.

This faithfulness constraint is violated by any reflexive that is not bound by, and does not corefer with, a local c-commanding antecedent. In a simple transitive clause, this constraint is violated by a reflexive object that is not coreferential with the subject. This faithfulness constraint interacts with another constraint, which Hendriks and Spenader assume is a markedness constraint from a universal constraint hierarchy reflecting the view that expressions with less referential content are preferred over expressions with more referential content (cf. Burzio, 1998; Wilson, 2001):

(7) Markedness constraint (MARK):

REFERENTIAL ECONOMY: Avoid full NP >> Avoid pronoun >> Avoid reflexive

This constraint hierarchy REFERENTIAL ECONOMY expresses a preference for reflexives over pronouns, irrespective of their meanings. The constraint AVOID PRONOUN from this hierarchy is violated by any occurrence of a pronoun.
Note that the constraint hierarchy REFERENTIAL ECONOMY resembles implicational hierarchies of referential forms such as Gundel’s Givenness Hierarchy (Gundel, Hedberg, & Zacharski, 1993). The Givenness Hierarchy ranks referential forms according to their presupposed givenness and not only includes pronouns and full NPs, but also distinguishes between definite and indefinite NPs. Whereas pronouns can be used to refer to a referent that is at the center of attention and definite NPs can be used to identify given referents, indefinite NPs rank at the lower end of the Givenness Hierarchy because they tend to be used to introduce new referents into the discourse. The constraint hierarchy REFERENTIAL ECONOMY may be extended to also accommodate the latter distinction between definite and indefinite NPs (as is done by van Hout, Harrigan and de Villiers, 2010, see below).

Returning to the use and interpretation of pronouns, consider a situation in which two referents are salient in the linguistic discourse, say Bert and Ernie. The constraints in (6) and (7) will select the pronoun *him* as the optimal anaphoric form of the direct object for expressing the disjoint meaning that Bert is washing Ernie. This is shown in Tableau 7.

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>FAITH: PRINCIPLE A</th>
<th>MARK: AVOID PRONOUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASH(Bert, Ernie)</td>
<td>Bert is washing himself</td>
<td>![ ]</td>
<td>*!</td>
</tr>
<tr>
<td><em>![WASH(Bert, Ernie)]</em></td>
<td>Bert is washing him</td>
<td>![ ]</td>
<td>*</td>
</tr>
</tbody>
</table>

Tableau 7. Children’s adult-like production of the meaning ‘Bert is washing Ernie’
Choosing a reflexive for expressing a disjoint input meaning will result in a violation of PRINCIPLE A. On the other hand, choosing a pronoun for expressing a disjoint input meaning results in a violation of AVOID PRONOUN. Because PRINCIPLE A is ranked higher than AVOID PRONOUN, the violation of PRINCIPLE A by the reflexive is fatal and the pronoun is the optimal anaphoric form for expressing a disjoint meaning. This corresponds to the anaphoric form chosen by both adults and children in their productions.

Now consider the mapping between form and meaning that is the result of applying these constraints in comprehension, reversing the direction of optimization:

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>FAITH: PRINCIPLE A</th>
<th>MARK: AVOID PRONOUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>✨ Bert is washing him</td>
<td>WASH(Bert, Bert)</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>✨ Bert is washing him</td>
<td>WASH(Bert, Ernie)</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Tableau 8. Children’s non-adult-like comprehension of the anaphoric pronoun *him*

In Tableau 8, the input is a sentence with an object pronoun. Two meanings compete for this input: the coreferential meaning that Bert is washing himself and the disjoint meaning that Bert is washing Ernie. PRINCIPLE A is the strongest of the two constraints, but applies to reflexives and does not apply to pronouns. Hence, this constraint is vacuously satisfied by all candidates. Therefore, to determine the optimal output we must turn to the weaker constraint. However, as before, the effects of the markedness constraint on forms AVOID PRONOUN are
neutralized in comprehension because the input is fixed. All candidates contain a pronoun in the input and hence all candidates violate the constraint AVOID PRONOUN. Therefore, the candidate meanings have the same constraint violation profile and satisfy PRINCIPLE A but violate AVOID PRONOUN.

Based on these two constraints, the coreferential meaning and the disjoint meaning are both optimal. This corresponds to the observation that children who make comprehension errors with pronouns seem to guess between the two interpretations of the pronoun or use some other non-linguistic strategy (van Rij, van Rijn, & Hendriks, 2010).

Although the constraint AVOID PRONOUN does not have any observable effects on the use and interpretation of pronouns in the situations discussed here and could easily be omitted from Tableaux 7 and 8, this constraint does have effect on the production of pronouns and prevents the use of a pronoun for expressing a coreferential meaning such as WASH(Bert, Bert) (see Hendriks & Spenader, 2006). Thus, AVOID PRONOUN has the same effect as the production part of Chomsky’s Principle B (A pronoun must be free in its local domain). Note that, in addition to the constraint PRINCIPLE A, the OT account of the Delay of Principle B Effect does not include a parallel constraint with the effects of Principle B. Rather, it derives the comprehension effects of Principle B from the combination of PRINCIPLE A and AVOID PRONOUN. This makes possible a competence-based explanation of the Delay of Principle B Effect, which would not be possible if Principle A and Principle B were both constraints of the grammar: it would then remain a mystery why Principle B is mastered so much later than Principle A.

To derive the comprehension part of Chomsky’s Principle B, Hendriks and Spenader (2006) argue that optimization proceeds bidirectionally (cf. Blutner, 2000; see Hendriks et al., 2010; Benz & Mattausch, 2011; Legendre et al., this volume, for various applications of bidirectional optimization in syntax, semantics and pragmatics). By not merely optimizing
from input form to optimal meaning, but optimizing over pairs of form and meaning, adult listeners can block the incorrect coreferential meaning for the pronoun. Because the coreferential meaning is already paired with the reflexive, as this form-meaning pair satisfies the constraints of the grammar best, the coreferential meaning is unavailable for the pronoun. As a result, bidirectional optimization pairs the pronoun with the correct disjoint meaning.

In contrast to adults, children are assumed to not yet be able to optimize bidirectionally. Hence, they fail to block the incorrect coreferential meaning. Although children’s inability to optimize bidirectionally is most likely due to cognitive factors such as insufficient processing speed (van Rij et al., 2010), immature Theory of Mind capacities (Hendriks & Spenader, 2006), a failure to inhibit the incorrect response (Conroy et al., 2009) or a combination of these, the origin of the asymmetry between production and comprehension may lie within the grammar, as is shown by Tableau 7 and Tableau 8.

A comparable explanation is provided by van Hout et al. (2010) to account for English-speaking children’s overly liberal interpretation of indefinites, which contrasts with these children’s adult-like production of indefinites. Van Hout et al. account for this asymmetry by assuming that a constraint requiring definite articles to correspond with discourse referents carrying determined reference conflicts with the markedness constraint AVOID INDEFINITE, which may be part of the constraint hierarchy REFERENTIAL ECONOMY. Note that, although van Hout et al. (2010:1976) refer to the constraint on determined reference as a markedness constraint, according to the distinction employed in this paper it should be considered a faithfulness constraint, as it expresses a correspondence between a form (a definite article) and a meaning (a discourse referent): A definite article corresponds with a discourse referent with determined reference, where a discourse referent has determined reference if it is unique and/or has anaphoric reference (Farkas, 2002; Hendriks et al., 2010).
These two constraints restrict the production of indefinites. Because the determined reference constraint does not apply to indefinites and the markedness constraint AVOID INDEFINITE is neutralized in comprehension, comprehension of indefinites is not restricted by these constraints. Hence, indefinites are ambiguous for children. Unlike the configuration of constraints discussed above in relation to pronominal binding, the two constraints governing the use of indefinites are assumed to be unranked. Apart from this difference, the explanation for the asymmetry with indefinites is completely parallel to the explanation for the asymmetry with pronouns.

The effects of the faithfulness constraint PRINCIPLE A and the determined reference constraint of van Hout et al. reveal a second configuration of constraints giving rise to asymmetries. The first configuration, as we saw in previous sections, is the configuration where a faithfulness constraint is ranked too low relative to one or more conflicting markedness or faithfulness constraints. The second configuration of constraints that can give rise to asymmetries, discussed in this section, is one in which a faithfulness constraint only restricts part of the behavior of a linguistic form. In the example presented in this section, PRINCIPLE A restricts the production of pronouns, but not their interpretation (as can be seen by comparing Tableau 7 to Tableau 8). Thus, the faithfulness constraint PRINCIPLE A underspecifies the behavior of pronouns. The same holds for van Hout et al.’s constraint on determined reference, which underspecifies the behavior of indefinites. Even if we also take into account the restrictions imposed by the markedness constraint AVOID PRONOUN, the interpretation of pronouns is still underspecified by the constraints of the grammar.

The possibility of underspecification allowed by constraints contrasts with the effect of rules in a rule-based linguistic framework. Compare the effects of the violable constraints PRINCIPLE A and AVOID PRONOUN with Chomsky’s Principle A (A reflexive is bound in its local domain) and Principle B (A pronoun is free in its local domain). The rules Principle A
and Principle B restrict the distribution of reflexives and pronouns to particular syntactic configurations and at the same time restrict the interpretation of reflexives and pronouns in these syntactic environments. Thus, these rules fully specify the grammatical behavior of reflexives and pronouns. Although Reinhart and Reuland (1993) revise Principles A and B of Binding Theory to only refer to reflexivity, the same holds for Condition A (A reflexive-marked syntactic predicate is reflexive) and Condition B (A reflexive semantic predicate is reflexive marked) of their revised Binding Theory. These conditions explicitly specify the distribution and interpretation of reflexives, but indirectly also specify the distribution and interpretation of pronouns, as pronouns are used when reflexives are not allowed and a non-reflexive interpretation is assigned when a reflexive interpretation is not allowed.

With other expressions than anaphoric pronouns, syntactic rules may fully specify the distribution of the form while leaving the interpretation of this form to compositionality, which is then expected to automatically lead to the correct interpretation. Either way, the result is a full specification of the linguistic behavior of a form, with adult production as well as adult comprehension being determined by the rules of the grammar. While this may be seen as an advantage from the point of view of the descriptive adequacy of the grammar as far as adult language is concerned, it makes a competence-based explanation of the asymmetry between pronoun production and pronoun comprehension and other production/comprehension asymmetries in syntax and semantics extremely challenging.

Because of the underspecification of the linguistic behavior of certain expressions in a constraint-based grammar, reversal of the direction of optimization may result in an underspecified meaning and hence in ambiguity. Unlike in the configuration of constraints discussed in previous sections, in this configuration of constraints the ranking of the constraints is less important. This is because the asymmetry is not due to a conflict between
constraints, but instead results from the only partial coverage of the linguistic behavior of an expression by the constraints of the grammar.

6. Faithful and unfaithful correspondences

In this paper we identified two configurations of constraints that give rise to asymmetries between production and comprehension. Asymmetries are predicted if a faithfulness constraint (1) is violated due to higher ranked constraints, or (2) underspecifies the correspondence between a form and its meaning. Because of the direction-sensitivity of optimization, the result may be an unfaithful correspondence between a form and a meaning in one direction of optimization, but a faithful correspondence between the same form and its meaning in the opposite direction of optimization. As a consequence, OT grammars are inherently asymmetric. This allows them to straightforwardly explain attested asymmetries between production and comprehension in child language as well as predict further asymmetries. Such asymmetries may involve cases where comprehension precedes production, as with early words. They may also involve more surprising cases where production precedes comprehension, as with subject-object word order, which-questions, pronominal binding and indefinites.

The inherent asymmetry of OT grammars suggests that language must abound with mismatches between form and meaning. This may be true for child language, but is certainly less so for adult language, as linguistic patterns gradually become more faithful due to learning. If a faithfulness constraint is ranked below one or more conflicting constraints, this faithfulness constraint can move up in the constraint ranking as a result of the OT learning mechanism of constraint reranking (either through the stepwise demotion of conflicting
constraints, as in Tesar and Smolensky’s Error-Driven Constraint Demotion Algorithm (1998), or through simultaneous gradual promotion of this constraint and demotion of conflicting constraints, as in Boersma and Hayes’ Gradual Learning Algorithm (2001)). A faithful correspondence emerges when this faithfulness constraint ends up dominating the conflicting constraints that promote an unfaithful correspondence between form and meaning. In the alternative situation giving rise to asymmetries, a faithfulness constraint underspecifies the correspondence between a form and its meaning. Because this faithfulness constraint may already be highly ranked, constraint reranking does not remove the asymmetry. In this case, the unfaithful mapping between form and meaning may be blocked through bidirectional optimization (Blutner, 2000). It should be noted that the symmetry-restoring effects of the OT learning mechanisms do not exclude the possibility that some asymmetries remain in the adult language, for example due to inadequate exposure or low frequency.

An apparent counterexample to the generalization that asymmetries result from a low ranking of faithfulness constraints in children’s grammar is Legendre and Smolensky’s (2012) OT account of French children’s asymmetry with third-person deictic pronouns. Their account is based on the finding that French children freely produce deictic pronouns by the age of 2, but fail to interpret third-person deictic pronouns correctly. In a fishing task in which they were asked questions such as Qu’est-ce qu’elle attrape? ‘what is she catching?’, 30-month-olds equally often referred to the speaker, the hearer and a non-participant in response to a question containing the third-person pronoun elle ‘she’ (Legendre et al., 2011). These children’s poor interpretation of third-person pronouns contrasts with their correct interpretation of first- and second-person pronouns in the same task.

According to Legendre and Smolensky’s account, French children’s incorrect comprehension but correct production of third-person deictic pronouns arises from the low ranking in these children’s grammar of a markedness constraint on meanings relative to a
faithfulness constraint. This constraint configuration is not only inconsistent with the proposed generalization about the emergence of asymmetries (as it is argued that, in this case, a markedness constraint rather than a faithfulness constraint is ranked too low), but also is a departure from the assumption in phonology that in children’s initial constraint ranking markedness constraints outrank faithfulness constraints (Demuth, 1995; Gnanadesikan, 2004). However, Legendre and Smolensky’s account may be slightly amended to solve both issues.

Legendre and Smolensky explain the acquisition of deictic pronouns in French through the interaction between the markedness constraint MAXIMPLRESUP and the faithfulness constraint FAITHRESUP. Simplifying their account quite a bit, their markedness constraint MAXIMPLRESUP is a constraint on meanings expressing a preference for reference to the speaker over reference to the listener, and reference to the listener over non-specified reference. This constraint is only relevant in comprehension, as in production the effects of markedness constraints on meanings are neutralized. In children’s comprehension, this markedness constraint is dominated by the faithfulness constraint FAITHRESUP, which requires identity between the presupposed feature values of a deictic pronoun and the feature values associated with its referent.

First- and second-person pronouns have fully specified presupposed feature values: I has the feature values [+P +S] and you has the feature values [+P –S]. Here, P stands for Participant and S for Speaker. Thus, the lexical specification of the pronoun I indicates that this pronoun refers to a participant (+P) that is a speaker (+S) and according to its lexical specification you refers to a participant (+P) that is not a speaker (–S). Because the feature values of the third-person deictic pronoun she are underspecified (indicated by [0P 0S]) and are compatible with reference to the speaker, the hearer and a non-participant, a high ranking of the faithfulness constraint FAITHRESUP explains why French 2½-year-old children allow
third-person deictic pronouns to refer to any of these referents. This is illustrated in Tableau 9, which presents a simplified version of Legendre and Smolensky’s (2012) account.
<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>FAITH: FaithPref Sup2</th>
<th>FAITH: FaithPref Sup1</th>
<th>MARK: MaxImpl Presup</th>
</tr>
</thead>
<tbody>
<tr>
<td>I [+P +S]</td>
<td>Speaker [+P +S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Speaker [+P +S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Hearer [+P –S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Non-participant [–P –S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Speaker or Hearer [+P 0S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Non-participant [–P 0S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Speaker [0P +S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Hearer or Non-participant [0P –S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Speaker, Hearer or Non-participant [0P 0S]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>she [0P 0S]</td>
<td>Non-participant and Speaker [–P +S]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tableau 9: Children’s non-adult-like comprehension of the deictic pronouns I, you and she (simplified from Legendre and Smolensky, 2012)
The first column lists the pronominal forms and the second column lists their potential interpretations. According to Legendre and Smolensky (2012), presupposed feature values of lexical items must be compatible with the feature values of their interpretations. Because of this restriction, the only feature values possible for the interpretation of a first-person pronoun with presupposed feature values \([+P +S]\) are the feature values \([+P +S]\) of a speaker. Similarly, the only feature values possible for the interpretation of a second-person pronoun with presupposed feature values \([+P –S]\) are the feature values \([+P –S]\) of a hearer. Therefore, the interpretations of first- and second person pronouns are not dependent on the constraints of the grammar. This is marked by the gray cells under the constraints in the rows for \(I\) and \(you\). Note, furthermore, that the feature specification \([-P +S]\) (bottom row) is not considered as a potential interpretation for \(she\), because \(+S\) implies \(+P\). This is also marked by gray cells in the corresponding row. If the faithfulness constraint \(\text{FAITH-PRESUP}\) dominates the markedness constraint \(\text{MAXIM-PRESUP}\), as is hypothesized for children, the optimal interpretation of the third-person pronoun \(she\) is \([0P 0S]\), corresponding to unspecified reference.

To explain the adult pattern, Legendre and Smolensky assume that the faithfulness constraint \(\text{FAITH-PRESUP}\) in fact consists of two constraints: one faithfulness constraint that is violated by resolving unspecified reference as reference to the speaker or the listener (\(\text{FAITH-PRESUP2}\)), and another faithfulness constraint that is violated by resolving unspecified reference as reference to a non-participant (\(\text{FAITH-PRESUP1}\)). If the input is unspecified for \(P\) and \(S\) (e.g., if it has the presupposed feature specification \([0P 0S]\), as is the case for the third-person pronoun \(she\)), \(\text{FAITH-PRESUP2}\) is violated by every \(+P\) or \(+S\) in the output and \(\text{FAITH-PRESUP1}\) by every \(–P\) or \(–S\) in the output. Irrespective of the input, the markedness
For children, the optimal interpretation for a third-person pronoun is the feature specification [0P 0S] corresponding to unspecified reference. As a consequence, children allow a third-person pronoun to refer to the speaker, the hearer or a non-participant. In contrast to children’s constraint ranking given in Tableau 9, the constraint ranking for adults is \textit{FaithPresup2} \gg \textit{MaxImplPresup} \gg \textit{FaithPresup1}. Because of the higher ranking of \textit{MaxImplPresup}, adults do not allow unspecified reference for a third-person deictic pronoun, but instead select reference to a non-participant.

The proposed constraints thus explain the pattern of production and comprehension of deictic pronouns displayed by French children and adults. However, an alternative explanation for children’s and adults’ comprehension of deictic pronouns that fits in with the underspecification pattern presented in Section 5, is that the markedness constraint \textit{MaxImplPresup} neither plays a role in children’s comprehension nor in adults’ comprehension and only the faithfulness constraint \textit{FaithPresup} is relevant. The ambiguity displayed by children and the choice of referent by adults may follow from (the lack of) bidirectional optimization.

Tableau 10 shows the effect of \textit{FaithPresup} on children’s comprehension of deictic pronouns.
<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate outputs</th>
<th>FAITH: FAITH\textsuperscript{PRESUP}</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I [+P +S]$</td>
<td>Speaker [+P +S]</td>
<td></td>
</tr>
<tr>
<td>$you [+P –S]$</td>
<td>Speaker [+P +S]</td>
<td>*!</td>
</tr>
<tr>
<td>$she [0P 0S]$</td>
<td>Speaker [+P +S]</td>
<td>**</td>
</tr>
<tr>
<td>$she [0P 0S]$</td>
<td>Hearer [+P –S]</td>
<td>**</td>
</tr>
<tr>
<td>$she [0P 0S]$</td>
<td>Non-participant [–P –S]</td>
<td>**</td>
</tr>
</tbody>
</table>

Tableau 10: Children’s non-adult-like comprehension of the deictic pronouns $I$, $you$ and $she$ (alternative analysis)

Candidate outputs consist of the potential referents for the deictic pronoun (speaker, hearer and non-participant) with their corresponding feature specifications. Thus, the candidate outputs do not contain unspecified features. The faithfulness constraint $\text{FAITH}$\textsuperscript{PRESUP} is violated by every feature value in the output that is different from a feature value in the input. Output candidates with feature values that are incompatible with the feature values of the input (as in the case of first- and second-person pronouns) are included in the candidate set, although they are ruled out by $\text{FAITH}$\textsuperscript{PRESUP} in Tableau 10. This potentially allows for an OT account of non-canonical interpretations of first- and second-person pronouns, where a first-person pronoun does not refer to the speaker and a second-person pronoun does not refer to
the hearer, under the influence of additional constraints. Such interpretations have been observed, also in English. For example, the first-person plural pronoun *we* must refer to a person other than the speaker when a nurse utters the question *How are we feeling today?* to a patient, as the patient cannot be expected to know how the nurse is feeling. Similarly, second-person pronouns often do not only refer to the hearer, as in *You could see that he was nervous.* Here, *you* receives a generic interpretation and refers to the speaker and anyone else who was there at that time (see de Hoop and Tarenskeen, submitted, for discussion and an OT account).

For unidirectionally optimizing children, the optimal interpretation for the first-person pronoun *I* is reference to the speaker. The optimal interpretation for the second-person pronoun *you* is reference to the hearer. The third-person pronoun *she* is ambiguous between reference to the speaker, the hearer and a non-participant. In contrast to unidirectionally optimizing children, for bidirectionally optimizing adults a third-person pronoun can only refer to a non-participant, because reference to the speaker is blocked by the bidirectionally optimal form-meaning pair <*I*, Speaker> and reference to the hearer is blocked by the bidirectionally optimal form-meaning pair <*you*, Hearer>.

If this slightly amended account of deictic pronouns is on the right track, this account of the acquisition of deictic pronouns in French aligns well with the OT explanation of production/comprehension asymmetries discussed here. Also, it would not constitute an exception to the general pattern that, initially, markedness constraints are ranked above faithfulness constraints.
7. Conclusions

In this paper, I presented several accounts of asymmetries between production and comprehension within the linguistic framework of Optimality Theory. Since the focus was on the configurations of constraints that predict and explain such asymmetries, and not on the empirical adequacy of the OT explanations, alternative explanations for these asymmetries were not discussed. Of course, for many of these asymmetries alternative – performance-based – explanations are possible and have been proposed. However, it should be emphasized that competence-based explanations of asymmetries come for free in the theoretical framework of OT. No additional assumptions have to be made about the grammar or the use of the grammar, nor do these explanations rely on the specifics of the linguistic phenomena under discussion. The predicted asymmetries merely follow from the way faithfulness constraints and markedness constraints behave and interact. This makes OT particularly suited to explain production/comprehension asymmetries in language.

In examining the relation between production and comprehension in child language, I tried to carefully distinguish aspects of linguistic form from aspects of linguistic meaning. This is not trivial, as in many linguistic analyses forms and meanings are considered together. An illustrative example is the syntactic work on pronominal binding in the Chomskyan tradition, discussed in Section 5, which usually considers the distribution of pronouns and reflexives in combination with their interpretational possibilities such as indicated by indices. However, because optimization is direction-sensitive and gives rise to different form-meaning correspondences when the input is a form than when the input is a meaning, aspects of form should be treated differently from aspects of meaning in OT syntax and semantics. For this reason, I reformulated a constraint that was previously proposed as a markedness constraint (which pertain to forms only or meanings only) as a faithfulness constraint (correlating forms
and meanings). A careful distinction between linguistic form and linguistic meaning not only allows us to fully exploit the properties of OT, but also respects the observed differences between language production and comprehension.

Endnotes

1 The faithfulness constraints PARSE and FILL have been reformulated by McCarthy and Prince (1995) as MAX (the input must be maximally represented in the output) and DEP (the output should depend entirely on the input), respectively.

2 Alternatively, one could treat markedness constraints as pertaining to candidate outputs only, instead of to input-output pairs, as is done here. In that case, both candidates would satisfy rather than violate NoCoda and *DORS, since these constraints apply to surface forms and not to underlying forms. However, the outcome would be the same, as the constraints would still not distinguish between candidates. To facilitate the comparison between production and comprehension, I continue to treat markedness constraints as pertaining to input-output pairs.

3 This is not to say that 2-year-olds do not possess knowledge of word order. If word order does not conflict with animacy (as in the studies by Gertner, Fisher and Eisengart, 2006, and Candan et al., 2012, who only tested sentences with animate entities), 2-year-old English-speaking are able to use word order as a cue to sentence interpretation.

4 If we wish to formulate this constraint as simple as possible (cf. Eisner’s Primitive OT, 1997), PRECEDENCE should be reformulated as two implicational constraints, one restricting the mapping from meaning to form and the other one restricting the mapping from form to meaning. This division of labor would correspond to that between PARSE and FILL (or their more recent versions MAX and DEP) in OT phonology.

5 In the present discussion we restrict ourselves to questions in the active voice. A special case are passive questions such as Welke dief wordt door de piloten gekieteld? (‘Which thief is being tickled by the pilots?’), in which agreement is between the semantic object and the verb. In Schouwenaar et al.’s production task, this form was produced quite often by adults as well as children, suggesting that also passive questions are optimal forms for expressing object question meanings. To account for their use, additional constraints referring to passive morphology should be included and candidate sets should be expanded.

6 Based on a survey of earlier studies and three new experiments, Conroy at al. (2009) argue that the Delay of Principle B Effect is largely an experimental artifact. However, as is pointed out by Hendriks (2014), their argument fails to fully explain English-speaking children’s errors in comprehension (which are especially striking when compared to these children’s adult-like performance in production). Furthermore, their argument fails take into account attested cross-linguistic differences (as the same experimental materials that give rise to a DPBE in English do not give rise to a DPBE in Romance languages such as Italian) and potential biases provided by the linguistic and extralinguistic context (which could have influenced the choice of antecedent for the pronouns in their experiments).

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