PRODUCTION/COMPREHENSION ASYMMETRIES IN LANGUAGE ACQUISITION

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The theme of this Special Issue is asymmetries in language acquisition, and the contributions present evidence for either the presence or the absence of a production/comprehension asymmetry in child language. The authors focus on various areas of linguistics, ranging from phonology and syntax to semantics and pragmatics, using a variety of empirical methods. Although the contributions do not agree on the existence of asymmetries or on the explanations for observed asymmetries, they all address the relation between children's production of a particular linguistic form and their comprehension of this form. As this Special Issue shows, the relation between children's performance in language production, their performance in language comprehension, and their knowledge of grammar may not be as straightforward as has often been assumed.

1. Introduction

If you have mastered your native language, this usually implies that you are able to speak and understand the language. Although the situation may be different for languages that are learned later in life, it is widely assumed that there is more or less perfect symmetry between a mature first language user's competence in production and his or her competence in comprehension. In

your native language, you are able to understand whatever you can produce, and you are able to produce whatever you can understand.

When acquiring this native language, however, the situation is different. To be able to learn a new task such as playing a musical instrument or speaking, according to common wisdom you somehow need to understand what you are doing. Before you can reproduce a pattern you observe, for example a piece of music being played or a sentence being uttered, you first have to be able to represent this pattern. As a consequence, you must have competence in language comprehension before you can acquire competence in language production. This general view is formulated by Eve Clark as follows: "Logically, comprehension must precede production. How else can speakers know which words to use to convey a particular meaning? They must already have mapped the relevant meanings onto specific forms, and have these units represented in memory, to be accessed on subsequent occasions whenever they hear the relevant forms from others." (Clark, 1993: 246). So the only logically conceivable possibility seems to be that comprehension precedes production, and this indeed appears to be the general tendency in language acquisition.

In the next section, however, we discuss a pattern in language acquisition that seems to go against this general tendency. The pattern under discussion suggests that it is also possible for production to precede comprehension. Section 3 looks into the systematicity of asymmetries between production and comprehension and addresses the question how common these asymmetries are. In section 4, we list four different ways to account for asymmetries between production and comprehension in language acquisition. Section 5, finally, introduces the contributions to this Special Issue and points out how they relate to the issues addressed here.

2. Puzzling asymmetries

The general tendency in language acquisition appears to be that comprehension precedes production. However, during the past decades evidence has emerged that the inverse pattern is also possible. The best-known example of a production/comprehension asymmetry (or production/comprehension asynchrony, as it is sometimes called) where production seems to precede comprehension, is the Delay of Principle B Effect. Consider the following two sentences:

(1) This is Mama Bear; this is Goldilocks. Is Mama Bear washing herself?

(2) This is Mama Bear; this is Goldilocks. Is Mama Bear washing her?

English-speaking children from the age of 4 onward consistently interpret the reflexive *herself* in (1) as coreferring with the local subject Mama Bear. They thus appear to have knowledge of Principle A of Binding Theory, which governs the use and interpretation of reflexives. At the same time, when presented with (2), the same children often allow both Goldilocks and Mama Bear as the referent for the object pronoun *her* (e.g., Chien & Wexler, 1990). This suggests that they do not yet have knowledge of Principle B of Binding Theory, which governs the use and interpretation of pronouns. Children's guessing pattern with pronouns seems to persist until the age of 6. The difference between children's early mastery of Principle A and their late mastery of Principle B is generally referred to as the Delay of Principle B Effect. Many studies have addressed the Delay of Principle B Effect, from a theoretical as well as from an empirical perspective (e.g., Baauw & Cuetos, 2003; Bloom et al., 1994; Conroy et al., 2009; de Villiers et

al., 2006; Grodzinsky & Reinhart, 1993; Hendriks & Spenader, 2005/6; Matthews et al., 2009; McKee, 1992; Reinhart, 2006; Spenader et al., 2009; Thornton & Wexler, 1999; van Rij et al., to appear).

The asymmetry between children's acquisition of Principle A and their acquisition of Principle B is highly unexpected from a theoretical perspective. Principle A and Principle B were originally formulated as two complementary principles (Chomsky, 1981). Principle A requires reflexives to be bound within their local domain, whereas Principle B requires pronouns to be free within the same domain. Furthermore, Principle A and Principle B were assumed to be part of the same innate module of grammar: Binding Theory. But if this is a correct characterization of language users' linguistic competence regarding reflexives and pronouns in English, Principle A and Principle B are expected to be available from an early age on. To be able to maintain a nativist view on grammar in the light of the Delay of Principle B Effect, many studies have attributed children's errors with pronouns to extra-grammatical factors such as performance difficulties or task effects. However, if the asymmetric results of comprehension experiments are somehow caused by extra-grammatical factors, a relevant question is why children's comprehension of reflexives is not affected by these factors, whereas children's comprehension of pronouns is.

In contrast to children's comprehension of reflexives and pronouns, children's production of reflexives and pronouns has been studied much less extensively. Bloom et al.'s (1994) study was one of the first to systematically investigate children's production of reflexives and pronouns in Principle B contexts. Looking at spontaneous production data in the CHILDES database, Bloom et al. collected first-person reflexives and pronouns in English occurring as objects of verbs. Because first-person reflexives and pronouns are unambiguous, in contrast to

second- and third-person forms, it is possible to determine their correct usage on the basis of the form of the utterances only. Longitudinal data from three children, whose ages ranged from 2;3 (read as: two years and three months) to 3;10 years old, were analyzed. The data showed correct production of the first-person reflexive *myself* 93.5% of the time, and correct production of the first-person pronoun *me* 99.8% of the time. So, very young children already obey Principle B in their production of first-person pronouns. This is quite surprising, given the results of the comprehension experiments which indicate that children do not yet show mastery of Principle B in comprehension until the age of 5 or 6. Although it is possible that the children in Bloom et al.'s study did not make any errors because children master first-person pronouns before third-person pronouns, it is highly unlikely that the difference between first-person pronouns and third-person pronouns would span several years. So the Bloom et al. study suggests the existence of an asymmetry between production and comprehension, which is unexpected from the point of view of a rule-based grammar, according to which the correct use of a rule in production implies knowledge of this rule. Obviously, if children possess knowledge of a particular rule, then they should in principle also be able to use this rule in comprehension.

To make sense of children's spontaneous production data from a nativist perspective, Bloom et al. conclude that it must be the case that the results of previous comprehension experiments do not adequately reflect children's knowledge of grammar. Later studies confirmed that children's correct early production of first-person pronouns is not due to a difference between first-person pronouns and third-person pronouns: In experiments testing the same children on the same type of materials with third-person pronouns, a significant difference was found between children's production of third-person pronouns and their comprehension of these forms (see de Villiers et al., 2006, and Matthews et al., 2009, for English; Spenader et al., 2009,

for Dutch). Thus, in an experimental setting children show more or less correct production of third-person pronouns from at least the age of 4;6 onward, while at the same time still making many errors in their comprehension of these pronouns.

So pronoun production seems to be ahead of pronoun comprehension by perhaps as much as several years. This asymmetry between production and comprehension is unexpected under the assumption that comprehension and production go hand in hand, or that comprehension must even precede production. However, producing a sentence is a different task than comprehending a sentence, requiring different cognitive and motor skills, so it may be impossible to directly compare one's competence in production to one's competence in comprehension. Furthermore, spontaneous production may reflect children's competence in a more direct way than children's responses in an experimental task do. This latter consideration led Bloom et al. to dismiss previous comprehension results in favor of their own production results. But simply dismissing the results of comprehension experiments as an experimental artifact does not give us a complete account of children's acquisition of pronominal binding. Recall that a complete account should not only explain the surprising asymmetry between pronoun production and pronoun comprehension, but should also explain the well-documented asymmetry between the comprehension of reflexives and the comprehension of pronouns. To account for this systematic asymmetry between reflexives and pronouns in English and several other languages, it is necessary that linguistic theory treats reflexives and pronouns differently. It is not sufficient to simply conclude that comprehension in general is more difficult than production. We would need an explanation for why pronouns, but not reflexives, are susceptible to extra-grammatical factors in comprehension. For this reason, many theoretical accounts of the Delay of Principle B Effect assume a distinction between variable binding and coreference, with variable binding being

simpler or more economical than coreference (see section 4.2 for a discussion of the motivation behind this distinction as well as empirical evidence against this distinction). Because reflexives always require variable binding, whereas pronouns also allow coreference, this assumption yields an explanation for the greater difficulty posed by pronouns than by reflexives in comprehension.

In the next section we will discuss another production/comprehension asymmetry displaying such systematicity, with particular forms being more prone to children's errors in comprehension than other forms.

3. Systematicity

In 1975, Robin Chapman and Jon Miller published a study about young children's mastery of SVO word order in English (Chapman & Miller, 1975). They found that the 15 children between ages 1;8 and 2;8 in their study tended to preserve subject-object order in the production task, but not in the comprehension task. In the production task, when having watched the experimenters perform the action of a toy car hitting a boy doll, the children would produce forms such as "car hit boy" or "hit boy", rather than "boy hit car" or "hit car". Thus, their production was characterized by correct SVO word order. However, these same children, when tested on the same type of sentences in a comprehension task, significantly less often used word order information as a cue to subject-object status. The children frequently demonstrated the action expressed by the sentence *The car is hitting the boy* with the boy doll hitting the toy car, suggesting that for them the sentence could carry the incorrect meaning that the boy is hitting the car. This gap between children's performance in production and their performance in

comprehension of SVO word order, with production preceding comprehension, has been replicated in a number of later studies (e.g., McClellan et al., 1986). Whereas recent explanations of the Delay of Principle B Effect have moved away from the domain of core syntax to incorporate extra-grammatical aspects of interpretation such as pragmatic knowledge or processing resources, it seems that basic word order is a more immediate reflection of the grammar.

If the general conclusion of the Chapman and Miller study holds, and production of SVO order indeed precedes comprehension of SVO order, why hasn't this conclusion led to the large-scale introduction of linguistic models in which production and comprehension are driven by separate grammars? Obviously, this is because assuming two independent grammars that develop at a different rate is highly unattractive. Although the combination of a production grammar and a separate comprehension grammar would explain why success in production is irrelevant to success in comprehension, such a linguistic model would never account for the general adult pattern that we are able to understand whatever we can produce and vice versa. Symmetry would then be the exception instead of the rule. Chapman and Miller themselves attributed the comprehension delay they found to the general inability of young children to reverse cognitive operations. Others have argued instead that the comprehension task employed in Chapman and Miller's study involves complex task demands that obscure the child's actual knowledge of grammatical structure (Bates et al., 1995).

Because the observed asymmetry between children's production of SVO order and their comprehension of SVO order seemed perfectly explainable by non-linguistic factors, Chapman and Miller's results did not have a large impact on linguistic theory. However, the explanations mentioned above overlook one important aspect of Chapman and Miller's results. In their study,

Chapman and Miller not only compared performance on production to performance on comprehension, but they also manipulated the animacy properties of the subjects and objects in their experimental materials. Although children's overall performance on comprehension was significantly worse than their performance on production, children were particularly bad at interpreting sentences with an inanimate subject and an animate object (such as *The car is hitting the boy*) and showed the fewest errors when interpreting sentences with an animate subject and an inanimate object (such as *The boy is hitting the car*). In other words, children's comprehension results showed systematic effects of animacy. Children seemed to use animacy as a cue in determining what is the subject and what is the object of the sentence. Their responses in comprehension are compatible with a preference for subjects to be animate and objects to be inanimate. Importantly, children only used this preference as a cue in comprehension, not in production. Because of this systematicity, a general explanation in terms of rule reversal or task effects does not account for the entire pattern.

A complete account of the acquisition of word order should make reference to this preference for subjects to be animate and objects to be inanimate. The crucial question is whether this preference is of a linguistic nature, or whether it has a non-linguistic cognitive basis. If the preference is of a linguistic nature, it follows that children's competence in their comprehension of SVO order lags behind their competence in the production of SVO order. On the other hand, if the preference has a broader cognitive basis, children's errors in comprehension can be dismissed as performance errors. So to be able to determine whether there is an asymmetry between linguistic competence in production and linguistic competence in comprehension, it is essential to know what aspects of comprehension and production belong to the grammar, and what aspects belong to the general cognitive system. Since different linguistic theories have different views on

the division of labor between grammar and other cognitive systems, they may differ in what they consider to be 'real' asymmetries. Moreover, some linguistic theories seem better equipped for explaining asymmetries than others (see section 4 below). How one can, and perhaps even should, explain a particular asymmetry (including the systematicity involved in this asymmetry) thus largely depends on the linguistic theory that is adopted. On the other hand, the more asymmetries can be explained by a linguistic theory, the greater its explanatory power. Everything else being equal, a linguistic theory that is able to explain asymmetries between production and comprehension is to be preferred over a linguistic theory that is unable to do so.

In this section and the previous one, we discussed two cases where production seems to precede comprehension: object pronouns and SVO word order. The pattern displayed by these cases goes against the overall tendency in language acquisition that comprehension precedes production. A relevant question for the study of asymmetries in language acquisition as well as for linguistic theory in general is how common this inverse pattern is. Importantly, does production precede comprehension in particular domains of language only, or is it a highly pervasive pattern? Asymmetries have been argued to occur in widely varying domains such as prosody (Cutler & Swinney, 1987), syntactic attachment of prepositional phrases (Hurewitz et al., 2000) and noun phrase interpretation (de Hoop & Krämer, 2005/6). However, we do not yet have a good overview of where asymmetries do occur and where they do not occur, because there have not been many systematic investigations into the relation between production and comprehension. Only recently, studies have begun to combine and compare production data and comprehension data related to the same linguistic phenomenon. This Special Issue hopes to contribute to this question by discussing such data from various linguistic domains, perhaps

allowing us to draw more definite conclusions about the occurrence of asymmetries in language acquisition.

A related question is whether production/comprehension asymmetries are language-specific, or whether the same asymmetries can be found across languages. We can answer this question on the basis of the many studies on the Delay of Principle B Effect. From these studies, it can be concluded that some languages (such as English, Dutch, and Danish) display this effect, but other languages (such as Italian, French, and Norwegian) do not. Whereas English-speaking children frequently make errors in their interpretation of object pronouns, Italian-speaking children do not make errors in their interpretation of object clitics (McKee, 1992). Interestingly, the Delay of Principle B Effect seems to be sensitive to syntactic structure. Spanish-speaking children are adult-like with respect to object clitics in transitive sentences, but make errors with object clitics in Exceptional Case Marking constructions (such as *La niña la ve bailar* 'the girl sees her dance') (Baauw & Cuetos, 2003). These observations suggest that an adequate account of the Delay of Principle B Effect, and perhaps also of other asymmetries, must somehow appeal to linguistic structure. The cross-linguistic variation with respect to the Delay of Principle B Effect, and its construction-dependency, again emphasize the systematicity of production/comprehension asymmetries.

4. Explaining asymmetries in child language

In the previous sections, we already alluded to possible explanations for the asymmetries under discussion. This section presents an overview of the most frequent types of explanations that have been offered for production/comprehension asymmetries, and their implications for the

study of language. Explanations of asymmetries between production and comprehension in child language generally fall into one of four categories. According to one type of explanation, these asymmetries are caused by particular properties of the experimental tasks used. A second type of explanation holds that these asymmetries are the result of children's lack of particular pragmatic knowledge. Alternatively, these asymmetries may be the result of children's insufficient processing resources or immature cognitive abilities. A fourth type of explanation attributes asymmetries between production and comprehension to particular properties of the grammar.

4.1. Asymmetries as an experimental artifact

Experimental tasks typically place the child in an artificial situation. Such an artificial situation may cause children to make errors that they would not make in a more natural situation. Therefore, it is conceivable that children's errors in those linguistic experiments that show a delay are caused by task demands that obscure the child's actual knowledge of the grammar. Several studies (e.g., Bloom et al., 1994; Conroy et al., 2009) have adopted this line of argumentation to dismiss the comprehension results in favor of the production results. These studies conclude that children do possess the relevant knowledge of grammar, even though they make errors in comprehension experiments. Comprehension errors are made because children are, for some unknown reason, more sensitive to the felicity conditions associated with the use of particular forms than adults are (Conroy et al., 2009; Crain et al., 1996; Gualmini, 2004).

There have also been studies that have argued for the exact opposite position. Observing an asymmetry between children's adult-like prosodic performance in production and their deficient performance in perception, for which their own perception experiments provided

additional evidence, Cutler and Swinney (1987) conclude that children's better production skills must only be apparent. That is, accenting must be a primitive physiological reaction associated with speaker excitation, without any linguistic intention or underlying meaning representation. So Cutler and Swinney dismiss the production results in favor of the comprehension results. In their view, children do not yet possess the relevant linguistic knowledge, a conclusion that is confirmed by children's errors in experiments assessing their prosodic understanding.

If the comprehension results or the production results can be dismissed whenever an apparent asymmetry is observed, there is no remaining asymmetry that is in need of an explanation. Consequently, this type of explanation does not have any implications for linguistic theory. However, it does have serious implications for the empirical foundations of linguistic theory. In studies showing a Delay of Principle B Effect, a variety of tasks has been used: truth-value judgment tasks, picture verification tasks, picture selection tasks, and act out tasks. If all of these tasks have serious shortcomings and cannot reliably be used for assessing children's knowledge of Principle B, a crucial question arises: How can children's knowledge of language be investigated? And perhaps, more generally, how do we know that the results of linguistic tasks reflect the knowledge of adult language users in an adequate way? Of course, one could restrict the study of language acquisition, and perhaps of language in general, to the study of spontaneous speech. However, it is impossible to study all aspects of comprehension by looking at transcripts of spontaneous speech only. This was the reason Bloom et al. (1994) could only investigate first-person pronouns in their study, and not third-person pronouns. Even if databases of spontaneous speech are enriched with video and other contextual information, it may still be necessary to test specific predictions in a controlled experiment. But if the results of none of the tasks can be trusted to truly reflect children's linguistic knowledge, there is no way we can

empirically test the linguistic theories under discussion. So this type of explanation runs the risk of introducing serious methodological obstacles, unless alternative ways of empirical testing can be found that are more natural but at the same time do not introduce any extra-grammatical clues that could point the child to the correct response. The latter condition is crucial, because designing a task in such a way that the form under investigation is used in a more felicitous way may result in accidentally introducing such contextual clues. For example, Spenader et al. (2009) argue that a coherent discourse context provides such clues for interpreting object pronouns correctly.

4.2. Asymmetries as a result of lack of pragmatic knowledge

Although children may have acquired all relevant knowledge of the grammar, they may not yet be aware of the subtleties involved in using this grammar. Chien and Wexler (1990) propose this type of explanation to account for children's errors with object pronouns. The distribution of object pronouns is governed by Principle B of Binding Theory. Principle B prohibits binding of an object pronoun by its local subject. However, there are several well-known exceptions to Principle B. Consider (3):

(3) That must be John. At least he looks like him.

In the context of (3), *him* may corefer with the local subject *he*. Chien and Wexler argue that exceptions such as (3) are not violations of Principle B, but rather illustrate the difference between variable binding and coreference. Although Principle B rules out binding of the pronoun

him by the local subject *he*, accidental coreference between *him* and *he* is allowed in special contexts, governed by a pragmatic principle that they termed Principle P. This principle later became known as Rule I (for Intrasentential coreference, cf. Grodzinsky & Reinhart, 1993; Thornton & Wexler, 1999). According to Rule I, coreference is only allowed if the coreference interpretation can be distinguished from the variable binding interpretation. Children make errors with object pronouns because they do not know this pragmatic principle yet. As a result, children also allow coreference in contexts where adults would not allow it.

Chien and Wexler's explanation of the Delay of Principle B Effect is based on a theoretical distinction between variable binding and coreference. Chien and Wexler tested this distinction by comparing children's comprehension of pronouns occurring with a proper name as their antecedent to children's comprehension of pronouns occurring with a quantified subject. In their study, children performed much better with quantified subjects, suggesting that children possess knowledge of binding and only have problems with coreference. Later studies however found that children do not perform better with quantifier binding (Conroy et al., 2009; Matthews et al., 2009). This casts serious doubt on the theoretical distinction between variable binding and coreference in pronoun interpretation.

An explanation of asymmetries in terms of children's lack of pragmatic knowledge assumes a sharp theoretical distinction between grammar and use of grammar: Knowledge of grammar is innate, whereas the use of the grammar as reflected in pragmatic knowledge must be learned. As a consequence, acquisition delays are only expected for those aspects of language that must be learned (e.g., coreference), and not for aspects of language that are assumed to be innate (e.g., binding). Postulating that certain aspects of pragmatic competence must be learned, however, is not uncontroversial. Some of the major approaches to pragmatics, Relevance Theory

(Sperber & Wilson, 1986/1995) and neo-Gricean pragmatics (e.g., Levinson, 2000), have argued that pragmatic competence is innate. Although shifting the task of explaining the Delay of Principle B Effect to pragmatics lifts the burden from grammar, this account must then explain why children appear to master many other aspects of pragmatic competence from an early age on, and how exactly children learn the allegedly missing aspects of pragmatic competence. A further challenge for an explanation of asymmetries in terms of children's lack of pragmatic knowledge is that it must be shown that all linguistic phenomena displaying an asymmetry between production and comprehension require specific pragmatic knowledge that children do not yet possess. The interpretation of object pronouns is clearly influenced by pragmatic knowledge. However, it is not immediately obvious how SVO word order in English is influenced by pragmatic knowledge of the sort that adults possess but children do not yet. For English-speaking adults, determining what is the subject of the sentence seems to proceed independently of discourse context. Furthermore, although Thornton and Wexler (1999: 95) point out that children's assumed lack of pragmatic knowledge not only has ramifications for children's comprehension but also for their production, they do not specify what these ramifications are for the production of pronouns. For this reason, it remains unexplained why children who make errors in their comprehension of object pronouns, show adult-like performance in their production of object pronouns.

4.3. Asymmetries as a result of cognitive limitations

It is also conceivable that children possess all relevant linguistic knowledge, both of the grammar and of the use of grammar, but are unable to apply this knowledge due to cognitive limitations.

Children's adult-like performance in production could be seen as an indication that they possess the relevant knowledge of grammar. However, they may not show adult-like performance in comprehension yet because they lack sufficient cognitive resources to perform particular computations involved in comprehension. These cognitive resources could range from the ability to perform Theory of Mind reasoning to sufficient working memory capacity.

Starting from a pragmatic account of the Delay of Principle B Effect, Tanya Reinhart's work evolved into a more general explanation of comprehension delays in terms of working memory limitations. In her most recent work (e.g., Reinhart, 2004; 2006), Reinhart argues that because the grammar generates two different derivations for a sentence containing a pronoun (namely a derivation involving variable binding and a derivation involving coreference), hearers must compare these derivations and their corresponding interpretations through an operation called reference-set computation. This comparison operation is not part of the grammar but applies at the interface of the grammar with other cognitive systems. If children do not yet have sufficient memory capacity to complete this comparison, they resort to a strategy such as guessing. The same type of explanation can be given for children's comprehension delays with respect to contrastive stress, quantifier scope and scalar implicatures. Thus, this approach generalizes to several other comprehension delays. With respect to production, Reinhart's account predicts no delays to arise (Reinhart, 2004: 135-136). This has to do with the different role of reference-set computation in comprehension and production. The grammar allows for certain additional procedures, such as coreference, stress shift and quantifier raising, which Reinhart (2004: 117) terms 'superfluous' procedures because they are not necessary from the perspective of the grammar, but only from the perspective of the use of language in context. Because such additional procedures can apply, in certain cases the grammar will generate

multiple derivations for one sentence. This results in multiple interpretational possibilities in comprehension, which the hearer must compare to obtain the intended interpretation. In production, on the other hand, it is unnecessary for the speaker to compare multiple derivations and interpretations, because the speaker "always knows which meaning he or she intends" (Reinhart, 2004: 136). Therefore, under Reinhart's view, the architecture of the language system is in a certain way asymmetric: Reference-set computation applies in comprehension but not in production.

As yet, few studies have empirically investigated the relation between children's pattern of comprehension errors with object pronouns, marked stress or quantifier scope, and the same children's cognitive limitations as measured on a relevant cognitive task. Although it seems reasonable to assume that young children have a lower working memory capacity than older children, this is not sufficient for concluding that these cognitive limitations must be the cause of children's errors in comprehension. To be able to draw this conclusion, it must be shown that children with higher working memory capacity perform better on the comprehension of object pronouns, marked stress and quantifier scope than children with lower working memory capacity. Furthermore, an account seems to be needed of why and how reference-set computation taxes working memory to a higher degree than other linguistic operations. A notable strength of this type of explanation is that it is able to account for a range of comprehension delays in a linguistically informed way. Errors in comprehension are predicted in those restricted areas of language where additional procedures such as coreference apply, whereas correct performance in production follows from the architecture of the language system. On the other hand, a limitation of Reinhart's account is that it only provides an explanation for comprehension delays, more specifically comprehension delays at the interfaces. No asymmetries are predicted

to arise in other areas of language. However, it remains to be seen whether other observed asymmetries between production and comprehension, such as the asymmetry with respect to SVO order (Chapman & Miller, 1975), which do not follow from Reinhart's account, can indeed be dismissed as experimental artifacts.

4.4. Asymmetries as a result of the grammar

Assuming two separate grammars, one for production and one for comprehension, is a highly unattractive solution to the problem posed by production/comprehension asymmetries. However, there are other ways of generating asymmetries on the basis of the grammar only. Certain models of grammar have the ability to generate different mappings between form and meaning depending on whether they are used for production or for comprehension (Keenan & MacWhinney, 1987; Smolensky, 1996). This direction-sensitivity of the grammar allows for a principled explanation of why production and comprehension need not go hand in hand in language acquisition. This type of explanation is not limited to delays in comprehension, but can also account for the well-known phenomenon that young children are able to understand much more than they are able to produce. For example, a young child may say *ta* to refer to a particular cat, while at the same time being perfectly capable of understanding the word *cat*. This early production delay is generally attributed to underdeveloped motor control. However, Smolensky (1996) points out that children's impoverished production shows a clear systematicity in that the same configurations which are disfavored cross-linguistically tend to be avoided in child language. This observation led him to propose an explanation for this general delay in children's masterly of early word forms in terms of a direction-sensitive grammar, Optimality Theory.

Asymmetries between production and comprehension can be generated by one and the same Optimality Theoretic grammar, applied in opposite directions of optimization. In production, the input to optimization is a meaning. Through a process of optimization over a set of potentially conflicting constraints which compare potential outputs for the input, this input meaning is mapped onto the optimal form for that meaning. In comprehension, the input is a form. Hence, the direction of optimization is reversed and proceeds from input form to optimal meaning, rather than from input meaning to optimal form. As a result of the different types of input in production and comprehension, and the fact that constraints in Optimality Theory are output-oriented (meaning that they only place restrictions on the output of optimization, not on the input), the grammar may generate different mappings between form and meaning in production and comprehension. This explains children's early pattern of impoverished production but correct comprehension (Smolensky, 1996). In the same way, Optimality Theory is able to account for the asymmetry with respect to SVO word order discussed in section 3 (Hendriks et al., 2005). Crucially, under this view production does not simply amount to reproducing an adult pattern which must first be acquired through comprehension. Instead, production and comprehension proceed separately, but on the basis of the same grammar.

If the constraints of the grammar are not yet ranked in the adult order, this may result in systematic non-adult outputs in production but not in comprehension, or vice versa, depending on the type of constraints that are ranked too high and hence are attributed too much importance. By assuming that linguistic optimization in adults proceeds in both directions at the same time, speaker effects on comprehension and hearer effects on production can be modeled as well. Bidirectional optimization results in a more restricted grammar that blocks particular occurrences of ambiguity and optionality. If children are not yet able to optimize bidirectionally, this may

give rise to additional delays in comprehension and production (Hendriks, 2008). An example of an ambiguity in child language that is blocked in adult language is the ambiguity of object pronouns in the Delay of Principle B Effect (Hendriks & Spenader, 2005/6). This ambiguity can still be observed in children's guessing pattern in comprehension experiments. So an Optimality Theoretic grammar may generate an entire range of asymmetries, not only at the interface with other cognitive systems but in all areas of grammar. These asymmetries disappear as a result of two mechanisms: the Optimality Theoretic learning mechanism of constraint re-ranking and the application of bidirectional optimization (Fikkert & de Hoop, 2009; Hendriks, 2008).

Rather than applying particular linguistic knowledge or particular computations in an asymmetric way (i.e., in comprehension only), as is the case in most pragmatic and processing accounts, in Optimality Theory the linguistic knowledge embodied in the constraints of the grammar is applied in a perfectly symmetric way (i.e., in comprehension as well as production). Asymmetries result from the direction-sensitivity of the constraints and hence of the grammar. Some of the constraints only have effects in production, other constraints only have effects in comprehension, and yet other constraints apply in both directions of use, depending on the whether they are defined as constraints on form (markedness constraints), constraints on meaning (also markedness constraints), or constraints on the mapping between form and meaning (faithfulness constraints). This potentially allows for an explanation of the cross-linguistic and construction-dependent variation of production/comprehension asymmetries, based on the particular linguistic constraints involved.

In contrast to the other types of explanations discussed, Optimality Theory not only predicts acquisition delays in comprehension, but also in production. Therefore, in addition to the delay in early word pronunciation discussed above, we should be able to find other delays in

production. A candidate for such a delay is children's production of unrecoverable subject pronouns (Karmiloff-Smith, 1985). If children are not yet able to incorporate the hearer direction of optimization when producing a sentence, they will prefer economical pronouns to uneconomical but more informative full NPs (see Wubs et al., 2009, for an Optimality Theoretic account and evidence for such a delay). Whether more production delays can be uncovered is an empirical issue. A serious gap in many explanations adopting a bidirectional optimization perspective concerns the question how children learn to optimize bidirectionally. Children may be unable to optimize bidirectionally because they do not yet possess knowledge of the mechanism of bidirectional optimization, or because they lack sufficient processing efficiency or working memory capacity to complete the process of bidirectional optimization, or perhaps because they do not yet have a sufficiently developed Theory of Mind to deal with the combination of speaker and hearer perspectives in bidirectional optimization. Because Optimality Theoretic models are linguistic models, they usually do not specify an answer to this developmental question. Nevertheless, a complete account of production/comprehension asymmetries will also require an explanation of how children learn to optimize bidirectionally. A possible answer to this question is given by Van Rij et al. (to appear). Based on a computational cognitive model of bidirectional optimization as well as an empirical study testing the predictions of this cognitive model, Van Rij et al. argue that children's inability to optimize bidirectionally is caused by their lack of sufficient processing efficiency to perform bidirectional optimization within the available amount of time (see also Hendriks et al., 2007). This however does not preclude the possibility that other factors may play a role as well.

To conclude, in this section we discussed four types of explanations for asymmetries between production and comprehension. The explanations proceed from different assumptions

about the grammar, and hence explain asymmetries in different ways. We considered their explanatory power with respect to several observed asymmetries by focusing on typically developing children. Some of the explanations refer to, or could potentially refer to, processing limitations or cognitive limitations. As such limitations may be characteristic of particular atypical populations, studying language production and language comprehension in atypical populations could further illuminate the complex interaction between cognitive processes, the dynamics of language use, and knowledge of grammar. Neurodevelopmental disorders such as autism, Williams Syndrome and Down Syndrome are characterized by different profiles of selective deficits and delays in language development, which seem to be related to particular impairments in non-linguistic cognitive skills (Tager-Flusberg, 2007). For example, autism is characterized by a significant impairment in pragmatic abilities, which is argued to be related to impairments in theory of mind mechanisms. On the other hand, Down Syndrome is characterized by an impairment of phonological and morphosyntactic aspects of language, which seems to be related to impairments in auditory working memory. For this reason, a systematic comparison of production and comprehension in typically developing as well as atypically developing children will most certainly increase our understanding of the human language faculty.

5. Overview of this issue

All contributions to this Special Issue address the relation between production and comprehension in language acquisition. The areas covered by the Special Issue range from phonology and syntax to semantics and pragmatics, and the topics addressed include phonological contrasts, number agreement, pronouns, (in)definites, focus and accentuation, and

relative clauses. Some of the contributions report the existence of an asymmetry between production and comprehension, with comprehension being ahead of production or production being ahead of comprehension, whereas others find that children show similar (either adult-like or poor) performance in production and comprehension.

Nicole Altvater-Mackensen and **Paula Fikkert** studied the production and perception of phonological contrasts in Dutch infants, focusing on the stop-fricative contrast. The infants in their study were more likely to confuse a stop with a fricative than vice versa, both in production and in perception. This asymmetry between stops and fricatives was found in longitudinal spontaneous speech data as well as in a perception experiment with 14-month old infants. Altvater-Mackensen and Fikkert argue that it is unlikely that processing limitations or task demands are responsible for infants' non-adult performance, and conclude that infants use partially unspecified phonological representations both in production and in perception. Their results thus suggest that in certain cases where perception appears to be adult-like whereas production is impoverished, perception may in fact also be impoverished. This impoverished perception cannot be detected through naturalistic observation, but was revealed in a cleverly designed experiment.

Whereas children generally produce subject-verb inflections correctly from a young age on, several studies suggest that children do not use verb inflection as a cue to subject number in comprehension before the age of 5 or 6. In an eye-tracking study with German-speaking 3- and 4-year old children, **Oda-Christina Brandt** and **Barbara Höhle** measured children's preferential looking behavior to two pictures when hearing an inflected sentence. In a second task, the children also had to point to the matching picture. In the first task, children generally looked at the correct picture. In the second task, however, children performed at chance. On the

basis of the looking task, Brandt and Höhle conclude that the children in their study are able to extract and use the number information conveyed by verb inflections in comprehension. Their conclusion therefore questions the hypothesis of an asymmetry in children's development of verb inflection. To explain the different results they obtained in the looking task and the picture selection task, Brandt and Höhle suggest that children's failure to demonstrate their comprehension ability on verb inflections when tested with the picture selection task may be caused either by the task demands involved in picture selection, or by the possibility that the on-line measurements of eye-tracking and the off-line response of picture selection target different stages in the interpretation process.

In a comprehension experiment, **Aoju Chen** investigated Dutch children's comprehension of focus-to accentuation mapping in syntactically simple SVO sentences. The study is motivated by a large body of literature reporting asymmetries between children's production abilities and their comprehension abilities with intonation, claiming that production of intonation precedes its comprehension. Reanalyzing data from an earlier production study, Chen argues that Dutch children's ability to use accentuation in marking focus approaches (but is not yet similar to) adult performance by the age of 4 or 5. In the comprehension experiment reported here, children of the same age had to make a judgment about the correctness of the answer of a question-answer dialogue, while reaction times were measured. Crucially, the sentences used as answers were of the same type as the sentences in the production experiment. As the comprehension experiment showed, pragmatically appropriate accent placement triggered shorter reaction times than pragmatically inappropriate accent placement, although children's reaction times were longer than those of adults. Comparing the results of this comprehension experiment with the results of the earlier production study, Chen concludes that 4- and 5-year-

old children's comprehension is as good as their production, and that there is no asymmetry in the focus-to-accentuation mapping in syntactically simple SVO sentences.

Carla Contemori and **Maria Garraffa** compared the comprehension, production and repetition of relative clauses in Italian typically developing children and children with Specific Language Development (SLI). Children with SLI were found to perform like typically developing children in comprehension, showing better performance with subject relatives than with object relatives, but to use different strategies in production and repetition. In production, children with SLI were unable to produce the subject relatives that they appeared to master in comprehension. They also showed poor repetition. Contemori and Garraffa argue that SLI children in fact use a non-syntactic linear strategy both in comprehension and production, assuming that the first NP in the sentence is the agent. So in this study, the typical pattern displayed by SLI children in comprehension is argued to have a non-typical cause, because of the same children's non-typical performance in production.

Focusing on English children's production and evaluation of referring expressions, **Catherine Davies** and **Napoleon Katsos** investigated whether these children produce over-informative utterances, and to which degree they judge over-informative utterances to be appropriate. Like adults, the 5-year old children in their study did not over-inform as speakers. However, unlike adults, the children did not reject over-informative utterances when given a binary judgment task. Rather, they almost always accepted these utterances. On the other hand, when given a magnitude estimation task, the children were sensitive to violations of informativeness and penalized over-informative utterances. Davies and Katsos conclude that the 5-year old children possess full grammatical and pragmatic competence in production, but are more tolerant to pragmatically infelicitous utterances in comprehension. As one possible

explanation for children's tolerance, they suggest that young children lack the metalinguistic awareness to treat pragmatic violations as grave enough to warrant a rejection when the only options are acceptance or rejection. However, when given a range of responses where they can select an intermediate response, young children do penalize over-informative utterances. The observed asymmetry with over-informativeness is thus explained as an artifact of the experimental task used.

Angeliek van Hout, **Kaitlyn Harrigan** and **Jill de Villiers** tested the production and comprehension of definite and indefinite NPs using parallel comprehension and production tasks in the same groups of 3- to 5-year old English-speaking children. They found two asymmetries between production and comprehension that are each other's mirror image. On the one hand, children overuse definite NPs in production but interpret them correctly. Consequently, van Hout et al. conclude that the comprehension of definite NPs precedes their production. On the other hand, children were found to produce indefinite NPs correctly but to interpret them overly liberally. On the basis of these results, van Hout et al. conclude that the production of indefinite NPs precedes their comprehension. The two asymmetries are explained as resulting from a direction-sensitive bidirectional optimality theoretical grammar. The study also finds a contrasting set of results in the two comprehension tasks (a truth-value judgment task and a newly designed referent-selection task), even for adults. Van Hout et al. argue that the two experimental tasks used for comprehension rely on different kinds of reasoning and relate to the grammar in different ways: A truth-value-judgment task requires the participants to perform unidirectional optimization, whereas a referent-selection task requires the participants to perform bidirectional optimization.

In languages such as English and Dutch, children have been argued to show an asymmetry between their production of object pronouns and their comprehension of these object pronouns. **Esther Ruigendijk**, **Naama Friedmann**, **Rama Novogrodsky** and **Noga Balaban** investigated the production and comprehension of reflexives and pronouns in children acquiring German and children acquiring Hebrew. The German-speaking children in their study comprehended pronouns in a picture selection task correctly from the age of 4 onward. Another group of German-speaking children of comparable ages did not make any errors in production. In contrast to the German-speaking children, the Hebrew-speaking children allowed local antecedents for pronouns up to the age of 6. The same children also incorrectly produced pronouns to describe reflexive actions. So both in German and in Hebrew there appears to be no asymmetry between production and comprehension: In German, there is no Delay of Principle B Effect, whereas in Hebrew the Delay of Principle B Effect also extends to production. The Delay of Principle B Effect in Hebrew is argued to be the result of children's limited processing capacity, which does not allow them to execute pragmatic Rule I to rule out coreference. Ruigendijk et al. suggest that in German accidental coreference is only exceptionally available, and therefore it is unnecessary to apply Rule I in German. Consequently, there is no Delay of Principle B Effect in German. Crucially, Rule I is argued to apply in comprehension as well as production. Thus, it is predicted that in languages in which a Delay of Principle B Effect is found in comprehension, the production of pronouns in reflexive action situations is also affected. Ruigendijk et al. suggest that the asymmetries that have been found for pronouns in English and Dutch in previous studies may have been caused by the experimental task used, a truth-value judgment task, and that in fact pronoun comprehension in these languages is as good as pronoun production.

The contributions to this Special Issue differ in whether they find an asymmetry between production and comprehension or not, and if they do, how they explain this asymmetry. Whether an asymmetry is found is highly dependent on the methodology used. The contributions strongly disagree on what they consider the best methodology for assessing children's linguistic knowledge. Several of the contributions to this issue (Brandt & Höhle; Davies & Katsos; van Hout, Harrigan & de Villiers) use two different methodologies for investigating children's comprehension of a particular linguistic form, with different results. Which of these methodologies gauges children's linguistic knowledge best? Rather than choosing a particular methodology because it gives us results that fit our initial assumptions best, it seems that we need a more principled way to decide which methodology to use, and how to interpret its results. This seems to be particularly urgent for language comprehension. For language production, the situation is generally perceived to be different. Spontaneous speech always results in directly observable production data, which should allow for an assessment of a language user's competence in production. However, speakers may sometimes resort to avoidance of forms they do not yet master or that are too taxing for their processing capacities (see the contributions by Contemori & Garraffa; Ruigendijk, Friedmann, Novogrodsky, & Balaban, this issue). Elicited production tasks are not entirely uncontroversial either, as they may suffer from some of the same drawbacks as comprehension experiments. Despite these concerns about existing methodologies for studying production, most debates in this Special Issue revolve around the experimental methods used for comprehension.

Because the process of interpretation does not yield directly observable data, it can only be studied through indirect behavioral measures, such as language users' intuitions or their communicative behavior. Such indirect behavioral measures include comprehension

experiments, which many believe to be essential to the study of natural language interpretation. Unfortunately, we do not have a full grasp yet of the cognitive demands that different experimental methods place on the language user, which type of linguistic knowledge these methods target, and which type of non-linguistic knowledge and skills they require. Asymmetries between production and comprehension highlight the importance of these issues. If a child shows correct production of a given form, the language input the child has received must have been sufficient for the child to acquire knowledge of the use of this form. If the child nevertheless seems to show poor comprehension of this same form, this immediately raises the question whether the child's comprehension actually is poor, or whether perhaps the method used to assess the child's knowledge in comprehension simply is not sensitive enough. Interestingly, using a possibly more sensitive method of investigation does not always reveal the presence of linguistic knowledge that could not be shown with other methods of investigation. It may also have the opposite effect, revealing the absence of linguistic knowledge, as Altvater-Mackensen and Fikkert (this issue) show.

Different methods of investigation not only differ in the linguistic effects they may or may not reveal, they also differ in the type of linguistic knowledge they target. Truth-value judgment tasks and picture verification tasks target the truth conditions of an utterance, picture selection tasks target relative preferences among interpretations, and preferential looking may target yet another type of linguistic knowledge. The methods we choose will ultimately be determined by the hypotheses our linguistic theory allows us to formulate and test. Ideally, these linguistic considerations are supplemented by knowledge of human cognition by means of which task effects and other non-linguistic factors can be either eliminated or controlled for.

Although there has been disagreement over the best methods for testing children's linguistic knowledge since the earliest child language experiments, the renewed interest in the relation between production and comprehension may lead to new ways of thinking about the empirical foundations of linguistic theory. We believe this Special Issue on production/comprehension asymmetries in language acquisition will make a significant contribution to this discussion.

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