Language Acquisition from a Biolinguistic Perspective

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Abstract

This paper describes the biolinguistic approach to language acquisition. We contrast the biolinguistic approach with a usage-based approach. We argue that the biolinguistic approach is superior because it provides more accurate and more extensive generalizations about the properties of human languages, as well as a better account of how children acquire human languages. To distinguish between these accounts, we focus on how child and adult language differ both in sentence production and in sentence understanding. We argue that the observed differences resist explanation using the cognitive mechanisms that are invoked by the usage-based approach. In contrast, the biolinguistic approach explains the qualitative parametric differences between child and adult language. Explaining how child and adult language differ and demonstrating that children perceive unity despite apparent diversity are two of the hallmarks of the biolinguistic approach to language acquisition.

Keywords:

Biolinguistics; Language Acquisition; Unification; Universal Grammar; Structure-dependence; Continuity Assumption; Usage-Based Approach

1. Introduction

There are many ways we could start this chapter, but a good place to start is with the Modularity Hypothesis. The Modularity Hypothesis supposes that the human mind/brain is comprised of "separate systems [i.e., the language faculty, visual system, facial recognition module, etc.] with their own properties" (Chomsky, 1988, p. 161). Proposals about the nature of modularity differ in at least two important respects. First, modular systems can be restricted to perceptual processes, or they can be taken to also encompass higher-level cognitive abilities, such as language and reasoning. A second difference concerns whether modular systems are innate, or become 'automatized' through experience. Although modularity does not entail the innateness of cognitive systems (see e.g., Karmiloff-Smith, 1992), most proponents of modularity advocate some version of the innateness hypothesis. All advocates of modularity share one assumption, that of domain-specificity. A module operates on objects in a specific domain. In the *Modularity of Mind* (1983, p. 51) Fodor asserts that "…the perceptual system for a language comes to be viewed as containing quite an elaborate theory of the objects in its domain; perhaps a theory couched in the form of a grammar of the language." The focus of the biolinguistic program is on language as a modular perceptual system. More specifically, the biolinguistic program is concerned with how sentences and their associated meanings are acquired by children, how they are used by both children and adults, how the system that pairs sentences and their meanings evolved, and how this system is represented in the mind/brain.

There is now considerable empirical evidence that language has the status of a module. The evidence takes several forms, including the fact that (a) any human language can be rapidly acquired by any typically-developing child in the absence of decisive environmental data, (b) language is unique to humans, (c) language shows

neurological localization from birth, and (d) language can be selectively impaired in special populations including some forms of brain damage and some genetic childhood disorders, and (e) language acquisition is governed both by a critical period and by a maturational timetable. The present study describes the biolinguistic approach to language acquisition. Chomsky (2007, p. 2) states the task as follows:

> "In biolinguistic terms, that means discovering the operations that map presented data to the I-language attained. Abstractly formulated, it is the problem of constructing a 'language acquisition device' (LAD), the problem of 'explanatory adequacy'. With sufficient progress in approaching explanatory adequacy, a further and deeper task comes to the fore: to transcend explanatory adequacy, asking not just what the mapping principles are, but why language growth is determined by these principles rather than innumerable others that can easily be imagined."

One of the most basic observations underpinning the biolinguistic approach to language acquisition is the naturalistic observation that all typically-developing children internalize a rich and complex linguistic system in just a few years. Acquisition of language is rapid and effortless for children, according to the biolinguistic approach, because the acquisition of language builds upon a foundation that is pre-determined by the biological endowment of the species. The human biological endowment for language is called Universal Grammar. Universal Grammar is the initial state of the language acquisition device (LAD). Universal Grammar contains core principles that are common to all human languages but, in addition, it contains information about ways in which human languages differ. Information about language variation is encoded in parameters. Universal Grammar, then, is a system of

principles and parameters. Although the principles of Universal Grammar are inviolable, children use triggering experience to set the parameters of Universal Grammar in order for children to adopt the same parameter values as adult speakers of the local language. Before certain parameters are set to the values adopted by the local language, however, the language spoken by children can differ from the language spoken by adults in the same linguistic community. Such differences are nevertheless highly circumscribed. Essentially, child language can differ from the language spoken by adults only in ways in which adult languages can differ from each other. This is called the Continuity Assumption (Crain, 1991; Pinker, 1994; Crain & Pietroski, 2001). The Continuity Assumption is one of the main topics of this chapter.

1.1. Elaborating the usage-based approach

The usage-based approach to language acquisition stands in stark contrast to the biolinguistic approach. There is nothing approaching the Continuity Assumption according to the usage-based approach. Rather, this approach supposes that children accrue linguistic knowledge in response to environmental input, using domain-general learning mechanisms, such as analogy and distributional analysis (Lieven & Tomasello, 2008; Saxton, 2010). Initially, linguistic knowledge is accrued in a piecemeal fashion. The products of language learning, including the generalizations that older children form, consist of 'shallow' records of their linguistic experience (see e.g., Pullum and Scholtz, 2002). The linguistic system that children internalize consists of constructions (*templates*, *schemas, constructs*) (see Goldberg, 2003, 2006). For this reason, many advocates of the usage-based approach call themselves constructivists.

A basic tenet of the usage-based approach is the claim that more frequent constructions are mastered earlier in the course of language development than less

frequent ones (Ambridge & Lieven, 2011; Lieven & Tomasello, 2008). Given that constructions are initially acquired piecemeal, children are expected to take a considerable time to internalize a system that pairs utterances and meanings in the same way as adult speakers. Moreover, when children start to form generalizations that extend beyond their experience, at around 4- to 5-years of age, the generalizations they form are just instances of a completely general problem of induction. Learning to project beyond one's linguistic experience is seen to be just one variant of the problem that arises for learning all sorts of things (see Cowie, 1999).

As noted earlier, one of the main issues we will be concerned with is the nature of the differences between child and adult language. According to the usage-based account, before children have identified the form-function mappings of the local language, they are expected to produce less articulated versions of the constructions that are produced by adults, missing certain of the linguistic ingredients that are present in adult speech. As children take on board more and more constructions, child language is expected to more closely match that of adults. Therefore the usage-based approach can be characterized as an "input matching" process. As Lieven and Tomasello (2008, p. 171) remark:

> "The difference between young children's inventories and those of adults is one of degree: many more, initially all, of children's constructions are either lexically-specific or contain relatively low-scope slots. As well as being less schematic than many adult constructions they are also simpler with fewer parts. And, finally, children's constructions exist in a less dense network — they are more ''island-like''."

The usage-based approach adopts the view that meaning is use, where "the primary

psycholinguistic unit of child language acquisition is the utterance, which has as its foundation the expression and understanding of communicative intentions" (Tomasello 2000, p. 61) What children acquire, then, is a mapping of forms with functions. The usage-based account purports that, in tandem, form and function also explain how children build up relations among constructions. As children progress towards the final stages of language development, they form abstract semantic relations among constructions. The final stage of language development is outlined as follows by Lieven and Tomasello (2008, p. 171):

> "Finally, the child has to abstract the relations between constructions. Evidence that this has occurred is that the child is able to transform an utterance in one construction into another construction, for instance a declarative into a wh-question or an active into a passive. This could be done by forming a semantic representation of what the speaker wishes to say, thereby allowing the production of the other construction. Whether and when the learner actually maps the form—function mappings of one construction to those of the other is an empirically open question at the moment. It depends on the metalinguistic expertise and/or educational level of different speakers."

As this quote indicates, the usage-based approach is open to findings showing that different people develop different proficiencies in language.

1.2. Elaborating the biolinguistic approach

In contrast to the usage-based approach, the biolinguistic approach contends that language acquisition is rapid and effortless, because language learners come

equipped with the principles and parameters of Universal Grammar. Children do not acquire constructions one-by-one. Rather children amalgamate even disparate-looking linguistic phenomena, where these draw upon the same principles of Universal Grammar. Principles of Universal Grammar apply within individual languages, tying clusters of phenomena together. And these same principles apply across languages, tying together similar phenomena in even historically unrelated languages. Uniting phenomena within and across languages requires principles that operate at a considerable distance from the surface. On the biolinguistic approach, it is likely therefore to turn out that what are considered to be different constructions on the usage-based approach draw upon the same principles of Universal Grammar. Because disparate-looking phenomena are derived from the same principles, children acquire these phenomena in concert, rather than piecemeal. This explains why language acquisition is so rapid and effortless for children, who master even seemingly complex structures by the age of 3.

The biolinguistic approach offers an explicit account of the (limited) ways in which child and adult languages can vary. This feature of language acquisition is explained, in part, by the parameters of Universal Grammar. Just as parameters determine, at least in part, how adult languages differ from each other, parameters are also invoked to explain children's non-adult linguistic behavior. This is stated as the Continuity Assumption, which maintains that children's non-adult linguistic behavior follows the natural seams of human languages. To cite just an example we will return to later, some languages require an overt (phonetically realized) copy of a *wh*-phrase in the middle of *wh*-questions. In other languages, inserting an 'extra' *wh*-word renders such questions unacceptable, as in *What do you think what Bill wants to do*? In keeping with the Continuity Assumption, some English-speaking children initially produce *wh*-questions with an 'extra' copy of the *wh*-word, so children produce questions that are

acceptable in some languages, but not in the local language (Thornton, 1990). The finding that children add structure is consistent with the Continuity Assumption, but it is not consistent with the usage-based approach, which contends that children's non-adult utterances should be "simpler with fewer parts."

Of course, the omission of linguistic material is also consistent with the Continuity Assumption. For example, it has been well documented that English-speaking children sometimes omit entire noun phrases that are required to be phonetically realized by adult speakers. A parade case of this is a stage at which English-speaking children omit Subject noun phrases (e.g., Hyams, 1986). Although many languages optionally omit Subjects (e.g., Spanish, Italian, Mandarin Chinese), the kinds of omissions children make are unacceptable for adult speakers of English. Again, child English differs from adult English in ways in which adult languages differ from each other. We will also report the findings of several experimental studies showing that children assign non-adult interpretations to certain sentences. Again, cross-linguistic research reveals that children's non-adult interpretations are licensed in possible human languages, but not in the language spoken by adult members of the community in which the child is being raised. This position was first formulated in Chomsky (1965); see also Pinker (1984) and see Yang (2002) for a formal implementation of this approach to language learnability.

In all of these cases, children's non-adult linguistic behaviour was the consequence of the fact that they initially adopt different values of parameters than those adopted by adult speakers of the local language. Children's initial non-adult assignments of parameter values do not impede their language acquisition, however. In each case, children's initial setting of parameters conforms to a learnability mechanism known as the Subset Principle (Berwick, 1985). This mechanism ensures that children have readily available 'positive' evidence informing them that they need to 'reset' the

relevant parameters to the values adopted by the local language. This evidence takes the form of 'detectable errors,' i.e., forms or meanings that the child's grammar cannot generate using the child's current grammar. The fact that child and adult language differs in non-trivial respects is not expected to hinder children from rapidly converging on a grammar that is equivalent to that of adult speakers.

It has been shown by advocates of the usage-based approach that children's productions represent only a small proportion of all of the possible syntactic combinations of certain word sequences. According to the usage-based approach, the finding that children's sentences are "island-like" reflects the statistical distribution of sequences of words in the input children encounter (cf. Tomasello, 2003). Even taking the findings at face value, the conclusion reached by advocates of the usage-based approach is unwarranted. The fact that children's productions lack broader statistical coverage, considering all of the syntactic combinations that are logically possible in adult language, does not entail that children's productions are not rule-governed (Valian et al., 2009; Yang, 2013). In this regard, it is worth pointing out that Valian et al. (2009) empirically demonstrated that child and adult language do not differ significantly in combinatory diversity. And Yang (2013) has demonstrated that (due to Zipf's law) the observed diversity in children's productions is more accurately modeled by a rule-based grammar than by models that rely on memorization and recall of word combinations.

Finally, according to the biolinguistic approach, all typically-developing children converge on a linguistic system that is equivalent to that of adult speakers of the local language. Because the human faculty for language is viewed as a domain specific perceptual system (i.e., a module), this approach contends that all children come to the task of language acquisition armed with the principles and parameters of Universal Grammar. The linguistic abilities of language learners are not expected to

depend on a person's level of education, for example. The principles and parameters of Universal Grammar explain children's convergence on the grammar of the local language before the age at which they begin to receive formal education. By 3-years-old, children are effectively adults in their abilities to produce and understand sentences they have never encountered before, to judge the truth or falsity of these sentences, and to discern entailment relations between them (see, e.g., Crain and Thornton, 1998, 2015).

The sections that follow, report the findings of experimental studies of child language that reveal young children's knowledge of a rich and complex grammatical system. We chose these studies because they focus on topics that have been investigated both by researchers who adopt the biolinguistic perspective and by researchers who adopt the usage-based perspective. The findings of these studies therefore allow us to compare the empirical and explanatory adequacy of both approaches to language acquisition. These studies were selected for two other reasons. First, they are experimental investigations of linguistic phenomena that children master before they reach school age, almost without exception.[1] Second, they are investigations of linguistic structures that children acquire in stages, including stages at which children produce non-adult sentences or assign non-adult interpretations to sentences.

2. Structure Dependence

Consider examples (1) and (2). Example (1) is a Yes/No question, and (2) is its declarative counterpart. On the biolinguistic approach, these two sentences are related. The Yes/No question (2) is transformed from the declarative sentence (1) by a rule.

[1] See section 3.2 for a discussion of the finding that children appear to be delayed in the acquisition of one linguistic phenomenon.

Essentially, the rule moves the copula verb *is* from its sentence-internal position in (1) to the sentence-initial position in the Yes/No question (2).

(1) John is happy

(2) Is John happy?

Advocates of the usage-based approach "do not accept the claim that questions are formed by a movement rule" (Ambridge et al., 2008, pp. 245-248) and "children acquire questions as an independent construction." According to the biolinguistic approach, all linguistic behaviour, including the formation of Yes/No questions, adheres to structure-dependence. The biolinguistic approach contends that all derivations by children and adults, across languages, are structure-dependent – the mind imposes structure onto experience, and not the other way around.

Note, however, that a computationally simpler, structure-independent operation could also derive (2) from (1). The structure-independent operation simply treats sentences like beads-on-a-string. The operation proceeds from left-to-right, one word at a time, until it encounters a member of a list of words {*is, can, will*,…}. When it finds one of these words, the word is repositioned at the beginning of the sentence. The structure-dependent rule (SD) and the structure independent operation (SI) are summarized in (3).

(3) **SD:** Move the auxiliary verb from the main clause to sentence-initial position

SI: Move the first verbal expression {*is, can, will*, …} to the front

Both the structure independent operation and the structure-dependent rule are compatible with the majority of the input available to young children (Chomsky, 1980).

The biolinguistic approach nevertheless proposes that children never adopt a structure-independent operation, according to which children treat sentences as strings of words. On this approach, all linguistic rules that child language learners formulate and execute are ones that analyze sentences into hierarchical structures. Children are precluded by human biology from treating sentences as strings. Therefore the biolinguistic approach predicts that children will not commit the kinds of errors that would result from the application of structure-independent operations. That is, children will never produce sentences using a structure-independent rule, despite the simplicity of such rules and their ability to replicate the input children encounter.

The empirical coverage of the structure-dependent rule and the structure-independent operation is roughly the same when the sentences under consideration are simple, as in examples (1) and (2). However, the superiority of the structure dependent rule becomes visible when the sentences that are under consideration are more complex. One kind of sentence that reveals the superiority of the structure-dependent rule is illustrated in (4). Sentence (4) contains both the auxiliary verb 'is', which appears inside the relative clause 'the dog that is sleeping', and another instance of the same word (the copula verb *is*) in the main clause. The Yes/No question that results from the application of the structure-dependent rule to the declarative sentence (4) is given in (5), and illustrated in the hierarchical structure shown in Figure 1. The Yes/No question that results from the application of the structure-independent operation is given in (6). Movement of the first verbal expression, from inside the relative clause, results in a clearly ill-formed Yes/No question. Assuming that children never formulate structure independent operations, they are never expected to produce Yes/No questions like (6), even when they first start to produce Yes/No questions that contain relative clauses.

(4) The dog that is sleeping is on the blue bench.

(5) Is the dog that is sleeping on the blue bench?

(6) *Is the dog that sleeping is on the blue bench?

('*' indicates deviance from adult usage)

insert Figure 1 here

This empirical prediction was first tested in an experimental study reported in Crain and Nakayama (1987). The Crain and Nakayama study elicited Yes/No questions from 3- to 5-year-old English-speaking children. The child's task was to pose questions to a character from Star Wars, Jabba the Hutt. The experimenter explained that this would be a good test to see if Jabba the Hutt could speak English. The declarative sentences, with relative clauses, were presented to the child in carrier phrases of the form "Ask Jabba if …". To elicit the Yes/No question corresponding to (4), for instance, the experimenter requested the child to "Ask Jabba if the dog that is sleeping is on the blue bench". Children produced many different kinds of Yes/No questions. About 60% of children's Yes/No questions were adult-like questions. The remainder differed in certain ways from those of adults, so it was clear that children were at the early stages in forming the Yes/No questions associated with sentences that contained relative clauses. Nevertheless, the child participants in the Crain & Nakayama study never produced any Yes/No questions that could be characterized as ones that had been derived from a structure-independent operation. Children never posed Yes/No questions like (6). Crain and Nakayama (1987) took this as evidence that children never hypothesize that a structure-independent operation is the source of Yes/No questions.

2.1. An account of Structure Dependence based on functional units

Advocates of the usage-based approach have disputed the conclusion reached by Crain and Nakayama (1987). We will discuss their objections momentarily, and point out why these objections are unwarranted. First, we wish to consider an alternative to the structure-dependent (SD) rule in (3). This alternative was introduced by Tomasello (2008, p. 85), who argues that children only *appear* to be using a structure-dependent rule. What children are actually doing is simply maintaining the integrity of the string of words, *the dog that is sleeping*. According to Tomasello (2008, p. 85), children refrain from extracting the auxiliary verb *is* from this string; otherwise, the remaining string, *the dog that _ sleeping*, would not serve its referential function:

> "If children understand NPs with relative clauses – if they understand that the whole phrase is used to make one act of reference – then there would never be any temptation to extract an auxiliary from it; they would simply understand that that unit stays together as one functional unit."

In sentence (5), on the other hand, the string of words, *the dog that is sleeping*, constitutes a referential unit. Tomasello reasons that children appear to conform to a structure-dependent rule because they are disinclined to interrupt functional units that are used to perform acts of referring.

2.3. Displacement in human languages

There may be some inherent plausibility of this account of children's behaviour in producing Yes/No questions with relative clauses, such as (5). It is unclear whether Tomasello (2008) intended this pragmatic account of the absence of structure-

independent errors to extend beyond this construction. If the account is extended, the generalization would be as follows: Children construct strings of words that form referential units, and do not extract words from sentences if the result would break up a "functional unit," i.e, strings of words that can be "used to make an act of referring." This extended generalization is clearly false. To see why, consider the example in (7). In the example, according to the biolinguistic approach, an expression has been displaced. A movement rule has displaced the *wh*-word *what.* Although this word appears in sentence-initial position, it was initially part of a referential NP that itself contains a *wh*-word, *a book about what*. Following the displacement of *what*, the string of words that remains, *a book about*, cannot be used to perform an act of reference.

(7) What did you read a book about?

cf. #A book about [ ] is worth reading.

insert Figure 2 here

The property of displacement is common in human languages. In English *wh*-questions, the displacement of part of a *wh*-phrase often leaves a preposition behind, at the end of the question, e.g., *Which book did you find the answer in* [ ]? or *Where does bacon come from* [ ]? These *wh*-questions end with the 'stranded' prepositions *in* and *from*. This phenomenon is called 'preposition stranding.' Preposition stranding is highly preferred in colloquial English. In some languages, however, preposition stranding is not tolerated; prepositions must be moved along with the remainder of the expression. This is referred to as pied piping - a reference to the Pied Piper of Hamelin, who used a flute to lure away rats, and later children, away from the town. The suggestion by Tomassello that functional units should remain intact implies that

children should consistently prefer pied piping to preposition stranding, just as some languages do. If this were the case, then English-speaking children would produce questions like *In which book did you find the answers*? and *From where does bacon come*? Clearly, these are not the kinds of questions children actually produce.

Although preposition stranding is preferred to pied piping in most *wh*-questions, English avoids displacement in questions with the *wh*-phrase *whose*, e.g., *Whose book did he buy*? and *Whose book do you think he bought*? In English, the possessive marker and the noun, -*'s book*, must undergo pied piping, resulting in the complex *wh*-phrase, *whose book*. English does not tolerate *whose*-questions such as *Whose did he buy book*? *Who do you think's book did he buy*?

Pied-piping is obligatory in English *whose*-questions, but it is not obligatory in many languages (e.g., Hungarian, Chamorro, Slavic languages). These languages permit the displacement of a *wh*–possessor word from the remainder of the phrase yielding whose-questions like (8) and (9), from Hungarian. Example (8) illustrates the (optional) extraction of the *wh*-possessor word *ki-nek* '*who*-Dative' from the remainder of the possessive phrase in a matrix question, and (9) illustrates the (optional) extraction of the *wh*-Possessor *ki-nek* '*who*-Dative' from the remainder of the possessive phrase in a long-distance question.

(8) Ki-nek$_i$ veszett el t_i a kalap-ja?
Who-Dat lose-Past away the hat-**poss**.3sg.Nom?
Literally: 'Who got lost hat?'
Meaning: 'Whose hat got lost?'

(9) Ki-nek$_i$ gondolod, hogy láttam t_i a báty-já-t?
Who-Dat think-2sg.def.DO that saw-1sg.def the brother-**poss**.3sg-Acc?

Literally: 'Who do you think I saw brother?'

Meaning: Whose brother do you think I saw?

The Continuity Assumption allows for the possibility that English-speaking children break up functional units in *whose*-questions, as in Hungarian. If so, the grammars of children acquiring English would generate *whose*-questions that are unacceptable for adults. This is exactly what was found in an elicited production experiment reported in Gavruseva and Thornton (2009). Several of the child participants in this study produced split English *whose*-questions, such as (10).

(10) Who do you think's book is on the table.

In (10), the adult *wh*-phrase *whose book* is divided into two parts, with the *wh*-word *who* separated from the remainder of the possessive phrase, *'s book.* For adults, the phrase *whose book* must remain intact, yielding *Whose book do you think is on the table*? The fact that English-speaking children break apart *whose*-phrases runs counter to Tomassello's proposal that children keep functional units intact. On the biolinguistic approach, there is no constraint, pragmatic or otherwise, that compels strings of words to "stay together as one functional unit." If, as Tomasello argues, such a constraint prevents children from extracting an auxiliary verb from a relative clause in Yes/No questions, then it is surprising that the constraint is not more widespread in human languages, and that children and adults consistently disregard it in so many linguistic structures.

The biolinguistic approach offers an alternative account of the absence of Yes/No questions in which an auxiliary verb is extracted from inside a relative clause, such as the unacceptable Yes/No question, *Is the boy who smoking is crazy*? The

account takes the form of a domain specific, cross-linguistic constraint that prevents displacement of linguistic material that resides in a certain structural position in sentence structures. The structure dependence of children's Yes/No questions is just one instance of this general constraint on the extraction of linguistic material (see Berwick, Chomsky and Piattelli-Palmarini, 2012; Crain and Pietroski, 2001).

2.2. Children as distribution analyzers

There is another proposal for why children do not make (or make very few) structure-independent errors. Ambridge et al. (2008) propose that children do not make structure-independent errors such as (11) because the bigram 'who smoking' is infrequent in the input that children experience. As distributional analyzers, children are unlikely to produce utterances that group infrequent words together.

(11) *Is the boy who smoking is crazy?

According to Ambridge et al. (2008), children's production of questions involves the same procedure as a recurrent network performing a word prediction task. Based on training with simple declarative sentences such as *Mummy is beautiful* and questions like *Is mummy beautiful*?, a recurrent network 'learns' to produce adult-like questions corresponding to declarative sentences with a relative clause, because the network downgrades the probability of 'smoking' (or any progressive verb form) following 'who'. The claim by Ambridge et al. is that children avoid structure-dependence errors because they are distributional analyzers.

If children's production of adult-like Yes/No questions is the result of their replication of the co-occurrence patterns they encounter in the input, then this leads to

clear empirical predictions. For example, children would be expected to make more structure-independent errors in cases where the transitional probability of a given bigram is higher than that of the bigram 'who smoking.'

Now consider the declarative sentence (12). This sentence contains the singular noun, *boy*, followed by the relative pronoun, *who*, the modal auxiliary verb, *can,* and the uninflected verb *run*. This brings together the well-formed substring *boy who can run*. Let us see what extraction of the auxiliary means in terms of the probability of resulting bigrams. If we extract *can* out of the relative clause *boy who can run*, we end up with the string *boy who run*. Even though this trigram has low probability, the bigram *who run* that is contained in it, has a high probability, as it is completely acceptable in sentences like *Boys who run are usually fit*. That is, the bigram *who run* has a higher probability than the bigram *who smoking*. According to Ambridge et al., then, this means that children will produce structure-dependence errors such as (13) more often than ones like (11).

(12) The boy who can run fast can jump high.

(13) *Can the boy who run fast can jump high?

Notice what happens, in addition, when the plural noun, *boys*, is substituted for the singular noun, *boy*. Example (14) is a declarative sentence with the plural noun 'boys.' The illicit structure-independent Yes/No question corresponding to this declarative sentence is (15), which contains, apart from the bigram *who run*, the higher frequency trigram *boys who run*. The trigram *boys who run* is a well-formed functional unit, in contrast to the trigram *boy who run*. So the trigram *boys who run* is much more likely to be in the input to children than *boy who run* or *boy who smoking*. On the distributional account of children's structure-independent errors, therefore, children are expected to

make an even greater number of structure-independent Yes/No questions with plural nouns that are modified by relative clauses, as compared to singular nouns (examples are adapted from Ambridge et al., 2008).

(14) The boys who can run fast can jump high.

(15) *Can the boys who run fast can jump high?

Ambridge et al. (2008) tested these predictions in two experiments based on the methodology used in the Crain and Nakayama study. Children were presented with declarative sentences with both singular nouns and ones with plural nouns, either with auxiliary verb, *can*, or with a form of the copula, *to be*. The task for the child participants was to convert these declarative sentences into Yes/No Questions. In contrast to the Crain and Nakayama study, the child participants in the Ambridge et al. study did produce some non-adult Yes/No questions like (11), (13) and (15), in which the auxiliary verb was absent from a relative clause. However, these errors were infrequent. The study found no significant difference in error rates between the different types of Yes/No questions. Non-adult Yes/No questions with singular nouns constituted 7% of all scorable[2] responses, and non-adult Yes/No questions with plural nouns constituted 9% of children's responses. The error rate for questions with a form of the copula verb, *to be*, did not differ significantly from the error-rate for questions with the auxiliary verb, *can*. Based on these null findings, it seems unlikely that the acquisition of Yes/No questions involves a straightforward application of the same mechanisms that are used in a recurrent network.

[2] Scorable responses are a proper subset of children's responses. Looking at all of children's responses would reduce the percentages of structure-dependence errors, e.g., to around 5% for the plural and singular questions with 'can' combined.

In summary, less than 10% of children's responses in the Ambridge et al. study were non-adult-like. Ambridge et al. conclude that their findings falsify the claim that children never postulate structure-independent rules: "Thus whilst structure-dependence errors are by no means frequent, they would seem to be made by a reasonably high proportion of children, at least for questions with the modal auxiliary CAN" (p. 233). However, there is no evidence that a structure-independent operation was the source of any child's responses. Non-adult responses were not characteristic of individual children, but were spread among the child participants. This suggests that children's non-adult productions were errors in performance, and not the result of a structure independent operation.

2.3. Structure-dependent interpretations

The distributional analysis of children's Yes/No questions also fails to engage with the interpretations that children and adults assign to sentences. Consider the often-cited Yes/No question (16). This question contains two verbs (*fly* and *swim*) and the sentence-initial modal auxiliary verb *can*. From a logical point of view, it is unclear where the auxiliary verb *can* originated. The two options are presented in (16a,b).

(16) Can eagles that fly swim?

a. Eagles that fly can swim

b. Eagles that can fly swim

Chomsky has introduced numerous arguments showing that the initial auxiliary verb is associated with the verb *swim*, and not with closer verb *fly*. Chomsky makes the relevant points in the following passage (2013, p. 651-652).

> "Consider the sentence "instinctively, eagles that fly swim." The adverb "instinctively" is associated with a verb, but it is *swim*, not *fly*. There is no problem with the thought that eagles that instinctively fly swim, but it cannot be expressed this way. Similarly the question "can eagles that fly swim" is about the ability to swim, not to fly. What is puzzling about this is that the association of the clause-internal elements "instinctively" or "can" to the verb is remote and based on structural properties rather than proximal and based on solely linear properties, a far simpler computational operation and one that would be optimal for processing language. … In technical terms, the rules are invariably *structure-dependent*, ignoring linear order. The puzzle is why this should be so – not just for English but for every language, not just for these constructions but for all others as well, over a wide range. … What is it about the genetically determined character of language – UG – that imposes this particular condition?"

As this passage from Chomsky makes clear, our native speaker intuitions tell us that the auxiliary verb *can* in (16) originated in the main clause, as a modifier of the verb *swim*. It follows that the declarative counterpart to the Yes/No question is (16a), not (16b). Native speakers of English not only have knowledge about the well-formedness of surface strings, but they also know which interpretations are compatible with a particular surface string and which are not. Moreover, there is no way to invoke either functional units of reference, or distribution analysis to explain why native speakers know that the auxiliary verb *can* has been extracted from the main clause in (16), and not from the relative clause. The string *eagles that fly* is as much a functional unit as *eagles that swim*, and it is highly unlikely that adding the auxiliary verb *can* to either string results in a different probability of occurrence in children's experience, i.e.,

eagles that can fly versus *eagles that can swim*. As such, the usage-based proposals based on functional units or distributional analyses seem ill-equipped to handle our native speaker intuitions about sentences like (16). These semantic intuitions about the underlying structure of Yes/No questions follow from structure-dependence, and are backed up by facts about morphological agreement, such as those exhibited in (17) and (18), which are taken from Chomsky (2012).

(17) Are eagles that fly swimming?

(18) Have eagles that fly been swimming?

This is not just an isolated case at far removed from children's experience. Native speakers of English also know immediately that the Yes/No question in (19) is derived from the declarative sentence (19a), and not from (19b). Again, these native speaker intuitions reflect our knowledge that Yes/No questions cannot result from a structure-independent operation. And again, these intuitions about interpretation cannot be explained by appealing to functional units of information or to differences in distributional frequency.

(19) Was the contestant who lost kept waiting?

a. The contestant who lost was kept waiting.

b. The contestant who was lost kept waiting.

(adapted from Berwick et al., 2011)

The evidence that human languages do not use local well-formedness as the basis for sentence meaning is not limited to abstract cases taken from adult speech. An experiment conducted by Gualmini and Crain (2005) showed that 3- to 6-year-old

English-speaking children do not group sequences of words into semantic units based on local well-formedness relations. The experiment presented sentences like (20) to children. This test sentence contained the well-formed substring ‘he cannot lift the honey or the doughnut’ (21).

(20) Karate Man will give the Pooh Bear he can not lift the honey or the doughnut.

(21) … he can not lift the honey or the doughnut.

Notice that the substring yields the ‘neither’ interpretation of the disjunction word ‘or’. This interpretation is assigned because, in the substring indicated in (21), the disjunction word ‘or’ appears inside the scope of negation. However, the ‘neither’ interpretation of the disjunction word ‘or’ is not available if language-users assign a hierarchical structure to sentence (20). Then, the substring in (21) is part of a relative clause, as indicated in the structural representation in (22).

(22) Karate Man will give [*the Pooh Bear he can not lift*] the honey or the doughnut

In the hierarchical representation, negation resides inside the relative clause and, therefore, cannot take scope over the disjunction word ‘or.’ The interpretation of (20) that results is the ‘not both’ meaning, rather than the ‘neither’ interpretation that would be assigned if the sentence was treated as a string of words.

Gualmini and Crain (2005) tested children’s interpretation of the disjunction word ‘or’ in sentences like (20). Children correctly accepted sentence (20) 80% of the time as a description of a story in which Karate Man had given Pooh Bear a doughnut, but not the honey. This shows that children do not analyze negation as taking scope over the disjunction word ‘or’ in the test sentences. If so, children would have rejected

the test sentences. This finding indicates that children assigned an adult-like hierarchical structure to sentence (20), as represented in (22). Children did not assign an interpretation consistent with the substring in (21).

This example and numerous others reveal the empirical inadequacy of the usage-based approach. According to one advocate of the usage-based approach (Lieven, 2010, p. 2547) "children build their grammars initially out of the phonological–lexical strings that they learn from the input rather than analysing that input in terms of pregiven, more abstract, linguistic categories." Instead of seeing children as projecting hierarchical structure in order to derive adult-like interpretations for sentences such as (21), the usage-based approach contends that children are sensitive to "surface co-occurrence patterns in the input data" (Ambridge et al., 2008, p. 234). If so, then nothing would prevent children from assigning the 'neither' interpretation to the disjunction operator in the substring (21), but children never make this assignment, as Gualmini and Crain showed.

To conclude this section, the alternatives proposed by the usage-based account for the absence of structure-independent errors are not convincing. On the one hand, the domain general mechanisms invoked by the usage-based approach to language acquisition are too strong, because they predict errors that children do not make. On the other hand, these mechanisms are too weak, because they fail to account for the possible interpretations that children do and do not assign to sentences.

3. Anaphoric Relations

From a biolinguistic perspective, the initial state in language acquisition consists of the same structure-dependent linguistic principles that govern adult languages. We saw how such principles operated in both adult and child language in the previous section,

where we discussed how English Yes/No questions were derived from their declarative sentence counterparts.

This section takes up another class of structure-dependent phenomena, ones that restrict the interpretations of noun phrases of various kinds, including ordinary pronouns such as *he* and *him*, reflexive pronouns like *himself*, and referring expressions such as *Papa Bear*. Anaphoric relationships between noun phrases are permitted in certain structural configurations, but not in others. The constraints on anaphoric relations are stated in a series of binding principles (e.g. Chomsky, 1981; Reuland, 2011). The biolinguistic approach anticipates that child language learners will adhere to the same structural constraints that are exhibited in adult languages, including the binding principles. These binding principles, and other linguistic constraints, are seen to be part of the innately specified Universal Grammar, so children are expected to exhibit knowledge of anaphoric relations as soon as they can be tested.

According to the usage-based approach, by contrast, there are no such structural constraints either in child or adult language. Instead, the usage-based approach contends that "the facts attributed to the binding principles reduce to a very simple functional explanation" (Ambridge et al., 2014, p. e80). According to the usage-based approach, children learn information-theoretic principles (e.g., noun phrase accessibility) that "could replace the need for innate syntactic constraints" (Matthews et al., 2009, p. 605). One mechanism that plays an important role in anaphoric relations according to the usage-based approach is pre-emption. For example, pre-emption prevents children from assigning co-reference between a pronoun and a referential noun phrase that both appear in the same simple sentence. An example is *Joe adores him*. According to Matthews et al. (2009, p. 605) "co-reference in sentences such as "Joe adores him" is not so much ruled out as pre-empted by sentences like "Joe adores

himself"."[3] Likewise, Boyd and Goldberg (2011, p. 55) contend that pre-emption is the means by which "speakers learn not to use a formulation if an alternative formulation with the same function is consistently witnessed." Essentially, the idea is that children repeatedly encounter sentences with a reflexive pronoun such as *Joe adores himself* in circumstances that depict a reflexive event. Pre-emption leads children to refrain from using ordinary pronouns, such as *him*, in these same circumstances. Before long, children use the pronoun *him* and the reflexive pronoun *himself* in the same way as adults do, restricting the use of *himself* to circumstances in which the referent of the Subject noun phrase stands in some abstract relation to himself, e.g., he adores himself, or performs some action upon himself. Thereafter, the 'reflexive' meaning is reserved for sentences with reflexive pronouns such as *himself*, and is not assigned in sentences with ordinary pronouns such as *him*. At that point, child language matches the adult language in this respect.

There is an immediate problem with this account, however. An extensive literature on this topic reveals some overlap in the use of ordinary pronouns and reflexive pronouns. Examples from English are provided in (23). The overlap in interpretations is indicated by the indices on the NPs. We will adopt the usual conventions: NPs that have the same index are interpreted as picking out the same referents(s); they are said to be anaphorically related, or coreferential. NPs with different indices are interpreted as picking out different individuals, and are not anaphorically related; they are said to be disjoint in reference, or non-coreferential.

(23) a. Max_i likes jokes about him_i/himself_i

b. Max_i saw a gun near him_i/himself_i

[3] See Yang (2015) for discussion of several formal problems in an account of pre-emption based on statistical analysis.

c. Lucie$_i$ counted five tourists in the room apart from her$_i$/herself$_i$

(This example is from Reinhart and Reuland 1993, p. 661)

In the case of the sentences in (23), the indices indicate that the ordinary pronoun, *him,* may be anaphorically related to the Subject NP, *the boy*. This is surprising on the usage-based account, because the examples in (23) show that the reflexive pronoun, *himself*, is also permitted. Presumably, pre-emption should prohibit coreference between the pronoun, *him*, and the referring expression, *the boy*. The fact that *him* is acceptable under coreference shows that other factors are at work in such examples. Moreover, if children were to use a pre-emption strategy to learn constraints on anaphoric dependencies, they would never master cases like (23). That is, children who applied pre-emption would not converge on a grammar that is equivalent to that of adult speakers of English. We turn next to the more far-reaching question - the extent to which information-theoretic principles are the equals of structural principles.

3.1. Blocking Coreference

From a biolinguistic perspective, sentences are hierarchically structured, and linguistic principles (e.g., the binding principles) constrain the interpretations that can be assigned to them (e.g., Everaert et al., 2015). In contrast, the usage-based approach contends that the adult final-state of language acquisition does not constitute a generative grammar, but, rather, a set of constructions (Ambridge and Lieven, 2011, p. 123). Structure-dependent rules therefore have no role on the usage-based approach. Instead of structure-dependent principles, the usage-based approach invokes information-theoretical principles to account for the same linguistic phenomena. For example, the interpretation of pronouns in single clause sentences is subject to the following

principle: "if a pronoun is used as the topic, this indicates that the referent is highly accessible, rendering anomalous the use of a full NP ANYWHERE within the same clause" (Ambridge et al., 2014, p. e77, fn.17). To unpack this principle we need to know how to identify the topic of a sentence. On the usage-based approach, "the topic/theme is the NP that the sentence is 'about', and about which some assertion is made (the comment/focus/rheme)" (Ambridge et al., 2014, p. e77).

We will examine this proposal as it pertains to some of the examples discussed in Ambridge et al. (2014). First, these usage-based researchers say that the principle just expounded explains why example (24) is unacceptable. In example (24), the pronoun, *he,* is the topic of the clause. As a result of the discourse principle under consideration, the lexical NP *John* cannot be used to refer to the same person as the pronoun does. To introduce some terminology, when a pronoun precedes a lexical NP, as in (24), this is referred to as backward anaphora, and when a lexical NP precedes a pronoun, this is called forward anaphora. As the examples in (24) indicate, coreference between a pronoun and a lexical NP is tolerated in sentences with forward anaphora, but coreference is blocked in certain cases of backward anaphora.

(24) *He$_i$ adores John$_i$'s mother dearly.

cf. John$_i$'s mother adores him$_i$ dearly.

Ambridge et al. (2014) propose to account for the unacceptability of (25) in the same way. We question this account, however, as we now discuss.

(25) *John$_i$'s mother, he$_i$ adores dearly

Sentence (25) is an example of a syntactic process called Topicalisation. In Topicalized structures, the sentence-initial noun phrase, *John's mother*, originated in object position, following the verb *adores*. This explains why the declarative sentence *John's mother adores dearly* is unacceptable; it lacks a Direct Object. Topicalization takes the topic phrase *John's mother,* and positions it at the front of the sentence. However, it moves back into its original position at the level of semantic interpretation. This process of interpreting an expression twice, once in its surface position, and a second time at a different position, is called reconstruction. The process of reconstruction for (25) is schematically depicted in (26).

(26) ~~John's mother~~ he adores < John's mother > dearly

insert Figure 3 here

After reconstruction, the semantic representation of sentence (25) is identical to that of sentence (24). In both cases, coreference between the pronoun *he* and the lexical NP *John* is ruled out. More specifically, coreference is ruled out in both (24) and (25) because *John* resides in the structural domain of the pronoun *he* (i.e., following reconstruction in the case of (25)).

Technically speaking, the structural relationship between the pronoun and the referring expression is known as c-command. It may be useful to think of c-command as sentence scope, so if a noun phrase A c-commands another noun phrase B, then A takes scope over B. One of the binding principles (called Principle C) dictates that coreference is ruled out whenever a pronoun takes scope over a referring expression.

As a result of reconstruction, the pronoun *he* in the Topicalized sentence in (25), *John's mother, he adores*, takes scope over *John*, just as it does in the declarative sentence (24). Hence, coreference is ruled out in both (24) and (25).

By contrast to this unified account of linguistic phenomena, the usage-based approach treats each construction as unique. The usage-based approach lacks structural constraints on anaphoric dependencies, and it also lacks mechanisms that displace (move) or reconstruct phrases from one position in a structural representation to another position. On this approach, therefore, there is no straightforward way to rule out both (24) and (25), as it treats the two sentences as unrelated linguistic units. The problem for the usage-based approach is that no single information-theoretic principle could apply to both sentences. In example (25) the sentence is clearly about John's mother, and not about John. So, the phrase *John's mother* is the topic of sentence (25). By contrast, the pronoun, *he*, is the topic of sentence (24). Because *John's mother* and not the pronoun *he* is the topic of (25), the sentence does not violate the discourse principle proposed by Ambridge et al. Given that the discourse principle is inoperative in (25), the pronoun *he* should be free to refer to the same individual as the lexical NP, *John*, just as it does in other cases of forward anaphora, e.g., *John's mother likes his tie*. In short, the account proposed by the usage-based approach incorrectly predicts that (25) should be acceptable on an interpretation that takes *John's mother* and *he* to be coreferential.[4]

In response, Ambridge et al. might contend that the Subject noun phrase is always the topic of the sentence. If so, example (25) would be ruled out, because *he* would be the topic in (25), just as it is in (24). However, this explanation of non-

[4] The same holds for the other examples of Topicalisation in their footnote 17. Still further cases can be found in the literature, such as (i).

(i) *Proud of John$_i$, he$_i$ was. (Heycock and Kroch, 2002, p. 159 (71a))

coreference turns on the structural notion of *Subject*, rather than the information-structural notion of *topic*. If the operative principle is about Subjects rather than topics, then the usage-based approach runs into further difficulties. One difficulty would be to account for the acceptability of (27) and (28), as compared to the unacceptability of (29).

(27) What he_i claimed was typical of Ian_i

(Heycock and Kroch, 2002, p. 143, example 12)

(28) Whose survey describing $John_i$ does he_i resent?

(adapted from Sportiche 2006)

(29) *Thinking of $John_i$ scares him_i

In (27), the pronoun *he* is the Subject/topic. This means, according to the information-theoretic principle, that coreference between *Ian* and *he* should be out. In contrast to this prediction however, coreference with *Ian* is allowed. Similarly, the usage-based approach incorrectly predicts that the pronoun *he* and the referring expression *John* cannot be coreferential in (28). Notice, also that, because the pronoun, *him*, resides in the object position in (29), it cannot be the Subject or the topic, so coreference should not be ruled out according to the information-theoretic principle. Again, this is contrary to fact.

The account offered by the usage-based approach for the assignment of anaphoric relations in multi-clause sentences is similar to the account of single clauses they offer, as the following remark makes clear: "In general, it makes pragmatic sense to use a lexical NP (including quantified NPs like *everyone*) as the topic about which some assertion is made, and a pronoun in a part of the sentence containing information that is secondary to that assertion, but not vice versa." There is an additional principle

at work in sentences with multiple clauses. The principle is this: "once a speaker has already referred to an individual with a full NP, it is quite natural to use a pronoun in a subsequent clause, and indeed, unnatural not to […]." It follows that the only cases in which coreference is ruled out, are sentences in which a pronoun which appears in the topic position precedes a noun phrase that appears in a clause that expresses presupposed information, i.e., a backgrounded clause. On this account, however, sentences like (30) and (31) are predicted to be acceptable, again contrary to fact. The NP precedes the pronoun in each of these examples, so coreference should be possible, but it is not.

(30) *It is $Spot_i$, that he_i brushed

(31) *$John_i$ is who he_i thinks they are about to fire

(Heycock and Kroch, 2002, p. 158, example 67)

The examples in (30) and (31) are cases of reconstruction, as in example (25). Because the usage-based account is based on strings, rather than structures, it has no recourse to syntactic operations (e.g., reconstruction) that reposition noun phrases from one place to another. But this prevents the usage-based approach from using syntactic structure to determine whether or not an anaphoric dependency is allowed. Sentences that involve the reconstruction of constituents will consistently run counter to the information-theoretical mechanisms postulated by the usage-based approach. On the other hand, the facts about coreference and non-coreference follow naturally from the biolinguistic approach. Again we would emphasize that the arguments we are making are not about idiosyncratic facts about adult English. Not only does the biolinguistic approach predict that the constraint on interpretation that is witnessed in sentences like (30) and (31) should be known to English-speaking children as soon as they can be tested, but this

approach predicts that children across the globe should adhere to this constraint on interpretation as it applies to a range of linguistic structures. We return to this point in section 7.

3.2. Thornton, Kiguchi & D'Onofrio (2015)

The prediction of the biolinguistic approach was empirically investigated by Thornton, Kiguchi and D'Onofrio (2015) using cleft sentences like (30). The study presented test sentences such as (32) and (33) to preschool children, as well as the control sentences indicated beneath them.

(32) Test Sentence: It was Spot that he brushed
Control Sentence: He brushed Spot

(33) Test Sentence: It was her pig that every girl carried
Control Sentence: Her pig carried every girl

Adults interpret the test sentence in (32) to require disjoint reference between the pronoun *he* and the name *Spot*, just as in the control sentence, *He brushed Spot,* where the pronoun precedes the name in the surface syntax. In the test sentence in (32), the full NP *Spot* undergoes reconstruction at the level of semantic interpretation. Coreference is prohibited in both the test sentence in (32) and in the control sentence, because the subject NP is in the structural (c-command) domain of the pronoun at the level of semantic interpretation. This is depicted in (34); the reconstructed NP 'Spot' is shown in the angled brackets. As advocates of the usage-based approach point out, in general pronouns can be anaphorically linked back to 'full' noun phrases that precede

them. However, the pronoun cannot be anaphorically linked back to the full NP that precedes it in (32).

(34) It was Spot that *he brushed* < *Spot* >

(35) It was her pig that *every girl carried* < *her pig* >

Reconstruction also applies to the cleft sentence (33), as indicated in (35). In this case, reconstruction of the noun phrase enables the assignment of a bound pronoun interpretation of the noun phrase, *her pig*. Therefore, example (33) licenses the meaning that every girl carried her own pig in addition to the meaning on which every girl carried some other girl's pig. The surface form of the sentence provides no clue to the ambiguity. The bound pronoun interpretation is licensed under c-command due to reconstruction. Since the surface forms in cleft sentences such as those in (32) is not indicative of the prohibition on interpretation that is enforced by adults, a usage-based approach would presumably not predict that young children assign the same constraint on interpretation as adults do to such sentences. This is what the generative account predicts, however.

The Thornton et al. study of children's comprehension of cleft sentences and the control sentences used a research methodology called the Truth Value Judgment. In this task, stories are acted out in front of the child participants in the experimental workspace using toy characters and props. While one experimenter acts out the stories, a second experimenter plays the role of a puppet. At the end of each story, the puppet produces one of the test sentences, or a control sentence. The child's task is to say whether the puppet "said the right thing", i.e., whether or not the puppet's statement was a true or false description of the events that took place in the story. If the child judges that the puppet said something true, then it is assumed that the child's grammar

generates a structure and meaning for the sentence that matches the events that took place in the story. If the child judges the puppet's statement to be false, this is taken as an indication that the child's grammar generates a structure and meaning that does not match the events in the story.

A corollary assumption is that, whenever possible, children (and adults) access a meaning that makes the puppet's sentence true. This is called the Principle of Charity. Therefore, when the child judges the puppet's statement to be false, it is inferred that the child was unable to access any sentence-meaning pair that made the puppet's statement true. That is, children's rejections of the puppet's statements are evidence that the sentence is unambiguous for the child, and evidence that the only interpretation permitted by the child's grammar is one that does not match the story context. Children's consistent rejections of test sentences in the Truth Value Judgment task provide evidence that their grammars impose a constraint on interpretation, for example structural constraints on anaphoric dependencies. Children who are too young to successfully perform other psychological tasks, such as judgments of grammaticality, have proven able to produce reliable judgments of truth and falsity using the Truth Value Judgment task.

Twenty children participated in the Thornton et al. study, as well as a control group of 20 undergraduate students. The children ranged in age from 4;0 to 5;5, with a mean age of 4;9 years. Here are the main findings. The child participants rejected coreference in the cleft sentences such as (32) 94% of the time for the clefts, and they rejected coreference in the control sentences 99% of the time. The adult participants rejected sentences both the target and control sentences 100% of the time. Turning to bound pronoun cleft sentences such as (33), children accepted the bound pronoun interpretation 65% of the time, whereas they ruled out this interpretation of the control sentences 83% of the time. The adult participants produced a similar pattern of

responses. They accepted the bound pronoun interpretation in the cleft sentences, as in (33), 50% of the time, but rejected this interpretation of the control sentences 83% of the time. In view of the ambiguity of cleft sentences such as (33), it is not surprising that both children and adults sometimes chose the alternative, direct reference, interpretation, according to which the pronoun *her* functions as a deictic pronoun in the expression *her pig*. Children had no difficulty interpreting binding relations in sentences requiring reconstruction, despite the fact that the surface form and, hence the adult linguistic input, is uninformative about the impossibility of assigning certain interpretations to cleft structures.

3.3. Language Delay: Illicit coreference

In the previous section we found that the information-theoretic principles used by the usage-based approach do not suffice in accounting for children's rapid acquisition of knowledge about the anaphoric relations that can and cannot hold between different kinds of noun phrases. This section examines a case where child and adult language differs in the assignment of anaphoric relations. To understand the phenomenon, we must first make a distinction between binding and coreference. A binding relationship is one in which one expression is dependent on another for its interpretation. By contrast, coreference is a relationship in which two expressions pick out the same referent in a domain of discourse.

Coreference is witnessed in sentences with referential noun phrases, such as *John thinks he is clever*, where the pronoun *he* can pick out the same individual as the

name *John*.[5] An example of binding is given in (36). Intuitively, it is clear that there is no referent corresponding to the quantificational expression *no one* in (36). Nevertheless, the pronoun *he* can depend on the quantificational expression *no one* for its interpretation, when the pronoun is not being used deictically to refer to someone in the domain of discourse. This dependency is linguistically encoded and crucially differs from the assignment of the same discourse referent to two linguistic expressions (e.g. Reuland, 2001).

(36) *No one* thinks *he* is smart

The difference between quantified and referential NPs has proven to be important in child language research. A well-known observation from the acquisition literature is that children as old as 6;6 assign a non-adult interpretation to sentences with referential NPs combined with ordinary pronouns in object position. An example is the sentence *Papa Bear is washing him*. For children, this sentence is true in two circumstances, one in which John is washing some other male individual, and one in which Papa Bear is washing himself. Adults only judge the sentence to be true in the first of these circumstances. Interestingly, at the same time, children do not misconstrue sentences with reflexive pronouns, such as *Papa Bear is washing himself*. Children display adult-like judgments in response to sentences with reflexive pronouns by age 4 (Chien and Wexler, 1990; Jakubowicz, 1984; Deutsch, Koster and Koster, 1986; on English; Koster, 1993; Philip and Coopmans, 1996 on Dutch).

[5] Note that pronoun *he* in this particular structural configuration can also be bound by *John*. The bound variable representation yields the same meaning representation as the coreference representation.

Children's delay in assigning the adult-like meaning to sentences like *Papa Bear is washing him* is unexpected both on the usage-based approach, and on the biolinguistic approach (Matthews et al., 2009). Advocates of the usage-based approach conjecture that children's limited experience with such sentences may be responsible, at least in part, for the delay they experience (recall that a reflexive interpretation of pronouns in cases like *Papa Bear is washing him* is not ruled out, but pre-empted according to the usage-based approach). That is, if the child has not heard sufficient instances of sentences with a reflexive pronoun, then the coreference interpretation of ordinary pronouns might not be blocked, because pre-emption will not be sufficiently strong. Children's performance is therefore expected to gradually improve with experience.

From a biolinguistic perspective, the structural principles on anaphoric dependencies are expected to be in place from the earliest stages of acquisition. It has been proposed, therefore, that the difficulties children experience in mastering the non-coreference facts in sentences with referential NPs and pronouns is not due to a lack of syntactic knowledge. Rather, children are seen to experience difficulty in executing certain pragmatic principles that govern the interpretation of pronouns, potentially because they lack the required processing resources (see Grodzinsky and Reinhart, 1993; Thornton and Wexler, 1999). If this account for children's non-adult responses is on the right track, then children are expected to perform without fail in responding to sentences that are not governed by pragmatic principles, but are instead governed by structural principles. The sentences in question involve replacing a referential noun phrase, e.g., *Papa Bear*, by a quantificational noun phrase, such as *every bear*, as in (37). As we have seen, according to linguistic theory, quantificational NPs such as *every bear* do not permit a coreferential relation with a pronoun, because they do not refer. Quantificational NPs can only bind pronouns, rather than establishing a

coreferential relation with them, as referential NPs do. Therefore, the anaphoric relations between quantificational NPs and pronouns are regulated by structural principles, and not by pragmatic principles.

(37) *Every bear$_i$ washed him$_i$

(38) *Papa bear$_i$ washed him$_i$

The situational contexts corresponding to the sentences in (37) and (38) in the experiments were clearly different, because there was a salient single individual, Papa Bear, in the context corresponding to (38), but there were several bears in the context corresponding to (37). It has been suggested that such differences is context could have influenced children's interpretation of the pronouns in the test sentences (see, e.g., Elbourne 2005; Conroy, Takahashi, Lidz and Philips 2009). However, one study of the contrast between quantificational NPs and referential NPs, by Thornton (1990), was immune to this criticism. The Thornton study compared indirect questions and their answers, such as (39), and declarative sentences with plural referential NPs, such as (40). The *wh*-question *Who scratched them?* was expected to pattern in the same way as a sentence with a quantificational NP, such as *Every bear is washing him*.

(39) I know who scratched them. Bert and Ernie.

(40) Bert and Ernie scratched them.

In the Thornton study, test sentences like (39) and (40) were presented to children in identical contexts. Nevertheless, the twelve 3- to 4-year-old child participants (who ranged in age from 3;7 to 4;8) accepted coreference in (40) on half of the trials, but the same children consistently (92%) sentences like (39) in the same context. That is, on

half of the trials, children interpreted sentence (40) to mean that Ernie and Bert scratched themselves. However, the same children assigned this same interpretation to sentences like (39) on fewer than 10% of the trials. This is additional confirmation for the conclusion that children's non-adult interpretations of sentences with referential NPs are due to a delay in the acquisition of pragmatic principles, and did not represent violations of the structural binding principle.

As such contrasts make clear, the alternative approaches to language acquisition make different predictions about the patterns of children's linguistic behavior that are expected to be manifested in the course of acquisition. From a biolinguistic perspective, structural principles are available to children from the outset of language development, whereas children need time to expand their processing resources and/or to develop pragmatic skills.[6] For the usage-based approach, input frequency plays the major role in determining the pattern of acquisition. On the biolinguistic approach, therefore, children should not display difficulty in interpreting the pronoun in sentences with quantificational NPs, such as (37) and (39), even at the stage at which they experience difficulties in responding to sentences with referential NPs, such as (38) and (40). This prediction about the contrast between these sentences does not follow from the usage-based approach. The usage-based approach predicts no differences in children's responses to sentences with referential NPs or with quantificational NPs as "only generativist approaches to language acquisition predict that children will have knowledge of the relevant syntactic constraint" (Matthews et al., 2009, p. 607).

The difference in children's pattern of responses to sentences with referential NPs and ones with quantificational NPs has been documented extensively in the literature, and we will not review the evidence here. Suffice it to say that there is ample

[6] Of course, the child might still not display at-ceiling performance in particular experimental tasks as a result of task demands (Crain and Thornton, 1998).

evidence that children perform significantly better on sentences with quantified NPs than ones with referential NPs, and the difference is found across languages (see e.g., Chien and Wexler, 1990; Matthews et al., 2009[7]; Philip and Coopmans, 1996). This result is unexpected on the usage-based approach to language acquisition, but it is entirely consistent with the biolinguistic approach.

3.3. Guasti and Chierchia (2000)

At this point, we have discussed reconstruction effects in child language, and we have discussed the distinction between binding and coreference. A study reported in Guasti and Chierchia (2000) investigated Italian-speaking children's understanding of sentences involving reconstruction to assess their knowledge that anaphoric binding is determined by the structural properties of sentences, rather than by discourse principles, as proposed by Ambridge et al. (2014). Guasti and Chierchia (2000) investigated children's understanding of sentences where a prepositional phrase (PP) is *fronted* to sentence-initial position. Example (41) illustrates the phenomenon, which is called PP-preposing.

(41) Near John's bicycle, he saw a snake.

(42) [he$_1$ saw a snake $_{PP}$[near John$_2$'s bicycle]].

[7] The children in the Matthews et al. study did not preform at ceiling in responding to sentences with quantified NPs, in contrast to earlier studies. It is worth asking why the Matthews et al. study obtained different results. But the main point is that children did perform significantly better in responding to sentences with quantified NPs than to ones with referential NPs in the Matthews et al. study. This difference is not expected on the usage-based account.

The semantic representation associated with (41) is depicted in (42). As indicated in (42), the preposed-PP is reconstructed to its original position at the level of semantic interpretation. Following reconstruction, the referring expression, *John*, is positioned inside the structural domain of the pronoun, *he*. Therefore, the interpretation that is assigned to (41) analyzes the pronoun and the referring expression to be disjoint in reference, as in the corresponding declarative sentences such as (43), where the PP *near John's bicycle* appears *in situ* in the sentence structure.

(43) *He_i saw a snake near $John_i$'s bicycle.

Despite PP-preposing, therefore, both sentences (41) and (43) are assigned the same interpretation, with coreference ruled out in both sentences by a structural constraint (i.e., Principle C of the binding theory). This would not be expected on any account that is based on the surface string of words. Sentences where the pronoun appears first are referred to as backward anaphora, and ones in which the referring expression appears first are called forward anaphora. As Guasti and Chierchia remark (2000, pp. 130-131):

> According to *reconstruction* approaches, the structures of [our example 41] and [43] are virtually identical and, hence, the ruling out of the two cases has to be uniform. If Universal Grammar drives acquisition, this seems to predict that as soon as children get [43] right, they must also get [41] right. This is the opposite of what one would expect just by considering how forward and backward anaphora work in general. Thus, looking at reconstruction effects in child grammar might help us choose among these different hypotheses.

Returning to the pragmatic account proposed by Ambridge et al (2014), the PP-preposing example in (41) (repeated here) is on a par with (44), rather than being on a par with (43). Since the preposed lexical PP, *near John's bicycle*, is the topic (what the sentence is about), it should be quite natural to use a pronoun to refer to the same individual, as (44) illustrates.

(41) Near John's bicycle, he saw a snake.

(44) $John_i$ saw a snake near his_i bicycle.

According to the pragmatic account, therefore, (41) should be accepted by children (and adults in fact) in the same circumstances that validate (44), when John saw a snake near his own bicycle. Again, the biolinguistic approach and the usage-based approach make opposite predictions about how sentences with PP-Preposing will be interpreted. The usage-based account predicts that coreference will be permitted by children for sentences like (41), whereas the biolinguistic account predicts that coreference will be prohibited by children.

The Guasti and Chierchia study introduced another innovation. We saw in section *3.2* that children respond differently to sentences with quantificational expressions (e.g., *every bear*) as compared to sentences with referential expressions (e.g., *Papa bear*). Children were found to reject anaphorical relations significantly more often when coreference is unavailable (e.g., *Every bear washed him*), rather than when coreference is allowed (e.g., *Papa bear washed him*). Based on this asymmetry, Guasti and Chierchia investigated Italian-speaking children's knowledge of reconstruction in sentences with quantificational expressions. English translations of their test sentences are given in (45).

(45) a. He put a gun in every pirate's barrel.

b. In every pirate's barrel, he put a gun.

The pair of sentences in (45) are both unacceptable on the reading where the pronoun *he* is anaphorically dependent on (bound by) the quantificational *NP every pirate*. So the sentences can't mean that every pirate put a gun in his barrel; it can only mean that someone else put a gun in each pirate's barrel.

The Guasti and Chierchia study investigated Italian-speaking children's comprehension of *PP*-preposing Italian sentences like (46). The semantic representation of (46) is depicted in (47). As (47) indicates, following reconstruction, the (phonetically empty) Subject position has scope over the preposed *PP* (*nel barile di ciascun pirata con cura*). As a consequence, anaphoric binding is prohibited in (46), just as in the English example (45a).

(46) *Nel barile di ciascun pirata con cura (pro) ha messo una pistola*.

In the barrel of each pirate with care (he) has put a gun

'He put a gun with care in the barrel of each pirate'

(47) *[[ciascun pirata]$_1$ [con cura *pro*$_1$ ha messo una pistola [$_{PP}$ *nel barile di* t_1]]]

The main finding of the study was that 4- and 5-year-old Italian-speaking children rejected the illicit bound pronoun reading 90% of the time. That is, children rejected the sentence as a description of a situation in which every pirate put a toy gun in his own barrel.

In this section we have shown that, contrary to the claim of the usage-based account, it is impossible to account for anaphoric dependencies solely on the basis of

information-theoretic principles. Anaphoric dependencies are governed by structural principles and, crucially, children demonstrate knowledge of these structural principles as soon as they can be tested, even in cases in which the underlying structure does not match the surface string. Children's difficulties appear only when they are required to respond to sentences that are governed by principles external to syntax.

4. Children's Long Distance *wh*-questions

Advocates of the usage-based approach contend that children acquire language by attending to the input and attempting to formulate constructions that replicate it. Before children have internalized the constructions of the adult language, they are expected to make certain kinds of errors, but not others. It is instructive to consider examples. For example, children sometimes produce non-adult utterances that lack a finite verb, such as "Her open it." According to the usage-based approach, children's non-adult productions can be explained without recourse to abstract linguistic principles and can be based on misanalysis of the input (Kirjavainen & Theakston, 2009). For example, Tomasello (2000, p. 71) remarks:

> "… children hear things like "Let her open it" or "Help her open it" all the time, and so it is possible that when they say these things they are simply reproducing the end part of the utterances they have heard."

And Kirjavainen & Theakston (2009, p. 1094) address the fact that such non-adult uses of pronouns are optional as follows:

> "Within this approach, children are expected to extract lexically specific chunks from complex but relatively frequent utterances in the input, as well as learning shorter utterances as a whole. Thus, errors where a NOM pronoun is erroneously replaced with an ACC pronoun could be due to children hearing both I+verb (e.g. *I do that every day*) and me+verb (e.g. *Let me do it*) sequences, which could result in children having two competing constructions for a given verb (e.g. *I/me+do*) when referring to themselves."

Similarly, it has been proposed that a non-adult utterance such as *He go* could result from the omission of the modal *can* from the statement *He can go*, or from the omission of *wants to* from *He wants to go* (cf. Croker et al., 2003).

As these examples illustrate, the usage-based approach anticipates child language to differ from adult language by being "less schematic," and " simpler with fewer parts." In general, the usage-based approach anticipates that children will produce errors of omission, rather than errors of commission. Convergence to the adult language is also expected to progress slowly, on the usage-based approach, from a less articulated linguistic repertoire to one that more closely approximates that of adult speakers of the local language. When children begin to form generalizations, these are based on similarities across constructions.

By contrast, the biolinguistic approach anticipates that children's non-adult productions could be even more filled out than the productions of adults, including linguistic material that is not attested in the input. Regardless of the nature of children's non-adult productions and interpretations, the biolinguistic approach anticipates rapid acquisition. First, children's non-adult responses are highly constrained. They are expected to be compatible with possible human languages, rather than being less articulated variants of the construction used by adults. Second, the biolinguistic

approach anticipates that children will acquire constructions in complexes, amalgamating structures that may look different on the surface. Finally, the biolinguistic approach expects children's non-adult productions to be overturned in the course of language acquisition by readily available 'positive' evidence.

The next two sections report the findings of studies investigating the acquisition of complex kinds of *wh*-questions, and sentences with negation. Both linguistic phenomena have been studied by advocates of the usage-based approach, and by advocates of the biolinguistic approach. The findings and how the findings are interpreted, therefore, are particularly revealing about the alternative approaches, and permit an assessment of the relative success of both approaches to explain the same observations from child language. We begin with the investigation of *wh*-questions.

4.1. Wh-copying by English-speaking Children

This section describes an example of a commission 'error' that is sometimes produced by children acquiring English.[8] Although the sentence structures produced by these children differ from those of English-speaking adults, on the biolinguistic approach it is more accurate to refer to children's productions as non-adult linguistic behaviour, rather than as errors. This way of characterizing children's behaviour is in keeping with the Continuity Assumption (Crain, 1991; Crain & Pietroski, 2001). The present case study is instructive in this regard.

The present example is also instructive because it underscores the point that any viable account of language acquisition must explain entire patterns of children's

[8] We put the term 'error' in scare quotes because this term technically misrepresents the differences between child and adult languages on the generative account. We will explain why shortly.

linguistic behaviour. It is not enough to demonstrate that an error committed by children could be produced using the mechanisms invoked by the usage-based account. After all, language acquisition is also characterized by the absence of an unlimited number of non-adult linguistic behaviours. Moreover, it turns out that children avoid many potential pitfalls that would be expected if they were employing the kinds of general-purpose mechanisms that are invoked by the usage-based account. Any viable account of language acquisition is obliged to explain why certain 'errors' never occur. We will show how possible, but not actual errors are avoided because children come forearmed with the principles and parameters of Universal Grammar.

This section is concerned with the acquisition of *wh*-questions. As the term suggests, *wh*-questions are ones that begin with words like *who* and *what*. There are both simple and complex *wh*-questions. A simple *wh*-question is *Who was Elmo talking to*? Notice the 'gap' that follows the verb phrase at the end of the question, … *talking to.* The question word fills this gap. Nearly all *wh*-questions contain an 'empty' noun phrase (a 'gap') somewhere in the sentence structure.[9] The *wh*-phrase can consist of a 'bare' *wh*-word (*who, what*) or a 'full' phrase (*which boy, what kind of car*). In either case, the *wh*-phrase is associated with the gap. For this reason, *wh*-phrases are sometimes referred to as 'fillers,' and the entire question is called a filler-gap dependency.

An example of a complex *wh*-question is *Who did you say Elmo was talking to*? Again, there is a gap following the verb phrase … *talking to,* and the question word *who* fills the gap. The question word *who* and the gap following *talking to* are a considerable distance apart, in different clauses, so these questions are called long-

[9] There are two main exceptions to this generalization, *wh*-questions with *why* and ones with *how come*. *Wh*-questions with these *wh*-phrases do not typically contain a gap, e.g., *Why did John order a pizza*?

distance questions. The *wh*-word in sentence initial position precedes the main clause, which contains a verb such as *say* or *think* that requires an entire sentence as its complement. The complement to the verb *say* in the long-distance *wh*-question, *Who did you say Elmo was talking to*? is the embedded sentence, *Elmo was talking to*. So, the *wh*-word *who* in sentence-initial position fills the gap following the verb phrase *talking to* _ in the embedded clause. In English, the appearance of a question word in a *wh*-question usually corresponds to the presence of a 'missing' NP (a gap) somewhere else in the sentence. To account for this correspondence, linguistic theory proposes that most question words are 'displaced' from their original position, leaving behind the gap when they are repositioned from their extraction site to their landing site in the sentence structure.

4.2. Children's long distance wh-questions

A cursory glance at any transcript of infant directed speech leads to the conclusion that long-distance questions are not abundant in young children's experience. This, in turn, led researchers working in the biolinguistic program to carefully study children's initial attempts at producing long-distance questions, as this promised to be extremely revealing about the extent to which child language draws upon the basic building blocks of Universal Grammar, including both its principles and its parameters.

To investigate this, Thornton (1990) used an elicited production technique. The technique was used to evoke long-distance questions from 21 3- to 5-year-old English-speaking child participants. Elicited production tasks have been used successfully to target linguistic structures that children rarely produce. In the Thornton study, the experimental procedures were designed to encourage children to pose complex information-seeking *wh*-questions to a puppet. Children posed these question to the

puppet, requesting the puppet to tell the child, on behalf of the experimenter, what it thought about various states of affairs - what it thinks Cookie Monster likes to eat, what it thinks the child had hidden inside a box, who it thinks Grover would like to give a hug, and so on.

Interestingly, in posing these *wh*-questions to the puppet, roughly a third of the English-speaking children Thornton interviewed inserted an 'extra' question word into their long-distance *wh*-questions. Two examples of children's non-adult questions are given in (48).

(48) a. What do you think what Cookie Monster eats?

b. Who do you think who Grover wants to hug?

These non-adult *wh*-questions have a copy of the *wh*-words *who* or *what* in the middle of the questions, so they are also referred to as medial-*wh* questions. Although medial-*wh* questions are not licensed by adult English-speakers, they are an option in other languages, including dialects of German, colloquial Dutch, Frisian, Afrikaans, and Romani (Du Plessis, 1977; Hiemstra, 1986; Höhle, 2000; McDaniel, 1986, 1989; Reiss, 2000). In other words, whether or not long-distance questions contain a 'copy' of the *wh*-question word is one way in which languages vary. On the biolinguistic account, young English-speaking children who posit medial-*wh* questions are simply speaking a fragment of a foreign language for a time, as sanctioned by the Continuity Assumption. Adopting principles of Universal Grammar, Thornton was able to explain in detail how the foreign-looking questions in (48) emerged in child English, and how they were jettisoned in favour of adult questions.

Let us set momentarily aside the issue of the 'extra' copy of the question word, and focus on the adult versions of these questions: *What do you think Cookie Monster*

eats? and *Who do you think Grover wants to hug*? The derivation of English *wh*-questions such as these involves several steps. As we noted, linguistic theory postulates that question words do not originate in sentence-initial position. Rather, these question words originate in the object position, following the verb in the lower clause. However, question words like *who* and *what* do not move to sentence-initial position in one-fell-swoop. The movement of a question word is more like a local train rather than an express train. Before a question word assumes its position at the front of a long distance *wh*-question, it must pass through an intermediate position, between the upper clause and the lower clause. As a question word passes through the medial position, it leaves a copy behind, just as it leaves a 'gap' at its site of origin.

insert Figure 4 here

Now we can characterize the differences between languages that generate medial-*wh* questions, and ones that do not. The difference is quite superficial; it is whether or not the copy of the intermediate wh-question word is pronounced (see also Rizzi, 2006). The copy of the question word is not pronounced in adult English, but it is pronounced in other languages. Children, who have little experience producing long-distance questions are thus presented with two options: to pronounce or not pronounce the copy. Many children choose the adult English option, and omit the copy. However other children choose the option found in other languages, and pronounce the copy. These children produce *wh*-questions like those in (48).

4.3. A Usage-based account of children's non-adult utterances

On the usage-based approach, children do not automatically have access to computation of syntactic structure and abstract notions such as movement of question words. Children have to learn the word order of complex structures. Therefore, it would be surprising, if children could produce such complex structures. As Dabrowska, Rowland & Theakston (2009, p. 1) note:

> "A number of researchers have claimed that questions and other constructions with long distance dependencies (LDDs) are acquired relatively early, by age 4 or even earlier, in spite of their complexity. … Analysis of LDD questions in the input available to children suggests that they are extremely stereotypical, raising the possibility that children learn lexically specific templates … rather than general rules of the kind postulated in traditional linguistic accounts of this construction."

These usage-based researchers go on to suggest that children form long-distance *wh*-questions by drawing on existing 'templates' for structures they have already learned. The idea is that children simply take two existing templates and put them together. As Dabrowska et al. (2009, p. 3) state:

> "Interestingly, in their productions of LDD children sometimes produced questions … with a WH word at the beginning of both the main clause and the subordinate clause.
>
> *What do you think what is in the b*ox?
>
> *What way do you think how he put out the fire*?

> Thornton and Crain regard such 'medial WH' [ones with a copy between clauses] questions as evidence for the … application of movement … Note, however, that such utterances could also be produced by simply juxtaposing two independent questions (*what do you think*? + *what is in the box*?) or an independent question and an indirect question (*what way do you think*? + *how he put out the fire*?)."

A more general statement of the formation of complex linguistic structures is provided by Tomasello (2000, p. 77).

> "When they have no set expression readily available, they retrieve linguistic schemas and items that they have previously mastered (either in their own production or in their comprehension of other speakers) and then "cut and paste" them together as necessary for the communicative situation at hand, what I have called "usage-based syntactic operations". Perhaps the first choice in this creative process is an utterance schema which can be used to structure the communicative act as a whole, with other items being filled in or added on to this foundation. It is important that in doing their cutting and pasting, children coordinate not just the linguistic forms involved but also the conventional communicative functions of these forms, as otherwise they would be speaking creative nonsense. It is also important that the linguistic structures being cut and pasted in these acts of linguistic communication are a variegated lot, including everything from single words to abstract categories to partially abstract utterance or phrasal schemas."

At first glance, a cut-and-paste account of children's non-adult *wh*-questions has some intuitive appeal. A closer examination suggests serious problems with this analysis, however. For any account to be viable, there are two desiderata. First, the

account must explain the entire pattern of data that is observed and second, the account must explain the absence of certain data. In the remainder of this section, we show that the usage-based account advanced by Dabrowska et al. (2009) can account for only a limited range of children's productions. The account has two main failings. First, the usage-based account fails to explain the entire pattern of children's productions. Children produce several medial-*wh* questions that the account does not explain. Second, the account predicts the appearance of medial-*wh* question that are not attested in children's productions. In other words, the usage-based account overgenerates. This is problematic because children must eliminate any non-adult productions that their grammars generate. This is no easy task given that children lack what is called negative evidence, such as corrective feedback from adults. Previous research has shown that children are not consistently corrected by adults when they make grammatical errors (e.g., Brown and Hanlon, 1970; Marcus, 1993; Morgan and Travis, 1984). The absence of negative evidence makes it difficult to explain how children 'unlearn' non-adult linguistic structures that their grammars generate. Later, we discuss in detail how the biolingustic approach contends with the problem. Let it suffice for now to say that, on the biolinguistic approach, children's non-adult productions are highly restricted, such that they can be expunged from children's grammars without recourse to negative evidence.

It is worth laying out in more detail what we mean by "overgeneration." On Dabrowska et al.'s proposal, children should be able to juxtapose direct questions with "What do you think?" for example. Furthermore, since direct questions are much more frequent than indirect questions children should be more likely to produce questions like (49) than ones like (48) or the ones in the quote above. But children have not been found to produce questions in which the auxiliary verb 'do' appears in both clauses.

(49) #What do you think? + What does Cookie Monster eat?

Fixed expression Direct question

In Thornton's study, however, children as young as three, and one child even younger, had no apparent difficulty producing a range of long-distance *wh*-questions, including medial-*wh*-questions like (50) and (51).

(50) What do you think what's in here? (P. 2;10)

(51) What do you think what babies drink to grow big? (M. 3;3)

It is conceivable, as Ambridge and Lieven (+ p. 306) remark, that *wh*-questions like (50) could have been formed simply by juxtaposing two independent questions (What do you think ? + What's in here?). Example (51) is not amenable to such an account, however, because the underlying question fragment . .. *what babies drink to grow big*? is not an acceptable stand-alone question. The unacceptability of the *wh*-question *What babies drink to grow big?* is caused by the absence of the auxiliary verb *do*. Adding *do* causes the question to become well-formed: *What do babies drink to grow big*? So, there must be another source of the question fragment . . . *what babies drink to grow big*. Usage-based researchers obaserved that this sequence of words is acceptable as the complement of an indirect question (e.g., *Do you know ... what babies drink to grow big*?). This observation led Dabrowska et al. to propose that children's medial-*wh* questions like (51) may also be created by the juxtaposition of an independent question and an indirect question.

The biolinguistic account of children's non-adult long-distance *wh*-questions first looks beyond English, to other human languages in order to make sure that children's non-adult English questions are UG-compatible. If English-speaking

children are simply taking up an option that is available for other languages, then their output should be similarly constrained. Here, we lay out the case using examples from German. In German, *wh*-copying is sanctioned when the question word originates in a finite clause, but not in an infinitive clause, as indicated by the unacceptability of (52).

(52) *Wen versuchst du wen anzurufen?
whom try you whom to call
'Whom are you trying to call?'
(McDaniel, 1986)

It is also not possible to use a *wh*-copying structure in sentences with full question phrases, such as 'which man' or 'whose hat'. This is shown in (53).

(53) * Welchen Mann glaubst du, welchen Mann sie liebt?
which man believe you, which man she loves?
'Which man do you believe that she loves?'
(Felser, 2004)

Given the ungrammaticality of (52) and (53) in German, the prediction is that English-speaking children who use *wh*-copying in many of their questions, will not produce *wh*-copying structures for the English counterparts to (52) and (53). This is exactly what happened. The English-speaking children who produced *wh*-questions with a copy of the *wh*-word in tensed embedded clauses did not pronounce a wh-copy in questions with infinitival embedded clauses. Thornton's (1990) production study elicited

questions with infinitival complements for the verb ‘want’ and found that no child produced questions like (54).

(54) #What do you want what to do?

Notice that the question in (54) could be generated using the usage-based ‘cut and paste’ mechanism. More specifically (54) could be formed by combining the well-formed adult question, *What do you want?*, and the embedded question structure *what to do*, which is a well-formed substring of the statement ~~*I know*~~ *what to do*.

Another finding favors the biolinguistic account, and is mysterious on the usage-based approach. As in German and other languages, English-speaking children never produced questions that contained a copy of a full question phrase, such as *which Smurf*, as indicated by the ‘#’ in (55).

(55) #Which Smurf do you think which Smurf is holding a toothbrush?

Instead of *wh*-questions like (55), the ‘extra’ ingredient in children’s questions with full *wh*-phrases (e.g., *which Smurf*) was a bare wh-word (e.g., *who*). Some examples with a bare *wh*-word are presented in (56).

(56) Which Smurf do you think who has roller skates on? (T.D. 4; 9)

Which guy did they guess who ate the green one? (D.W. 3; 9)

More often than not, however, children did not insert an extra copy of the wh-word in their long-distance *wh*–questions with full wh–phrases. Instead, children produced adult-like long-distance wh-questions, as in (57).

(57) Which Smurf do you think is holding a toothbrush?

Again, the mechanisms available on the usage-based approach can easily accommodate illicit *wh*-questions like (55). These can be created simply by juxtaposition of the question phrase, *which Smurf do you think* and the well-formed English *wh*-question *which Smurf is holding a toothbrush*? The fact that children avoided such *wh*-questions with full *wh*-phrases is further evidence that children do not access the kinds of mechanisms posited by the usage-based approach.

5. Negation in Child Language

Another linguistic phenomenon that has been investigated by both approaches to child language is sentences containing negation. Research on sentences with negation began with the seminal studies reported in Bellugi (1967) and Klima and Bellugi (1966). These early studies documented the developmental stages of negation in three children: Adam, Eve, and Sarah (Brown, 1973). These were longitudinal studies in which children's spontaneous productions were recorded and then transcribed for subsequent analysis. The analysis found that the three children passed through two non-adult stages (Stages 1, 2) before they attained adult-like competence in producing negative sentences (Stage 3).

At Stage 1, children expressed negation by positioning the negative markers 'no' or 'not' at either end of a word or phrase. Also, the Subject noun phrase was typically omitted. Examples include *No sit there*, *Not a teddy bear*, *Wear mitten no*. Stage 1 is often characterized as a period during which negation is external to the sentence, but this analysis has been challenged (see, e.g., Déprez and Pierce, 1993;

Drozd, 1995; de Villiers and de Villiers, 1985). At Stage 2, children continue to use 'no' or 'not', but negation is clearly positioned sentence-internally. Negation often combines with some kind of predicate, including main verbs: e.g., *He no bite you*, *I no want envelope*. As these examples illustrate, the main verb is frequently uninflected at Stage 2, as in Stage 1. Children at this stage begin using 'don't' and 'can't' (e.g., *I can't catch you*, *I don't sit on Cromer coffee*). However, children's speech lacks the corresponding positive auxiliary verbs 'can' and 'do'. Bellugi (1967) took this to suggest that 'can't' and 'don't' are unanalyzed ('fixed') forms in children's grammars, rather than being composed from an auxiliary verb and a negation marker, as in the adult grammar (but see Schütze (2010)). At Stage 2, children's utterances do not include the auxiliary verb 'does' or its negative counterpart 'doesn't'. It was recently discovered that children achieve adult-like mastery of negation, i.e., they reach Stage 3, soon after the negative auxiliary verb 'doesn't' appears in their speech (Thornton and Tesan, 2007, 2013; Thornton and Rombough, 2015). As a final observation, children exhibit considerable individual variation in the age at which they reach Stage 3. Eve reached this stage at 2;02, Adam at 3;02, and Sarah at 3;08.

5.1. A Usage-based account of the acquisition of negation

A usage-based account of the acquisition of negation in English analysed the transcripts of the speech of a child called Brian and his mother. The findings and the usage-based analysis are presented in Cameron-Faulkner, Lieven, and Theakston (2007). The study analysed the extent to which the forms and functions of Brian's negative sentences matched those of his mother. Brian's negative utterances include samples taken from his spontaneous speech between the ages of 2;3-3;4. The Cameron-Faulkner et al. study documents the emergence of the negators 'no', not' and the contracted form 'n't' in

Brian's speech, and the correspondence between the emergence of these forms and their frequency in his mother's speech. The usage-based account predicts a strong correspondence between the forms in the input and the child's output.

With only minor variations, the emergence of negative markers in Brian's spontaneous speech conformed to the three stages charted by Bellugi (1967). Initially Brian's primary negative marker was 'no.' Brian combined 'no' with uninflected verbs in utterances that lacked a Subject noun phrase, e.g., 'no run', 'no move', 'no reach'.[10] Although 'no' was also the most frequent negative marker in the speech of Brian's mother, she only used 'no' twice in multiword utterances, and it was never followed by an uninflected verb, since this combination is ungrammatical in adult English. Therefore, Brian's negative utterances did not match the input, as they were mainly non-adult linguistic forms. During Stage 1, Brian made an abrupt shift from using 'no' to signal negation, to using 'not' to serve the same functions. As he had done previously with 'no,' Brian combined 'not' with uninflected verbs in utterances that also lacked a Subject noun phrase, yielding utterances such as 'not see' and 'not run'. At Stage 2 (2;9-3;3), Brian continued to use 'not', but his negative utterances also included the other negative markers 'can't' and 'don't'. Brian used the negative marker 'can't' more often than 'don't. However, Brian's mother used 'don't' more often than 'can't'. After 3;3, Brian's negative utterances were reported to be similar in form and function to those in the input. The conclusion reached by Cameron-Faulkner et al. is as follows: "The pattern of negator emergence was found to follow the frequency of negators in the input; that is negators used frequently in the input were the first to

[10] Presumably, the negator, *no*, was used in single word utterances by Brian's mother to express PROHIBITION. By contrast, Brian used *no* followed by an uninflected verb to express four functions: FAILURE (*No move*), PROHIBITION (*No touch*), REJECTION (*No apple*), and INABILITY (*No reach*).

emerge in the child's speech" (p. 254). The authors' add a caveat, however: "the findings also indicate creative learning on the part of the child from the earliest stages of multiword negation" (p. 254).

To explain Brian's non-adult negative utterances, Cameron-Faulkner et al. consider the possibility that Brian produced truncated versions of sentences produced by his mother. A truncation analysis has been advanced by usage-based researchers to explain several of children's non-adult affirmative utterances. For example, children at Stage 1 and Stage 2 often produce affirmative utterances with uninflected main verbs, such as 'She eat grapes. A truncation account was offered in Tomasello (2000a, p.240), who suggested that children simply omit the sentence-initial auxiliary verb in adult Yes-No questions, e.g., "Does she eat grapes?"

Cameron-Faulkner et al. consider a similar truncation account of children's non-adult negative sentences like 'not see' and 'not run.' They entertain the possibility that these are truncated versions of adult negative sentences such as 'I can not see' and 'He did not run'. They reject this analysis, however, based on the frequency of the kinds of negative sentences children encounter in the input. Adult English speakers, including Brian's mother, rarely combine auxiliary verbs with the negative marker 'not'. Rather, auxiliary verbs are used to host the contracted form of negation, e.g., 'I can't see' and 'He didn't run.' Such sentences could not be the source of children's non-adult negative sentences such as 'not see' and 'not run.' Therefore, a truncation analysis of children's non-adult utterances falls victim to contraction.

It is clear that input frequency is not the only factor in the acquisition of negation, especially at the early stages of language acquisition. It is also clear that the truncation of adult sentences is not the source of children's non-adult utterances. Based on these observations, Cameron-Faulkner et al. present the following conjecture (p. 273):

> "it is possible that Brian's early *no V* constructions are an amalgamation of his existing negation strategy (i.e. single word *no*) with various entities, states or processes that he wishes to negate. In this way, Brian's *no V* utterances represent a structure-building approach to multiword negation, as opposed to imitation of existing multiword combinations in the input."

In a review of the same study, Lieven and Tomasello (2008, p. 174) reach a similar conclusion:

> "This is an example of creative structure-building at the outset of multiword speech but in complex interaction with the frequency of forms in the input and of Brian's own usage."

As these quotes indicate, input frequency alone cannot account for children's non-adult utterances, even on the usage-based account. It is surprising, however, that Lieven and Tomasello invoke "creative structure building" to account for children's non-adult negative utterances until they develop the ability "to identify more specific form-function mappings" (Lieven and Tomasello, 2008). This seems inconsistent with the claim that children's productions are "island-like."

In assessing the empirical adequacy of the usage-based approach, it is critical to know what it means for children to be "creative learners." Two possible accounts of children's "creative structure-building" are offered. One is a discontinuity account and the second is a continuity account. On the discontinuity account, children form 'emergent categories' "that 'carve up' conceptual space differently from adults," according to Cameron-Faulkner et al. Discontinuity is a recurrent theme for the usage-

based approach. For example, Tomasello (2000b p. 62) states that "it is obvious to all empirically oriented students of language acquisition that children operate with different psycholinguistic units than adults, this theoretical freedom to identify these units on the basis of actual language use, rather than adult-based linguistic theory, is truly liberating." Although the discontinuity hypothesis may seem obvious and liberating to advocates of the usage-based approach, it is not the null scientific hypothesis because it introduces unwanted degrees of freedom in explaining how children achieve the same linguistic competence as adults. An alternative continuity scenario is offered by Cameron-Faulkner et al. On this account, children and adults have the same "conceptualization of negation" Cameron-Faulkner et al. suggest that children's conceptual system "already contains the fine-grained distinctions that underlie the English negation system" (p. 276). The child's task then is "to discover how [the] target language realizes these distinctions."

In conclusion, the data on children's production of negation show no clear correspondence between the input to the child and the utterances the child produces. Moreover the usage-based approach fails to provide an account of children's non-adult negative utterances, beyond attributing children's non-adult utterances to "creative structure building" (cf. Lieven and Tomasello, 2008, p. 174). In addition, the usage-based approach has next to nothing to say about how children make the transition from the non-adult stages of language development to convergence on the adult grammar of negation. Let us see how well the generative approach fares in addressing these issues.

5.2. A Biolinguistic account of the acquisition of negation

We now turn to a biolinguistic account of the acquisition of negation. All biolinguistic accounts of child language begin with an analysis of the linguistic phenomena in the

adult grammar. For English negative sentences, the critical ingredients for deriving negative sentences in the adult grammar can be highlighted using the examples in (58)-(62).

(58) Susie eats broccoli

(59) Susie never eats broccoli

(60) *Susie not eats broccoli

(61) Susie does not eat_ broccoli

(62) Susie doesn't eat_ broccoli

In affirmative sentences like (58), the verb carries tense as part of the 3rd person 's' morpheme, which also carries number agreement (i.e., the verb form in (58) agrees with a singular Subject NP). The form of the main verb does not change if a negative adverb (e.g., *never*) is added, as (50) illustrates. By contrast, it is not possible to have an inflected main verb like *eats* (with the 3rd person 's') if the negative marker *not* is selected. This is shown by the ungrammaticality of (60) (marked by '*'). Negative sentences with *not* can be rescued, however, by inserting the 'dummy' auxiliary verb, *do*, as in (61). Since the auxiliary verb *do* carries the 3rd person 's' morpheme in (61), the main verb remains bare (uninflected). The main verb also remains bare when the contracted (clitic) form of negation, *n't*, is selected. This is shown in (62). The auxiliary verb *do* not only carries the 3rd person 's' morpheme in (62), it also serves as the host for the clitic form of negation, *n't.* So, the negative auxiliary verb *doesn't* is decomposed into three parts: *do* + *s* + *n't*. As we will see, these features of *doesn't* provide critical information for children acquiring English, advancing them from Stage 2 to Stage 3.

Examples (58) to (62) indicate that English has two kinds of negation. One is adverbial negation, as illustrated in example (59) (Haegeman, 1995; Zanuttini, 2001). Adverbial negation is relatively simple in that it does not require a special, dedicated negation phrase in the hierarchical structure of English; negative adverbs are just adverbs like 'always' and 'usually.' By contrast, the second kind of negation in English, illustrated in example (62), requires the addition of a special phrasal projection called the Negation Phrase (NegP). Like other phrasal projections, the NegP has internal structure, which includes a head. Certain negative elements, including the clitic form of negation, *n't*, reside in the head position of NegP, so the second form of negation in English is called head negation. Example (62) shows that the head form of negation, n't, can be an affix supported by an inflected auxiliary verb such as *does* (and also by both the copula verb *is* and the auxiliary verb *is*, and by modal verbs, e.g., *can, should, will*).

Most languages have just one form of negation or the other. Following a survey of 25 languages, Zeijlstra (2004) concluded that languages can be broadly partitioned into languages in which negation is an adverb and languages in which negation is the head of a phrasal projection (NegP). In view of this limited variation, a parameter for negation, the Negative Concord Parameter was postulated. The Negative Concord Parameter determines where negation is positioned in the sentence structure of a language, i.e., whether or not the language requires a NegP projection. According to Zeijlstra (2004, 2008), learnability considerations dictate that the parameter has a default setting. Assuming that children initially construct the most economical syntactic representations available, the default value of the parameter is adverbial negation. As we noted earlier, to incorporate the head form of negation, the language learner must construct an additional phrasal projection, beyond that needed for adverbial negation.

Initially, then, children acquiring all human languages are predicted to analyse negation as an adverb. If so, then children acquiring languages with head negation, including English-speaking children, are predicted to analyse negative markers as instances of adverbial negation. This will result in non-adult negative utterances in sentences with head forms of negation (as illustrated by the difference in acceptability between (59) and (60)). In particular, treating *not* like the adverbial *never* results in the ungrammatical sentence in (60). However, these non-adult utterances are expected to be short-lived, because language learners will encounter abundant positive evidence informing them that their grammar needs to accommodate a NegP projection.

Assuming that *not*, and *don't* are (unanalysed) initially as negative adverbs in children's grammars, then young children are expected to produce non-adult negative sentences incorporating these negation markers. The specific prediction is that children at this age should optionally combine these negative markers with the 3rd person 's' morpheme. As we saw in example (50) above, sentences with the adverb *never* can be followed by an inflected main verb. An example is *It never fits*. If negation is adverbial in young children's grammars, then negative sentences such as *It not fits*, and *It don't fits*, in addition to their uninflected counterparts *It not fit*, *It don't fit* could, in principle occur. In order to converge on the colloquial adult grammar of English, children need to discover that *n't* is a head form of negation. Once they have discovered this, they can produce negative sentences with *doesn't*, such as *It doesn't fit*, which is the colloquial form used by adults.

The information that Standard English has a head form of negation in addition to adverbial negative markers is readily available, but it requires children to deal with an idiosyncratic aspect of the auxiliary verb system of English, called *do*-support. To cut a long story short, the critical evidence for children that English requires the construction of a negation phrase (NegP), is the observation that the clitic form of

negation, *n't*, is supported by the auxiliary verb *do* in affirmative statements and in questions (*It does fit.*, *Does it fit*?) and in negative sentences (*It doesn't fit.*). Negative sentences with *doesn't* are particularly informative because they indicate the tripartite decomposition into *do* + *s* + *n't*, revealing that the 3rd person 's' morpheme is higher in the syntactic structure than negation. This led Thornton and Tesan (2007) to propose, and empirically evaluate the prediction that, as soon as a child produces the negative auxiliary verb *doesn't*, that child will have made the transition from Stage 2 to Stage 3.

As Thornton and Tesan (2007) note, moreover, once children have acquired *doesn't*, all of their non-adult forms of negation are predicted to disappear. There have been reports of children producing negation followed by an inflected verb, as predicted by Thornton and Tesan. For example, Harris and Wexler (1996) conducted a detailed investigation of the transcripts of the spontaneous speech of 10 children (1;06 to 4;01) using the CHILDES database (MacWhinney, 2000). They searched for negative sentences with a 3rd person subject (such as a name or *he* or *she*) and a main verb that required *do*-support in the adult grammar. The transcripts yielded 54 negative sentences with the negative markers *not* or *no*, and 5 of these contained an inflected main verb (see also Croker et al., 2003). The paucity of these negative utterances (less than 10%) led Harris and Wexler to consider them to be performance errors. However, the small sample size makes any classification tentative at best.

In order to increase the sample size of relevant utterances, Thornton and Tesan (2007, 2013) and Thornton and Rombough (2015) conducted two experimental studies using an elicited production task to target the kinds of sentences that would confirm or disconfirm their proposal that first, children might initially produce utterances like *It not fits* and second, that the negative auxiliary *doesn't* is critical to children's transition from Stage 2 to Stage 3. One was a longitudinal study of four 2-year-old children. The longitudinal study incorporated an elicited production task that targeted negative

sentences with the third person '*s*' morpheme. The second study was an elicited production study, using the same technique, with 25 2- and 3-year-old children (mean age = 2;11). In the elicitation component of the longitudinal study, the four 2-year-old child participants produced 497 negative sentences in total with 3rd person subjects combined with a main verb. Ninety-nine of these 497 negative sentences (20%) contained negation followed by an inflected main verb. The majority of these negative sentences contained the negative marker *not* (e.g., *Minnie Mouse not fits*), but some contained *don't* (e.g., *Minnie Mouse don't fits*). As predicted, these and many other non-adult negative utterances disappeared from the speech of these children (within 2-3 months) following the appearance of the negative auxiliary *doesn't*.

The larger study by Thornton and Rombough (2015) confirmed the findings of the longitudinal study, and supported the proposal advanced by Thornton and Tesan that *doesn't* triggers children's transition to the adult grammar. To investigate this proposal, Thornton and Rombough (2015) divided the 25 child participants into two groups, based on whether or not they produced adult-like negative sentences, with the auxiliary *doesn't*, in the elicited production task. Children (n = 12) who produced at least 5 instances of *doesn't* were identified as the Advanced group, and the children (n = 13) who did not produce *doesn't* were called the Less Advanced group. The children in the Less Advanced group produced a total of 4 utterances with *doesn't*, and 89 negative utterances with an inflected main verb (like *Minnie Mouse not/don't fits*). By contrast, children in the Advanced group produced 228 adult-like negative sentences with *doesn't* and only 5 utterances with negation and an inflected main verb. Taken together, the findings from both the cross-sectional study and from the longitudinal study are compelling evidence that the negative auxiliary *doesn't* is potentially a decisive factor in children's convergence to the adult grammar.

6. Scope Relations in Human Languages

All human languages contain semi-idiosyncratic constructions that cannot be derived by universal linguistic principles, and that cannot be acquired by the application of innate linguistic knowledge. On any account of language acquisition, these 'peripheral' constructions must be learned. According to the usage-based account, the same mechanisms that children use to add these constructions to their language are also used to learn the core phenomena of human languages. The reason is that, on the usage-based approach, core linguistic phenomena differ from peripheral phenomena only in degree – core phenomena are more regular and occur more frequently. It follows that core phenomena should be easy to learn. Here is a representative statement by Goldberg (2006, p. 14).

> "In fact, by definition the core phenomena are more regular, and tend to occur more frequently within a given language as well. Therefore, if anything, they are likely to be easier to learn."

If core linguistic phenomena were simply constructions that are more regular and more frequent than more peripheral constructions, then the usage-based approach would indeed be a contender as an account of language acquisition. Children have been found to be reasonably skilled at detecting (local) regularities in the input. For example, Saffran, Aslin and Newport (1996) found that 8-month-old infants could exploit statistical regularities in the input to extract information about 'word boundaries.' Infants successfully inferred the existence of boundaries between three-syllable pseudowords (nonsensical combinations of sound sequences). Those three-syllable sequences that crossed a word boundary were not treated by the child subjects as a

'word' during the post-test phase of the study, because there was a lower probability for such sequences to be repeated if they crossed a word boundary than if they were part of a 'word.'

It is conceivable that children could apply these same skills to extract other kinds of regularities. It has been argued, for example, that the input contains relevant features in sufficient abundance to support statistically based acquisition of several seemingly complex facts about language (MacWhinney, 2004; Pullum and Scholtz, 2002). These findings have led some researchers to conclude that children are "perfectly well able to acquire the 'abstract' syntactic concepts that they need to form [structure-dependent] hypotheses through statistical analysis of the speech they hear around them" (Cowie 2003, p. 192-193).

It is worth noting that the skills children require to form generalizations about linguistic input are domain general, rather than specific to language. According to Tomasello (2003), children utilize the same basic psycholinguistic "perceptual and cognitive skills that are employed in other domains as well as language learning." Elaborating on Tomasello's comment, Cowie (2010) asserts that children's analytic skills include "general reasoning skills, such as the ability to recognize patterns of various sorts in the world, the ability to make analogies between patterns that are similar in certain respects, and the ability to perform certain sorts of statistical analysis of these patterns."

The biolinguistic approach has a different conception of core linguistic phenomena. Linguistic phenomena are not in-and-of themselves core or peripheral; rather core principles underlie 'natural kinds' of linguistic phenomena. What counts as a natural kind sometimes includes linguistic phenomena that appear quite disparate on the surface. An example may be helpful. Consider the different expressions that form the class of downward entailing operators. This includes expressions from several

different syntactic categories, prepositions, verbs, adverbs, complex linguistic structures such as relative clauses with certain quantificational expressions, and conditional statements. Many downward entailing expressions have a negative cast – e.g., the preposition *without*, the verb *forbid*, the adverb *never*. However, the natural kind also includes expressions that do not have a negative cast, such as the preposition *before*, the antecedent of conditional statements, *if,… then* …, and the Subject phrase of the universal quantifier *every*. A child who is equipped solely with domain general perceptual abilities that form generalizations based on analogy or similarity would be unlikely to uncover several facts about the class of downward entailing expressions. One of the facts is that all English downward entailing expressions license the word *any*.[11] A second fact is that disjunction words (English *or*) generate a 'conjunctive' entailment in downward entailing linguistic contexts.[12] As the example illustrates, core principles underlie linguistic phenomena that are not regular or frequent. It is not often, for example, that children encounter sentences with disjunction in the Subject phrase of the universal quantifier, e.g., *Every passenger who ate chicken or fish* …. However, because downward entailment is a core property of human languages, children are expected to license *any* in downward entailing linguistic environments and they are expected to generate the entailments that are associated with the disjunction word *or* in

[11] English sentences that license any, bassed on downward entailing expressions with a negative cast - *Bill left without eating any fruit. Bill is forbidden from eating any fruit. Bill never eats any fruit*. But any is also licensed in the sentences - *Bill takes a pill before eating any fruit. If Bill eats any fruit, he becomes ill*.

[12] Consider, for example, the sentence *Bill never eats apples or oranges*. This statement with disjunction has two entailments: (1) Bill never eats apples, and (2) Bill never eats oranges. Taken together, they form the 'conjunctive' entailment - *Bill never eats apples and Bill never eats oranges*.

the same environments. This knowledge is expected to emerge in child language as soon as children have acquired the meanings of the relevant words (*never*, *every*, *any*, *or* and so forth). Core phenomena do not readily lend themselves to statistical analysis for another reason, namely that children's knowledge includes the interpretations that can and cannot be assigned to sentences, and is not just based on which words appear together. On the biolinguisitic approach, moreover, children are expected to demonstrate such knowledge as soon as they can be tested, by 3- or 4-years-old.

In addition, language acquisition is not just a special case of induction, or projection beyond one's experience according to the biolinguistic perspective. Consider the following remark from Crain and Pietroski (2001, p.161).

> "… projecting beyond experience is just one aspect of language acquisition. Children also fail to project beyond their experience in characteristic ways. It is *this* fact that most impresses nativists. The theoretical problem posed by human language learning is to explain why children project beyond their experience just so far and no further; the specific "angle" of projection seems arbitrary (and idiosyncratic to *linguistic* projection)."

In the literature, the argument about the specific angle of linguistic projection has primarily focused on language specific constraints on form and interpretation. These constraints include the principles of binding, for example, as discussed in the section on Anaphoric Relations. We saw there that children's linguistic input includes sentences like (63) and (64). In both sentences, the pronoun *he* can be interpreted as picking out the same individual as the referring expression *Papa Smurf*, as indicated by the indices.

(63) While he_i was dancing, Papa $Smurf_i$ was eating a pizza.

(64) Papa Smurf$_i$ was dancing while he$_i$ was eating a pizza.

If children avail themselves of domain general learning mechanisms, then it is conceivable that some children at least would conclude that coreference between the pronoun and the referring expression is licensed in sentences like (65), whereas coreference is ruled out for adults.

(65) *He$_i$ was dancing while Papa Smurf$_{\underline{i}}$ was eating pizza.

As soon as children can be tested, however, they adhere to the constraint that prohibits coreference in sentences such as (65) (see Crain and Thornton (1998) for discussion). This is an example of what Crain and Pietroski are referring to when they speak about the specific angle of linguistic projection. To explain the acquisition of language, we require a theory that enables children to license coreference in both (63) and (64), but not in (65). On the biolinguistic approach, the theory that best accounts for children's linguistic knowledge is one that postulates innate knowledge that is specific to language. According to this approach, children come to the task of language acquisition equipped with detailed knowledge of core linguistic principles. Not only does the set of core principles explain why children prohibit coreference in sentences like (65), these principles explain why children as young as 3- or 4-years-old are able to judge certain sentences to be false, why they are able judge other sentences to be ambiguous, as well as how children are able to discern that certain sentences engender particular entailments, and others do not.

The biolinguistic approach has tried to substantiate the claim that children are able to perform these feats from the earliest stages of language acquisition, before age 3, by pointing to a significant body of experimental research that demonstrates children's adherence to linguistic constraints on form and meaning by age 3- or 4-years. Because

demonstrating that children have complex linguistic knowledge at an early age compresses the timeframe for language learning, this reduces the plausibility that children's linguistic knowledge is acquired using domain general learning mechanisms that enable them to extract regularities in the primary linguistic data.

In several cases, researchers working within the biolinguistics approach have documented children's knowledge of facts for which there is (arguably) no decisive evidence in the primary linguistic data. This includes the fact that coreference is not tolerated in sentences like (65). Facts about non-coreference are negative facts, in the sense that children know what sentences like (65) can not mean, not just what it can mean.

The kind of evidence that would support the acquisition of negative facts is appropriately called negative evidence. The literature contains several extensive reviews of the availability of negative evidence in children's experience. These reviews not only discuss the availability of direct negative evidence, such as corrective feedback when children produce ungrammatical sentences, but they also discuss the availability of various 'substitutes' for negative evidence, such as caretakers' expansions of children's utterances. It does not appear that negative evidence of any kind is available in sufficient quantities and at the right time to promote the acquisition of linguistic knowledge using the kinds of "perceptual and cognitive" mechanisms invoked by the usage-based approach (Morgan & Travis, 1989; Marcus, 1993). In addition to the original Brown and Hanlon (1970) study, Slobin (1972) reported that children were not corrected for ungrammatical utterances in many of the societies studied by his research group. In a representative review of the literature, Pinker (1990, p. 217) states the following conclusion.

> "When parents are sensitive to the grammaticality of children's speech at all, the contingencies between their behavior and that of their children are noisy,

indiscriminate, and inconsistent from child to child and age to age."

Other researchers have reached the same conclusions (e.g., Bowerman, 1988; Morgan and Travis, 1989; Marcus, 1993). Even if negative evidence were available, of course, children might not avail themselves of it. As far as we know, there is no compelling evidence that children exposed to negative evidence use it to purge their grammars of incorrect hypotheses (see Newport, Gleitman and Gleitman, 1977).

6.1. A Substitute for negative evidence

Not to be dissuaded, advocates of the usage-based approach have postulated another substitute for (direct) negative evidence. This is the non-occurrence of predicted sentence structures. For example, Cowie (2003, p. 223) asserts that "the non-appearance of a string in the primary data can legitimately be taken as constituting negative evidence". Children could use this substitute for negative evidence, for example, to expunge the errors that would result from the application of a structure-independent rule for forming Yes/No questions:

> "the fact that she has never heard any utterance with the structure of **Is that girl who in the jumping castle is Kayley's daughter* or **Is that mess that on the floor in there is yours?* is evidence that strings of that type are not sentences."

To exploit this kind of information, however, children must keep accurate records of the *absence* of structures (sentence types) in the adult input. Cowie's example suggests that young children keep a record of the absence of certain kinds of 'deviant' relative clauses (… *who in the jumping castle*, … *that on the floor in there*) which are themselves embedded inside 'deviant' matrix sentences (*Is that girl ... is Kayley's daughter*?, *Is that mess ... is*

yours). Children do not record sentence tokens, however. Rather, children keep records of sentences types. So, what children would need to notice is the absence of the construction type AUX+RelPro+PP+AUX+NP in the input they have encountered, as well as the presence of the construction type AUX+RelPro+AUX+PP+NP.

Researchers working within the biolinguistic approach do not attempt to prove that children lack the cognitive skills to keep records of the presence and absence of such complex structures. Rather, they question the plausibility of this substitute for negative evidence as a vehicle used by children in language acquisition. The proposal that children keep accurate records of non-attested linguistic structure can be challenged, for example, by citing conclusions that have been reached in experimental studies of children's computational resources. The suggestion that children keep detailed records of the complex construction types that they do and do not encounter appears to be at odds with studies of human memory. We know, for example, that adults can at best recall the gist of word strings they have just encountered, not the phonological or syntactic details of these word strings. Surely children cannot be expected to have far superior memories than adults do. Moreover, unless children know in advance which absences to be on the lookout for, they would have to maintain records for all kinds of construction types that can be extracted from the input. These records would include much information that will prove irrelevant for grammar formation.

6.2 The Isomorphism Hypothesis

We turn now to another feature of child language that poses a challenge to the usage-based approach. The aspect that is problematic concerns what are known as scope phenomena. Scope phenomena resist explanation by the kinds of mechanisms the usage-based approach attributes to children. However, these phenomena can be explained

straightforwardly by invoking lexical parameters whose values are ordered in advance by a learning mechanism known as the Semantic Subset Principle (Crain, Ni & Conway, 1994; Crain, 2012). The Semantic Subset Principle entreats children to initially adopt specific scope assignments, namely ones that can be adjusted using readily available positive evidence. By encoding these default scope assignments in the parameters of Universal Grammar, children are prevented from forming erroneous generalizations that they could otherwise make. In this way, children avoid forming linguistic generalizations that they would need to retract later. As we have seen, the absence of negative evidence makes it difficult for children to recover from false starts. On the biolinguistic approach, this is not problematic because children's access to innate linguistic knowledge imposes substantive restrictions on their grammatical hypotheses, prevents the numerous false starts that children could make if their hypotheses were based on domain general learning mechanisms. So the acquisition of scope phenomena illustrates the specific "angle of projection" taken by children in the course of language acquisition.

On the usage-based approach, children's assignments of scope relations between logical expressions, like their assignments of anaphoric relations, must be based on the surface properties of the input. The most obvious surface property is word order. There is near consensus in the literature that language users and language learners prefer a direct linear mapping between surface syntax and semantic interpretation. Putting it the other way around, there is near consensus that both children and adults experience difficulty in interpreting sentences that require them to compute an 'inverse' mapping between the surface syntax and the semantic interpretation. A direct mapping between sentence word order and semantic interpretation is called isomorphism. Therefore, the preference for a direct mapping between surface word order and semantic interpretation is called the Isomorphism Hypothesis, which can be stated as follows.

Isomorphism Hypothesis: If a logical expression, A, takes scope over another logical expression, B, in the surface syntax, then A also takes scope over B in the semantic interpretation.

In scope ambiguities involving two logical expressions, a distinction is drawn between the surface scope interpretation and the inverse scope interpretation. On the surface scope interpretation, the logical expression that comes first takes scope over the one that comes later. On the inverse scope interpretation, the logical expression that comes later takes scope over one that came earlier. According to the Isomorphism Hypothesis, children's initial scope assignments are expected to be surface scope interpretations, rather then inverse scope interpretations.

Surface scope interpretations are seen to be computationally less complex than inverse scope interpretations. Complexity is reduced because surface scope interpretations represent 1-to-1 mappings between word order and semantic interpretation. On surface scope interpretations, structural units are interpreted "on-line." That is, structural units can be semantically composed incrementally, as they are encountered. Sentences that require inverse scope assignments, by contrast, introduce delays in interpretation. Assuming that on-line incremental interpretations are easier for the human sentence processing mechanism (the parser), the usage-based approach is led to formulate concrete predictions about children's initial scope assignments, based on the Isomorphism hypothesis. For example, the Isomorphism Hypothesis predicts that the universal quantifier, *every*, will take scope over the negation marker, *not*, if the universal quantifier precedes the negation marker in the surface word order. Simply put, the negation marker will be interpreted *in situ*.

This concrete prediction of the Isomorphism Hypothesis initially appeared to be

confirmed.[13] In an early study of negative sentences with the universal quantifier, Musolino (1998) found that young children rejected sentence (66) if one of the horses did not jump over the fence. This suggests that the universal quantifier was taking scope over negation, resulting in an interpretation of (66) that can be paraphrased as *none of the horses jumped over the fence*. This is the surface scope interpretation indicated in (66a), rather than the inverse scope interpretation indicated in (66b).

(66) Every horse did not jump over the fence.

a) for every horse(x), ¬[x jumped over the fence]

b) ¬ for every horse(x), [x jumped over the fence]

Another early finding that is consistent with the Isomorphism Hypothesis was reported in an elicited production study by O'Leary and Crain (1994). The study was designed to evoke sentences with existential quantifiers from children, such as *something* and *anything*. In one story, it turned out that one among several dinosaurs could not find anything to eat, but all of the other dinosaurs managed to find something to eat. The puppet produced a false statement about what happened in the story, as illustrated in (67). In response, children often used the indefinite NP *something* in the scope of negation.

(67) Puppet: Every dinosaur found something to eat.

Child: No, this dinosaur didn't find something to eat.

[13] This conclusion was subsequently challenged by Gualmini (2008). Gualmini demonstrated that children access the inverse scope interpretation of scopally ambiguous sentences in pragmatic contexts that satisfy the felicity conditions associated with the use of negation (cf. Musolino and Lidz, 2006).

For adults, the sentences children produced are not accurate descriptions of the situation. This is because, for adults, the existential expression *something* is a Positive Polarity Item. By definition, Positive Polarity Items (PPIs) take scope over negation at the level of semantic interpretation. For adults, therefore, the sentence the child produced, *No, this dinosaur didn't find something to eat*, means that there is something that the salient dinosaur didn't find to eat - but that wasn't what happened in the story. Clearly, children initially differ from adults in their scope assignments. Essentially, children use *some* to mean *any*. Although this finding is consistent with the Isomorphism Hypothesis, it is also consistent with the constraint on language learnability we have discussed called the Semantic Subset Principle.

To avoid learnability problems in the absence of negative evidence, the Semantic Subset Principle dictates that children initially adopt specific values of lexical parameters. In the case at hand, the Semantic Subset Principle dictates that children initially refrain from interpreting the existential expression *someone* as a Positive Polarity Item. Consequently, *someone* has approximately the same meaning as *anyone* in the language spoken by children acquiring English. We will discuss the reason for this momentarily. First, we describe two linguistic phenomena that undermine the Isomorphism Hypothesis.

6.3 A challenge to the Isomorphism Hypothesis: Reconstruction

Despite its simplicity and empirical coverage, children have been found to respond to several kinds of sentences in ways that are not consistent with the Isomorphism Hypothesis. There are two kinds of linguistic phenomena that are not expected on the Isomorphism Hypothesis. Both phenomena give rise to inverse scope interpretations.

One way inverse scope interpretations can be derived is by reconstruction. Earlier, we described a syntactic process called Topicalization. This process explained the interpretation

of ‘topicalized’ sentences such as *John’s mother, he loves dearly*. In sentences such as this, the pronoun *he* and the referring expression *John* are disjoint in reference. Linguistic theory accounts for this by supposing that the topic phrase, *John’s mother*, reconstructs to Object position following the verb *loves*. Following reconstruction, the topic phrase *John’s mother* and the pronoun *he* cannot be assigned coreference; they must be disjoint in reference, just as they are in the declarative counterpart - *He loves John’s mother dearly*.

Reconstruction has been invoked in the literature to account for certain scope phenomena. In the resolution of scope ambiguities, reconstruction ‘lowers’ one scope-bearing expression to a position beneath another scope-bearing expression in the hierarchical sentence structure, resulting in the inverse scope interpretation. If there are inverse scope interpretations that are preferred to surface scope interpretations, this would undermine the Isomorphism Hypothesis.

One case in point is an example from Italian. The example concerns the interpretation that is assigned by Italian-speaking children and adults to modal expressions in negative sentences. The interaction between modal verbs and negation is straightforward in adult Italian. Scope relations are entirely determined by surface word order. This represents a compelling success story for the Isomorphism Hypothesis. The modal paradigm is indicated in examples (68) and (69).

(68) Gianni può non venire (possible > not)
Gianni mod neg come
‘Gianni might not come’

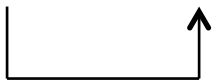
(69) Gianni non può venire (not > possible)
Gianni neg mod come
‘Gianni can not come’

When the modal verb *può* precedes negation (*non*), as in (68), adult speakers of Italian assign the (possible > not) interpretation. When these words appear in the reverse order, as in (69), adult speakers assign the (not > possible) interpretation. If children acquiring Italian adopt a domain general strategy based on the distributional analysis– the Isomorphism Hypothesis – they would be expected to easily identify the adult pattern of scope assignment. In Italian, what you see is what you get.

The problem with this acquisition scenario is that child language learners do not know in advance whether they are acquiring Italian, versus English or German. Consider the simple negative English sentence (70). This sentence illustrates that English-speaking children would be in dire straights if they were to adopt the Isomorphism Hypothesis, because the adult interpretation of (70) is the inverse scope interpretation, not the surface scope interpretation. To generate the adult scope assignment for (70), the modal verb *can* must be reconstructed to a position beneath negation, as indicated in (71).

(70) John can not come.

(71) John ~~can~~$_{[+R]}$ not < can > come



Based on considerations of language learnability in the absence of negative evidence, the Semantic Subset Principle dictates that children acquiring all languages initially reconstruct modal verbs that express possibility (Italian *può*, English *can*) such that they are interpreted within the scope of negation. The reason is that this inverse scope assignment makes sentences true in a narrower range of circumstances than the surface scope interpretation does. If some event may not take place, then this leaves open the possibility that

the event could take place – but this is ruled out on the 'not possible' interpretation. Adopting the Semantic Subset Principle, Moscati and Crain (2014) predicted that children acquiring Italian would initially assign the English-language interpretation (as illustrated in 70) to Italian sentences such as (68). If the inverse scope interpretation turns out to be children's initial interpretation of negative sentences like (68), then this would be evidence that children acquiring Italian do not adhere to the Isomorphism Hypothesis. The benefit for children, however, would be that they would be guaranteed to encounter evidence informing them that the surface scope interpretation is assigned by adults. The evidence would come in the form of adult utterances of sentences like (68) in circumstances in which it turned out that Gianni did come after all. This eventuality would be precluded by children inverse scope assignment. Of course, this circumstance would never eventuate in English, since English-speaking adults assign the inverse scope interpretation to sentences like (70).

Based on this line of reasoning, Moscati and Crain (2014) predicted that Italian-speaking children would initial reconstruct the modal verb *può* to a position beneath negation in interpreting sentences like (68), despite the fact that adult speakers of Italian do not. Adults, as we have seen, assign the isomorphic (surface scope) interpretation in sentences where the modal verb *può* precedes negation in the surface syntax. As a consequence, the interpretation assigned to sentences like (68) by Italian-speaking children would be completely ungrammatical for adult speakers. This makes it highly unlikely that children's interpretation could be based on the input from adult speakers. This finding would therefore pose a direct challenge to the usage-based approach, and provide evidence against the Isomorphism Hypothesis.

Moscati and Crain (2014) conducted two experimental studies with young Italian-speaking children and adults. These experiments documented that the scope relations assigned by adult speakers of Italian were determined by surface word order. However, Italian-speaking children assigned the inverse scope interpretation to negative sentences with

epistemic modals, as in (68). The findings indicated that surface word order did not dictate children's initial assignment of scope relations, whereas adults do use surface word order to dictate their semantic interpretations.

6.4 A second challenge: Raising

The Isomorphism Hypothesis has been found to make the wrong prediction in a second linguistic phenomenon. In this case, children have been found to initially 'raise' scope-bearing expressions to a position above negation. Again, to avoid subset problems, the Semantic Subset Principle compels children to generate inverse scope interpretations. An example of raising involves children's interpretation of negative statements with conjunction. Consider sentence (72).

(72) Ted did not order both pasta and sushi.

English-speaking adults accept (72) in three circumstances: (i) when Ted ordered just pasta (ii) when Ted ordered just sushi, and (iii) when Ted did not order either pasta or sushi. When sentence (72) is translated into Mandarin or Japanese, however, adult speakers accept the corresponding sentences in only one of these circumstances, namely when Ted did not order either pasta or sushi. Based on these observations, the Semantic Subset Principle dictates that children acquiring all languages will initially raise conjunction words to take scope over negation. The interpretation that results resembles that of a cleft sentence in English: 'It was both sushi and pasta that Ted did not order.' This inverse scope reading is schematically represented in (73).

(73) < both pasta and sushi > Ted did not order ~~both~~ ~~pasta and sushi~~

In adult Mandarin and Japanese, words for conjunction are Positive Polarity Items (Crain, 2012). By definition, conjunction words must be assigned scope over negation at the level of semantic interpretation, regardless of their position in the surface syntax. In English and German, by contrast, conjunction words are interpreted *in situ*. In this case, Mandarin and Japanese constitute the subset languages, and English and German are superset languages.

The Semantic Subset Principle predicts that English- and German-speaking children should initially interpret conjunction as a Positive Polarity Item, as in Mandarin and in Japanese. So children acquiring English and German are expected to assign a different interpretation than adults do to negated conjunctions like (74). On this parametric account, English- and German-speaking children are expected to raise conjunction to take scope over negation, just as it does in Mandarin and Japanese. By contrast, conjunction is predicted to remain *in situ* on the Isomorphism Hypothesis.

(74) The bunny rabbit did not eat both the carrot and the pepper.

As in the case of Italian modals, the findings do not conform to the Isomorphism Hypothesis. The relevant findings were obtained in a study by Notley, Zhou and Crain (2016). This team of researchers interviewed 21 3- to 5-year old English-speaking children (average age = 4;9). On a typical trial, a pig had eaten the carrot on offer, but not the green pepper. A control group of English-speaking adults consistently accepted sentence (74) in this circumstance, whereas the child participants resoundingly rejected (74) in this context (98% of the time). Children justified their rejections on the grounds

that the pig had eaten one of the foods. Children's responses and justifications are clear evidence that they assigned the inverse scope reading to the test sentences. This is another counter-example for the Isomorphism Hypothesis.

6.8. Domain Specificity

One of the main differences between the biolinguistic approach and the usage-based approach concerns domain specificity. According to the usage-based approach, in acquiring a language, it suffices to have "perceptual and cognitive skills that are employed in other domains as well as language learning" Cowie (2010). According to the biolinguistic approach, by contrast, the acquisition of language is not simply one of many problems of induction that children solve using general cognitive skills.

There are other features of language that resist explanation if we invoke mechanisms such as pattern-finding processing or distributional analysis, which are seen to apply in other cognitive domains in addition to language. In this section, we indicate how scope parameters, in particular, limit the application of learning principles in human language.

Consider example (75). For adult English speakers, the existential expression *someone* in (75) is a Positive Polarity Item (PPI). The sentence can be paraphrased using the cleft sentence *There is someone that the detectives didn't find*.

(75) The detectives didn't find someone.

As this paraphrase indicates, *someone* takes scope over negation on the interpretation assigned to (75). A graphic depiction of this interpretation is given in (76). According to linguistic theory, there are two copies of the existential expression *someone* in the

semantic representation. The 'lower' is pronounced, whereas the 'upper' copy indicates its scope.

(76) someone$_{[+PPI]}$ the detective didn't find < ~~someone$_{[+PPI]}$~~>

As noted earlier, children's productions do not generate the same scope assignment as adults do for negative sentences with the existential expression *someone* (O'Leary and Crain, 1994). In a comprehension task, (Musolino, Crain and Thornton, 2000), children were found to reject sentence (75) in circumstances in which the detectives did find someone. Children accepted sentence (75) only if there wasn't anyone that the detectives found. That is, children interpret *someone* as if it meant *anyone*, so children's interpretation of (75) can be paraphrased by the sentence - *The detectives didn't find anyone.* The non-adult interpretation on which *someone* received this interpretation was especially prominent in younger children who participated in the study.

The findings led Musolino et al. to propose that children's non-adult analysis of *someone* represented children's initial setting of a lexical parameter. According to the parameter, *someone* is a Positive Polarity Item (PPI) for adults, but not for children. That is, the lexical parameter has two values. The adult value is represented as [+PPI]. On this value, the existential expression *someone* raises to take scope over negation. On the alternative value, *someone* is interpreted *in situ*. This value is represented as [-PPI]. The fact that *someone* is [-PPI] in child language explains why children interpret *someone* to have the same meaning as *anyone* in negative sentences.

Musolino et al. point out that children's adoption of the [–PPI] parameter value

for *someone* conforms to the Semantic Subset Principle (SSP) (Crain, Ni & Conway, 1994; Crain, 2012). A moment's reflection indicates that the adult value of the lexical parameter [+PPI] makes sentences true in a broader range of circumstances than the [–PPI] value. The SSP therefore entreats children to initially assign the [–PPI] value of the lexical parameter. This guarantees that they will encounter positive evidence if they are acquiring languages in which adults enforce a polarity restriction on any given existential expression. Notice that, on the subset value, *someone* is interpreted *in situ*. Because *someone* appears in Object position, negation takes wider scope than *someone* both in the surface order and at the level of semantic interpretation. In other words, children's interpretation of sentences like (75) is consistent with the Isomorphism Hypothesis, as well as being consistent with the SSP.

Musolino (2006) presents a critique of the Semantic Subset Principle (SSP). This critique concludes that the SSP is not the source of children's interpretation of sentences like (75) after all. This leaves open the possibility that the source of children's interpretations is the Isomorphism Hypothesis, so it is important to see if the SSP can be rescued from the critique by Musolino.

Musolino (2006) argues that the SSP is deficient on both theoretical and on empirical grounds. Space only permits us to discuss one empirical challenge (see Moscati and Crain (2014) for a full response). One of Musolino's empirical arguments against the SSP is based on the interpretation that children and adults assign to sentences like (77).

(77) Some girls won't ride the merry-go-round.

In (77), the existential expression *someone* occupies the Subject position. According to Musolino, the SSP entails that *someone* must reconstruct to a position beneath negation

in order to generate the subset 'none' interpretation. Following reconstruction, children would interpret (77) to mean that none of the girls will ride the merry-go-round. However, the findings from experimental research show that neither children nor adults assign this interpretation to (77). Instead, *someone* is interpreted *in situ*, so *someone* takes scope over negation at the level of semantic interpretation, just as it does in the surface syntax. The empirical findings, therefore, favor the Isomorphism Hypothesis and are not consistent with the SSP, according to Musolino. The problem confronting the SSP is stated as follows (Musolino, 2006, p.207).

> "children should initially be restricted to the "none" interpretation of sentences containing … existentials and negation, regardless of the syntactic position of the quantified NPs. This follows from the fact that entailment relations between two logical operators are not affected by their syntactic position."

This quote indicates that Musolino views the SSP as a general purpose learning principle. On this formulation, the SSP applies in all sentences that contain both an existential expression and negation. This formulation of the SSP turns it into a search procedure that analyzes surface regularities, like the structure-independent distributional analyzer discussed in section 2.2. A distributional analyzer ignores the syntactic position of lexical items, just as in Musolino's assertion that "entailment relations between two logical operators are not affected by their syntactic position."

The version of the Semantic Subset Principle that Musolino critiques is one advanced in Crain and Thornton (1998 p. 118). It is important to note, however, that the version of the SSP proposed in Crain and Thornton (1998) is domain specific, not domain general. More specifically, Crain and Thornton state that the SSP is operative when "the interpretive component of Universal Grammar makes two interpretations, A

and B, available for a sentence, S". This design feature prevents children from making false starts in cases of scope ambiguity, where a false start would need to be retracted later, in order for children to converge on the adult language. As we have seen, recovering from false starts is problematic in the absence of negative evidence. To avoid potential learnability problems, the SSP guides children's initial setting of lexical parameters.

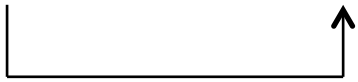
As the quote from Crain and Thornton (1998) makes clear, both values of lexical parameters must be possible in human language. Therefore, sentence (77) is a viable counter-example to the SSP only if some possible human language assigns the 'none' interpretation to such sentences. If there is no language that reconstructs an existential expression such as *someone* from Subject position to a lower position, then there is no potential subset problem, and the SSP is not operative. To state the point differently, the SSP must be consistent with the Continuity Assumption. According to the Continuity Assumption, every stage that a child goes through in the course of language development represents a possible human language (cf. Brown, 1973, Crain & Pietroski 2001).

We began with the observation that English-speaking children initially assign a 'none' interpretation to sentence (75). We explained this as a consequence of the fact that children assigned the [–PPI] value to the lexical parameter governing the interpretation of the existential expression *someone*. On this value of the parameter, children are expected to interpret the existential expression *someone in situ*, regardless of its position in the surface syntax. When *someone* appears in Subject position, sentence (77) has the surface scope interpretation, as indicated in (78).

(78) $\text{some}_{[\text{-PPI}]}$ girls won't ride on the merry-go-round

To falsify the SSP, it must be shown that it is possible for a language to compel existential expressions to undergo reconstruction, as depicted in (79).

(79) ~~some$_{[P]}$ girls~~ won't ride < some$_{[P]}$ girls > on the merry-go-round



We have seen that reconstruction is not required in English. And, as far as we know, no language assigns the 'none' interpretation to sentences like (77) (Moscati and Crain, 2014). If not, then there is no lexical parameter from which the SSP selects children's default setting.

Although the Semantic Subset Principle (SSP) and the Isomorphism Hypothesis often make the same empirical predictions, the SSP constrains children's search space, because it is domain specific in virtue of being tied to lexical parameters. We have pointed out two kinds of linguistic phenomena that can be used to assess the empirical adequacy of these alternative accounts of children's initial scope assignments. Despite the intrinsic appeal of the Isomorphism Hypothesis, it is far too general. This is why it is no match for the SSP. The SSP is domain specific; its application is limited to lexical parameters. Again, what needs to be explained is the specific "angle" of projection that children take in the course of language acquisition, not just the fact that children project beyond their experience.

6.5 How languages differ in scope assignments

According to the Continuity Assumption, child and adult languages can differ only in ways that adult languages can differ. One way that adult languages differ is in the

assignment of scope relations to logical expressions. One interpretation of a scope ambiguity can be strongly favoured in one class of languages, whereas the alternative interpretation is strongly favoured in another class of languages. This kind of cross-linguistic variation holds the potential to pose a learnability dilemma for children.[14] According to the biolinguistic approach, however, children come equipped to deal with the problem, so this aspect of language acquisition is worth discussing in detail. We begin by considering the English sentences (80) and (81).

(80) It was pasta or sushi that Ted did not order.

(81) Ted did not order pasta or sushi.

Both of these sentences contain two logical expressions, negation (*not*) and disjunction (*or*). Potentially, these logical expressions can be assigned two scope relations. In the case of example (80), disjunction takes scope over negation (OR > NOT), so the sentence can be paraphrased as *Ted didn't order pasta or Ted didn't order sushi*. The reverse scope assignment is exhibited in example (81). In this example, negation takes scope over disjunction (NOT > OR), so the sentence can be paraphrased as *Ted didn't order pasta and Ted didn't order sushi*. The scope assignment in the English example (81) conforms to one of de Morgan's laws of propositional logic. According to this law, a negated disjunction - NOT(A OR B) - entails two negative propositions, NOT(A) and NOT(B).

[14] More technically, subset problems arise when the forms and/or meanings that are generated on one parameter value asymmetrical entail the forms and/or meanings generated on the other value. Assuming the absence of negative evidence, the biolinguistics approach supposes that children initially adopt the parameter value that generates the most restricted set of forms and/or meanings.

As examples (80) and (81) illustrate, the surface word order of English dictates the semantic scope assignments for negative disjunctions. So English conforms to the Isomorphism Hypothesis, at least in this case. An isomorphism between surface word order and scope assignment is not characteristic of other languages, however. It is not characteristic, for example, of how disjunction words are interpreted in negative sentences in Mandarin Chinese. Example (82) is the Mandarin Chinese translation of the English example (81).

(82) Tàidé méiyǒu diǎn yìdàlìmiànshí huòzhě shòusī.
Ted not order pasta or sushi
'It's either pasta or sushi that Ted did not order'

Notice that Mandarin and English have the same word order. In example (82), the Mandarin word for negation, *méiyǒu*, precedes the word for disjunction, *huòzhě*, just as in the English example in (81). Nevertheless, adult speakers of Mandarin judge (82) to express the same meaning as the English cleft sentence in (80), on which disjunction takes scope over negation (OR > NOT), so the Mandarin sentence (82) means that Ted didn't order pasta *or* Ted didn't order sushi. In contrast to English, the surface word order in Mandarin does not dictate the semantic interpretation. Negation (*méiyǒu*) takes scope over disjunction (*huòzhě*) in the surface syntax, but disjunction takes scope over negation at the level of semantic interpretation. This is another example of the inverse scope interpretation. Other languages that favour the inverse scope interpretation of disjunction in negative sentences include Japanese, Hungarian, Russian, Portuguese, Serbo-Croatian, Slovak, and Polish.[15]

[15] It might appear that these languages fail to conform to the relevant law of propositional logic: $\neg(A \vee B) \Rightarrow (\neg A \wedge \neg B)$. However, appearances are deceiving.

6.6. The Disjunction Parameter

Universal Grammar is a theory of the initial state of the language learner. At the initial state, children acquiring all human languages are expected to start out with the same default settings of the class of parameters that hold the potential to pose subset problems. In a real sense, all children are therefore expected to speak the same language, at least in part. In the case of negative sentences with disjunction words, the question arises: Do children start off speaking a language in the same class as English or a language in the same class as Mandarin?

It was predicted by Goro (2004) that all children would initially speak a language in the same class as English when they first attempted to interpret negative sentences with disjunction. The reason is that the different scope assignments for negated disjunctions in sentences like (81) and (82) across languages stand in a subset/superset relation. On the scope assignment preferred by adult English speakers, negative sentences with disjunction are true in just one circumstance, where both disjunctions are false: NOT A and NOT B. This was illustrated earlier using sentence (81), *Ted did not order sushi or pasta*. This sentence is true only if Ted failed to order sushi and failed to order pasta. However, the scope assignment preferred by adult speakers of Mandarin makes the corresponding sentence (82) true in a broader range of circumstances. Sentence (82) is true for adult speakers of Mandarin when Ted failed to

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Because disjunction takes scope over negation in these languages, negation does not influence the interpretation of disjunction. Disjunction is assigned the same interpretation in negative sentences as it is in affirmative sentences, and is subject to the same implicature of 'exclusivity.' For evidence that all human languages adhere to certain laws of first order logic, see Crain (2012).

order pasta, or when Ted failed to order sushi, or when Ted failed to order either pasta or sushi.[16] Based on this asymmetry in truth conditions, Goro (2004) reasoned that children would confront a potential learnability dilemma if they initially selected the (superset) scope assignment that is characteristic of Mandarin, OR > NOT.

Based on this line of reasoning, Goro predicted that children acquiring all languages would initially assign the (subset) scope relations exhibited in languages like English, NOT > OR. This assignment of scope relations would mean that children acquiring Mandarin would initially judge sentences to be false in certain contexts where adult speakers would judge them to be true. Adopting the Principles and Parameters framework of Universal Grammar, Goro proposed that the scope assignment of disjunction words was governed by a lexical parameter, called the Disjunction Parameter. Adopting different terminology, Goro's proposal was that disjunction words were Positive Polarity Items in some languages (e.g., Mandarin) but not in others (e.g., English). As we noted earlier, Positive Polarity Items must take scope over (local) negation at the level of semantic interpretation, regardless of the structural relations that obtain between disjunction and negation in the surface syntax.

Setting details aside, we can summarize Goro's proposal as follows: disjunction words are associated with a lexical parameter, such that words for disjunction, OR, are either [+PPI] or [–PPI]. This led Goro to predict that children acquiring all human languages would initially assign a default value to the lexical parameter, taking disjunction words to be [–PPI]. The default setting of the lexical parameter is the 'subset' value, so children acquiring languages in which words for disjunction were

[16] Consider ambiguous sentence S, with two possible interpretations, A and B. If interpretation A asymmetrically entails B, then A is true in a subset of the circumstances that make B true. A is the 'subset' interpretation, and B is the 'superset' interpretation.

[+PPI] would encounter adult input that would lead them to abandon the default value, in favour of the 'superset' interpretation.

As an empirical consequence, adopting the [-PPI] value of the disjunction parameter would mean that Mandarin-speaking children would interpret the negated disjunction in (82) in the same way as English-speaking children and adults interpret the negated disjunction in (81) *Ted didn't order pasta or sushi*. That is, Mandarin-speaking children were expected to initially take negation to have scope over disjunction (NOT > OR), just as English-speaking children and adults do. This prediction runs counter to the usage-based approach, because the scope assignment that Mandarin-speaking children are predicted to make is not attested in their input, due to the fact that adults adopt the [+PPI] value of the disjunction parameter.

These predictions have been pursued in seven languages so far: Mandarin, Russian, Japanese, Turkish, German, English, and Korean. In four of these languages, (Mandarin, Russian, Japanese and Turkish) adult speakers assign the [+PPI] value of the disjunction parameter. So, adult-speakers of these four languages are expected to accept sentences corresponding to the English sentence *Ted didn't order sushi or pasta* in contexts in which Ted ordered only sushi, or only pasta. The critical observation is that children acquiring these four languages were predicted to reject these sentences, in the same fashion as children and adults who are speakers of languages that adopt the default value of the disjunction parameter, [–PPI]. As Figure 1 indicates, this prediction was confirmed. Children acquiring the four [+PPI] languages consistently rejected the test sentences, whereas adult speakers of these languages consistently accepted them. Children differ from adults, according to Goro (2004), because children adhere to the Semantic Subset Principle (Crain, Ni and Conway, 1994; Crain, 2012). The Semantic Subset Principle (SSP) enforces an ordering on the values of parameters in cases where one value makes a sentence true in a subset of the circumstances that make it true on

the other value. The SSP enjoins all children to initially adopt the subset value of the Disjunction Parameter, regardless of the scope assignment in the local language.

*Insert Figure 5 here *

Adult speakers of Mandarin, Russian, Japanese and Turkish typically interpret disjunction phrases as taking scope over negation. In contrast to adults, children acquiring these languages consistently take negation to be the dominant logical operator, taking scope over disjunction.

6.7. A Linguistic Universal

Although the interpretation of negative sentences with disjunction differs across (adult) languages, there are certain sentence structures that eliminate these cross-linguistic differences. Moreover, both child and adult speakers of all human languages are expected to assign the same interpretations to these sentences, so these are true linguistic universals. We will go through one example. This example combines several of the concepts we have surveyed in previous sections, but the examples are complex.

Consider sentence (83). Notice that the disjunction word *huozhe* 'or' licenses a Free Choice 'conjunctive' inference in (83). So both Mandarin speaking children and adults interpret (83) to mean that Papa Smurf is able to catch bees and Papa Smurf is able to catch snakes. This is not a logical entailment; it is an inference. This inference is drawn when disjunction appears in the scope of a modal verb like *neng* 'can.'

(83)	Lanbaba	neng	zhuadao	mifeng	huozhe	xiaoshe, …
	Smurf papa	can	catch	bee	or	snake, …

'Papa Smurf can catch bees or snakes, …'

Free Choice Inference: Papa Smurf can catch bees and can catch snakes.

In a recent study by Gao, Crain, Zhou and Thornton (2016), sentences like (83) were followed by two kinds of continuations. One continuation was a full sentence and the other was a fragment of a sentence, where the disjunction phrase was removed (elided) from the predicate phrase. Let us look first at the full sentence continuation, which is illustrated in (84).

(84) … danshi lanmeimei bu neng zhuadao mifeng huozhe xiaoshe
… but Smurf sister not can catch bee or snake
'… but Sister Smurf can't catch a bee or a snake.'

Child: 'Sister Smurf cannot catch bees and cannot catch snakes.' 'Neither'
Adult: 'It's bees or snakes that Sister Smurf can not catch.' 'Not both'

Sentence (84) contains both a negation marker (*bu* 'not) and disjunction (*huozhe* 'or'). We saw earlier that Mandarin-speaking children and adults assign different interpretations to (84). Based on these different interpretations, adults judge (84) to be true, whereas children judge it to be false in certain circumstances. One such circumstance is where it is revealed that Sister Smurf cannot catch snakes, but can catch bees. Children reject (84) in this context. Children reject (84) because they adopt the default setting of the Disjunction Parameter, according to which disjunction is [– PPI]. According to this value, disjunction is interpreted *in situ*, as in English. Therefore, (84) generates a conjunctive entailment for Mandarin-speaking children; it entails that

Sister Smurf cannot catch bees and that Sister Smurf cannot catch snakes. Mandarin-speaking children reject (84) in this context.

In contrast to children, adult Mandarin-speakers accept (84). For adults, the disjunction word has the [+PPI] value of the Disjunction parameter. According to this value of the parameter, disjunction is forced to take scope over negation at the level of semantic interpretation. This yields the 'not both' interpretation of sentences such as (84). So, for adults, (84) is true as long as sister Smurf either cannot catch bees or cannot catch snakes. In the context, Sister Smurf cannot catch snakes, so sentence (84) is true for adults.

Next consider (85). This is the second continuation following sentence (83). In this continuation, the main verb and the disjunction phrase have been elided. The whole verb phrase was used in (85): *bu neng zhuadao mifeng huozhe xiaoshe* 'not can catch bee or snake'. But in (85) only the negation marker and the modal verb remain: *bu neng* 'not can'.

(85) … danshi lanmeimei bu neng.
… but Smurf Sister not can
'… but Sister Smurf can't.'

Child: 'Sister Smurf cannot catch bees and cannot catch snakes.' 'Neither'
Adult: 'Sister Smurf cannot catch bees and cannot catch snakes.' 'Neither'

Because the disjunction phrase has been elided, it can no longer take scope over negation (cf. Crain, 2012). In response to (85), therefore, Mandarin-speaking children *and* Mandarin-speaking adults generate a 'conjunctive' entailment (the 'neither' interpretation). Both child and adult speakers of Mandarin are expected to interpret sentences like this in the same way as English-speaking children and adults. Speakers

of both languages are expected to reject (85) in the context under consideration, where Sister Smurf can catch bees, but can not catch snakes. Although sentence (85) contains disjunction, it licenses a 'conjunctive' inference - Sister Smurf cannot catch bees and Sister Smurf cannot catch snakes. Gao et al. recently interviewed 20 4-year-old Mandarin-speaking children and 20 adults using both full sentence continuations like (84), and fragment continuations like (85). As predicted, children and adults produced different responses to the continuation in (84). Children rejected these continuations, whereas adults accepted them. However, both children and adults rejected continuations like (85) over 90% of the time in a context in which Sister Smurf was only able to catch bees. This is just one example of many in which both cross-linguistic and cross-generational differences are negated, leaving all language users with the same interpretation.

7. Complete nature as different aspects of one set of phenomena

From a biolinguistic perspective, the goal of linguistic theory is the unification or amalgamation of phenomena that look different on the surface, but which are really just different combinations of the same basic building blocks of human languages. Forming generalizations that tie together phenomena that appear different on first inspection is the common aim of sciences of all stripes, and has long been at the foundation of linguistic theory. As the physicist Richard Feynman put it: … the aim is to see *complete nature* as different aspects of *one set* of phenomena (2011, Chapter 2).

Experimental linguistics provides the yardstick for measuring the empirical success of the amalgamations proposed by linguistic theory. Several of the putative deep-seated regularities proposed by linguistic theory have been empirically assessed in studies of child language. These assessments are made using experimental techniques

designed to unveil young children's knowledge of the relevant phenomena. A proposal about the amalgamation of disparate-looking phenomena is confirmed if the phenomena are acquired as a package by young language learners. The alternative (i.e., disconfirmation) would be the finding that one or another of the phenomena are acquired later than others in the course of language development. In fact, acquisitionists working in the generative tradition often make an even stronger hypothesis, namely that children across languages will demonstrate mastery of all of the relevant phenomena as soon as they can be tested, presumably once they know the meanings of the expressions under investigation. There is generally no reason to expect that children need months or years to acquire complex linguistic knowledge, in view of the assistance they receive from Universal Grammar.

Early mastery of complex linguistic phenomena compresses the time frame during which children have access to decisive input from adult speakers. Therefore, on the biolinguistic approach, a useful way of deciding between alternative theories about the course of language acquisition is to investigate the possibility that young children have knowledge of seemingly complex linguistic phenomena both within the language they are being exposed to, and across languages. These investigations are especially useful when the linguistic phenomena are different in character, at least on the surface. The reason is that the usage-based approach invokes general cognitive processes, such as analogy and surface regularities. The biolinguistic approach, by contrast, anticipates that young children will master clusters of disparate-looking phenomena, which are tied together by deep-seated principles of Universal Grammar.

It will be instructive to describe the alternatives in more detail. According to the usage-based approach, constructions are expected to be acquired in a piecemeal fashion, especially early in the course of language development. The order of acquisition is seen to be largely determined by the frequency of the construction in the

input. By eschewing abstract representations as the basis for early acquisition, the usage-based approach anticipates that the process of amalgamation unfolds only later in the course of acquisition. Moreover, the abstraction processes that underpin the amalgamation of different constructions when children are 4- or 5- years old are based on domain general and species general "pattern-finding" cognitive mechanisms. This position is expressed in the following quote from Tomasello (2008, pp. 85-86).

> "Ontogenetically, children hear individual utterances and then (re-)construct the abstract constructions of a language. All of this is done with general cognitive processes, and universals of linguistic structure derive from the fact that people everywhere have the same set of general cognitive processes. As noted at the outset, Tomasello (2003) argues that we may segregate these general cognitive processes into the two overall headings of: (1) intention-reading, comprising the species unique social cognitive skills responsible for symbol acquisition and the functional dimensions of language, and (2) pattern-finding, the primate wide cognitive skills involved in the abstraction process."

Cowie (2008/2010) characterizes children's general reasoning skills as "… the ability to recognize patterns of various sorts in the world, the ability to make analogies between patterns that are similar in certain respects, and the ability to perform certain sorts of statistical analysis of these patterns."

Although the usage-based approach credits child language learners with powerful reasoning tools, it would not predict that children, across languages, successfully amalgamate clusters of linguistic phenomena that are seemingly unrelated on the surface. In this final section, we look at examples of such amalgamation both within and across languages. We present a case study of a cluster of apparently unrelated

linguistic phenomena that occur within and across languages, which linguistic theory has attempted to account for using just a few basic concepts and inferential mechanisms. The description of the theory is followed by a review of experimental studies of these phenomena in children acquiring Mandarin Chinese. We have chosen to use Mandarin to showcase children's unification of disparate looking linguistic properties as an example for several reasons. First, Mandarin is historically unrelated to English. If it can be shown that children acquiring Mandarin draw upon the same linguistic toolkit as children acquiring English, this would be compelling evidence that the biolinguistic approach is on the right track. Mandarin is also useful because of its special linguistic properties. We will demonstrate that the language particular properties of Mandarin are merely different ways of assembling the same basic linguistic structures, as compared to English, or any other language.

7.1. Disjunction as an existential expression

We begin by pointing to the theoretical overlap between statements with disjunction, and the corresponding statements with existential expressions. In human languages, as in logic, disjunction words (English *or*, Mandarin *huozhe*) and existential expressions (English *any*, Mandarin *renhe*) are intimately linked. Suppose Ted is choosing from a limited menu, with only two main offerings, pasta and sushi. If Ted decides against pasta, but orders sushi, then English translations of sentences (86) and (87) will both be judged to be false. Moreover, the Mandarin sentences are both false for Mandarin-speaking children. In contrast to children, however, Mandarin-speaking adults judge (87) to be true because Ted ordered sushi, but not pasta.

(86) Tàidé méiyǒu diǎn yìdàlìmiànshí huòzhě shòusī

Ted not order pasta or sushi

Adult: ‘It’s either pasta or sushi that Ted did not order.’

Child: ‘Ted did not order either pasta or sushi.’

(87) Tàidé méiyǒu diǎn renhe cài.

Ted not order any food.

Adult and Child: ‘Ted did not order any food.’

Sentence (86) is false for children acquiring any language, as far as we know. The reason is that is the default value of the Disjunction Parameter is [–PPI], and this value results in a conjunctive entailment (the ‘neither’ interpretation). This is also the value of the Disjunction Parameter for adult English speakers. The Mandarin and English sentences in (86) are logically equivalent to the sentences in (87) as long as disjunction is interpreted within the scope of negation. On this scope assignment, both (86) and (87) are called ∃-items. They receive this designation because both *huozhe/or* and *any/renhe* are variants of the existential quantifier, ∃. If disjunction is [+PPI], however, then disjunction takes scope over negation, as in adult Mandarin.

Across languages, children’s interpretation of sentences like (86) and (87) reveals their knowledge of the unity between disjunction and existential expressions such as Mandarin *renhe* and English *any*. The challenge for the usage-based approach to language acquisition is to explain how Mandarin-speaking children could have discovered the unity of disjunction and existential expressions based on their linguistic experience, given that adult speakers of Mandarin judge (86) to be true and (87) to be false, whereas children judge both sentences to be false. It is unlikely, therefore, that children could have discovered that disjunction and existential expressions are both ∃-items using domain general cognitive mechanisms based on similarities in the

distributions of lexical items. Because Mandarin-speaking adults assign the [+PPI] feature to disjunction, sentences (86) and (87) do not pattern in the same way for them. But this means that the parental input obscures the underlying generalization - that disjunction and existential expressions are cut from the same cloth. Therefore, the finding that children interpret sentences like (86) and (87) as equivalent in meaning must be explained without recourse to children's pattern-finding abilities. These findings are consistent with the biolinguistic approach, because this approach anticipates that children will postulate that these lexical items are built from the same basic building blocks, despite their differences for adult speakers.

7.2. Free Choice Inferences

The final topic is another kind of amalgamation that takes place both within and across languages. It turns out, not accidently, that English *any*, its Mandarin counterpart *renhe* and Mandarin question words such as *shenme* 'what' are all licensed by the negative quantificational phrase, *nobody / meiyouren*: *Meiyouren chi renhe* / (*shenme*) *shuiguo* ' Nobody ate any fruit.' In this linguistic environment, these expressions are labeled Negative Polarity Items (NPIs). In the same linguistic environment, the Mandarin disjunction word *huozhe* and its English counterpart *or* generate a conjunctive interpretation. For example, the English sentence *Nobody ate an apple or an orange* entails that nobody ate an apple and it entails that nobody ate an orange. When English *any* and Mandarin *renhe* appear sentence initially, however, they license Free Choice Inferences.

Free choice inferences are also licensed in English when *any* appears in sentences with a modal verb, including the epistemic modal *can* (meaning *is able to*) or the deontic modal *may* (meaning *is allowed to*). This is illustrated in examples (88). Again,

in a finite domain, with just one green car and one red car, example (88) is logically equivalent to the disjunctive statement (89). Both of these sentences can be paraphrased using conjunction, so they can both be paraphrased as follows: *Kung Fu Panda can/may push the green car, and Kung Fu Panda can/may push the red car; he is free to choose which car to push.* (The formal algorithm for computing Free Choice Inferences is called recursive exhaustification.[17])

(88) Kung Fu Panda can/may push any of the cars.

(89) Kung Fu Panda can/may push the green car or the orange car.

The observation that disjunction words license free choice inferences is surprising.

(90) Kung Fu Panda pushed the green car or the orange car

[17] Recursive exhaustification involves two applications of a 'exhaustfication' operator, ONLY. First, ONLY factors in subdomain alternatives and their associated inferences. Take statement (106), which we render as ◊[G ∨ O], where G stands for *green*, and O for *orange*. The subdomain alternatives include {◊G, ◊O}. For alternative ◊G, the first exhaustification ONLY(◊G) generates the inference [◊G ∧ ¬◊O]. For alternative ◊O, it generates [◊O ∧ ¬◊G]. The second application of ONLY disposes of alternatives (with their associated inferences) that are informationally stronger than the original assertion ◊[G ∨ O]. Both of the propositions generated at the first step are stronger than the assertion, so they are inferred to be false. Therefore, the second exhaustification yields ◊[G ∨ O] ∧ ¬[◊G ∧ ¬◊O] ∧ ¬[◊O ∧ ¬◊G] or, equivalently, ◊[G ∨ O] ∧ [◊G ↔ ◊O]. In sum, the assertion ◊[G ∨ O] entitled us to infer [◊G ↔ ◊O] = ◊G ∧ ◊O.

As (90) illustrates, disjunction phrases do not typically license Free Choice Inferences. These inferences are licensed only when a disjunction phrase is combined with certain linguistic expressions, such as the modal verbs *can* and *may*. In fact, adult English speakers have the reverse intuition about (90). For most adults, (90) means that Kung Fu Panda did NOT push both cars. This 'exclusivity' ('not both') inference is effected by the fact that (90) contains *or* rather than *and*. If Kung Fu Panda had pushed both cars, then *and* would be the operative logical connective in (90), since the use of *and* would have conveyed the facts more directly. The use of *or*, therefore, invites readers to infer that Kung Fu Panda did not push both of the cars.

Free Choice Inferences are not just a property of English. Mandarin licenses Free Choice Inferences in sentences with *renhe* 'any' and in sentences with disjunction *huozhe* 'or', just as English does. Moreover, Mandarin licenses Free Choice Inference with question words such as *shenme* 'what.' We illustrate this in examples (91)-(93) using one of the most intriguing expressions in Mandarin, the adverbial quantifier *dou* 'all/always.'[18]

(91) Gongfu xiongmao lüse xiaoche *huozhe* juse xiaoche dou keyi tui.
Kung Fu Panda green car or orange car all may push
'Kung Fu Panda is allowed to push the green car or the orange car.'

[18] English and Mandarin differ in how quantification is realized. In English, quantificational expressions can appear in two syntactic positions, either as Determiners or as Adverbs. The universal quantifier *every* is a Determiner, and so are the existential indefinites *some* and *a*. The expressions *always, often, seldom, necessarily*, and *sometimes* are Adverbs of quantification. In Mandarin, quantificational expressions are always adverbs, since Mandarin lacks Determiners altogether.

(92) Gongfu xiongmao *shenme* xiaoche dou keyi tui.
Kung Fu Panda what car all may push
'Kung Fu Panda is allowed to push any car.'

(93) Gongfu xiongmao *renhe* xiaoche dou keyi tui.
Kung Fu Panda any car all may push
'Kung Fu Panda is allowed to push any car.'

As expected, the Mandarin expressions *renhe* 'any' and *shenme* 'what' in sentences (92) and (93) have the same meaning. This underscores the conclusion that these expressions have a common source. Despite the apparent differences between these expressions in ordinary sentences, looking at more complex examples brings to light evidence in favour of the unified account, according to which these expressions are different instantiations of the existential quantifier, ∃, in both English and in Mandarin.

8. Conclusion

This chapter has compared the usage-based approach to language acquisition with the biolinguistic approach. We reported the findings of experimental studies in several areas of child language, in most cases where both approaches have conducted research. It seems clear to us that the biolinguistic account is both more descriptively adequate, and more explanatory. We offered several examples of linguistic phenomena where children have reached conclusions that are not a direct reflection of the input, including children's productions and their understanding of language. We have also discussed several examples of children's non-adult productions and comprehension that resist

explanation by the general cognitive processes adopted by the usage-based approach, but ones that are expected on the biolinguistic approach. The biolinguistic approach expects there to be differences between child and adult language. However, when child and adult language differ, children are expected to invoke structures from a possible human language, just not the one the child is exposed to. Finally, children were found to amalgamate linguistic phenomena that look different on the surface, rather than forming generalization based on similarity, analogy, or distributional analysis. Finding unity when confronted by diversity is the hallmark of the biolinguistic approach to language acquisition.

References

Ambridge, B. & Lieven, E.V. 2011. *Child language acquisition: Contrasting theoretical approaches*. Cambridge: Cambridge University Press.

Ambridge, B., Pine, J. M., & Lieven, E. V. 2014. Child language acquisition: Why universal grammar doesn't help. *Language, 90*(3), e53-e90.

Ambridge, B., Rowland, C., & Pine, J. 2008. Is structure dependence an innate constraint: Experimental evidence from children's complex-question production. *Cognitive Science, 32*, 222-255.

Bellugi, Ursula. 1967. *The acquisition of the system of negation in children's speech.* Unpublished doctoral dissertation, Harvard University, Boston, MA.

Berwick, R. C. 1985. *The acquisition of syntactic knowledge*. Cambridge, MA: MIT Press.

Berwick, R.C., Pietroski, P., Yankama, B., Chomsky, N. 2011. Poverty of the stimulus revisited. *Cognitive Science 35*(7), 1207-1242.

Berwick, R.C., Chomsky, N., & Piattelli-Palmarini, M. 2012. Poverty of the stimulus stands: Why recent challenges fail. In M. Piattelli- Palmarini & Berwick, R. C.

(Eds.), *Rich languages from poor inputs* (pp. 19-42). Oxford, UK: Oxford University Press.

Bowerman, M. 1988. The 'no negative evidence' problem: How do children avoid constructing an overly general grammar? In J. Hawkins (Ed.), *Explaining language universals* (pp. 73-101). Oxford: Basil Blackwell.

Boyd, J.K. & Goldberg, A.E. 2011. Learning what *not* to say: The role of statistical preemption and categorization in *a*-adjective production. *Language 87*(1), 55-83.

Brown, R. 1973. *A first language: The early stages*. London: Allan and Unwin.

Brown, R., & Hanlon, C. 1970. Derivational complexity and order of acquisition in child speech. In J. R. Hayes (Ed.), *Cognition and the development of language* (pp. 11-54). New York: Wiley.

Boyd, J. & Goldberg, A. 2011. Learning what not to say: the role of statistical preemption and categorization in "a"-adjective production. *Language, 81*, 1- 29.

Brown, R. 1973. *A first language: The early stages*. Cambridge, MA: Harvard University Press.

Cameron-Faulkner T, Lieven E.V. & Theakston A. 2007. What part of no do children not understand? A usage-based account of multiword negation. *Journal of Child Language, 34*, 251–282.

Chien, Y.-C. & Wexler, K. 1990. Children's knowledge of locality conditions in binding as evidence for the modularity of syntax and pragmatics. *Language Acquisition, 1*, 225-295.

Chierchia, G. 2013. *Logic in grammar: Polarity, free Choice, and intervention.* Oxford University Press.

Chomksy, N. 1965. *Aspects of the theory of syntax*. Cambridge, MA: MIT Press.

Chomsky, N. 1980. *Rules and representations*. New York: Columbia University

Press.

Chomsky N. 1981. *Lectures on government and binding*. Dordrecht: Foris.

Chomsky, N. 1988. *Language and problems of knowledge: The Managua lectures* (Vol. 16). Cambridge, MA: MIT Press.

Chomsky, N. 2007. Of minds and language. *Biolinguistics*, *1*, 009-027.

Chomsky, N. 2012. Poverty of the stimulus: Willingness to be puzzled. In M. Piattelli-Palmarini and R. C. Berwick (Eds.) *Rich languages from poor inputs*, 61.

Chomsky, N. 2013. The Dewey Lectures 2013: What kind of creatures are we? *The Journal of Philosophy Volume CX, 12*, 645-700.

Conroy, A., Takahashi, E., Lidz, J. & Phillips, C. 2009. Equal treatment for all antecedents: How children succeed with Principle B. *Linguistic Inquiry, 45*, 446-486.

Cowie, F. 1999. *What's within: Nativism reconsidered*. New York: Oxford University Press.

Cowie, F. 2010. Innateness and language, *The Stanford Encyclopedia of Philosophy* (Summer 2010 Edition), Edward N. Zalta (ed.), URL: <http://plato.stanford.edu/archives/sum2010/entries/innateness-language/>.

Crain, S. 1991. Language acquisition in the absence of experience. *Behavioral and Brain Sciences, 14*, 597-650. DOI: 10.1017/S0140525X00071491

Crain, S. 2012. *The emergence of meaning*. Cambridge: Cambridge University Press.

Crain, S. & Nakayama M. 1987. Structure dependence in grammar formation. *Language, 63*, 522–543.

Crain, S., Ni, W. & Conway, L. 1994. Learning, parsing and modularity. In C. Clifton, L. Frazier, and K. Rayner, [Eds.], *Perspectives on sentence processing,* Lawrence Erlbaum Associates, Inc., Hillsdale, New Jersey.

Crain, S. & Pietroski, P. 2001. Nature, nurture and Universal Grammar. *Linguistics and Philosophy, 24*, 139-186.

Crain, S. & Thornton R. 1998. *Investigations in universal grammar: A guide to experiments on the acquisition of syntax and semantics*. Cambridge, MA: MIT Press.

Croker, S., Pine, J.M. & Gobet, F. 2003. Modelling children's negation errors using probabilistic learning in MOSAIC. In F. Detje, D. Dörner & H. Schaub (Eds.) *Proceedings of the Fifth International Conference on Cognitive Modeling,* 69-74. Bamberg:Universitäts-Verlag.

Dabrowska, E., Rowland, C., & Theakston, A. 2009. The acquisition of questions with long-distance dependencies. *Cognitive Linguistics, 20*(3), 571 - 598.

Déprez, V. & Pierce, A. 1993. Negation and functional projections in early grammar. *Linguistic Inquiry 24*, 25-67.

de Villiers, J. & de Villiers, P. 1985. The acquisition of English. In D. Slobin (Ed.), *The crosslinguistic study of language acquisition, vol 1: The Data*, (pp. 27-140). Hillsdale, NJ: Lawrence Erlbaum.

Deutsch, W., Koster C. &Koster J. 1986. What can we learn from children's errors in understanding anaphora? *Linguistics 24*, 203–225. doi: 10.1515/ling.1986.24.1.203

Drozd, K. 1995. Pre-sentential negation as metalinguistic exclamatory sentence negation. *Journal of Child Language 22*, 583-610.

Du Plessis, H. 1977. Wh movement in Afrikaans. *Linguistic Inquiry, 8*, 723–726.

Elbourne, P. 2005. On the acquisition of Principle B. *Linguistic Inquiry, 36*, 333-365.

Everaert, M. B., Huybregts, M. A., Chomsky, N., Berwick, R. C., & Bolhuis, J. J. 2015. Structures, not strings: Linguistics as part of the cognitive sciences. *Trends in Cognitive Sciences*, *19*(12), 729-743.

Felser, C. 2004. Wh-copying, phases, and successive cyclicity. *Lingua, 114*, 543-574.

Feynman, R. P. 2011. Six Easy Pieces. Basic Books.

Feynman, R. P., Leighton, R. B., & Sands, M. 1963. *Feynman lectures on physics. vol. 1: Mainly mechanics, radiation and heat*. Addison-Wesley.

Fodor, J. 1983. *Modularity of mind*. Cambridge, MA: MIT Press.

Gao, N., Crain, S., Zhou, P. & Thornton, R. (2016). The interpretation of disjunction involving negative linguistic contexts in Mandarin Chinese. Paper presented at *Disjunction days: theoretical and experimental perspectives on the semantics ad pragmatics of disjunction*. Zentrum für Allgemeine Sprachwissenschaft (ZAS Berlin), June 2-3.

Gavruseva, E. & Thornton, R. 2001. Getting it right: Acquisition of whose-questions in child English. *Language Acquisition, 9*, 229-267, doi: 10.1207/S15327817LA0903_2

Goldberg, A. 2003. Constructions: A new theoretical approach to language. *Trends in Cognitive Sciences, 7*, 219–224.

Goldberg, A. 2006. *Constructions at work: The nature of generalizations in language*. New York: Oxford University Press.

Goro, T. 2004. The emergence of Universal Grammar in the emergence of language: the acquisition of Japanese logical connectives and positive polarity. Unpublished doctoral dissertation, University of Maryland, College Park, MD.

Grodzinsky, Y. & Reinhart, T. 1993. The innateness of binding and coreference. *Linguistic Inquiry, 24*, 69-101.

Gualmini, A. 2008. The rise and fall of Isomorphism. *Lingua 118*, 1158-1176.

Gualmini, A. & Crain, S. 2005. The structure of children's linguistic knowledge. *Linguistic Inquiry, 36*, 463-474.

Guasti, M. T. & Chierchia, G. 2000. Backward versus forward anaphora: Reconstruction in child grammar. *Language Acquisition 8*, 129-170.

Haegeman, L. 1995. *The syntax of negation*. Cambridge: Cambridge University Press.

Harris, T. & Wexler, K. 1996. The optional-infinitive stage in child language: Evidence from negation. In H. Clahsen (Ed.), *Generative perspectives on language acquisition*, (pp.1-42). Amsterdam: John Benjamins.

Heycock, C., & Kroch, A. 2002. Topic, focus, and syntactic representations. In *Proceedings of WCCFL*, 21, (pp. 141-165). Somerville, MA: Cascadilla Press.

Hiemstra, I. 1986. Some aspects of wh-questions in Frisian. North-Western European *Language Evolution (NOWELE), 8*, 97–110.

Höhle, T., 2000. The w...w construction: appositive or scope indicating? In: Lutz, U., Müller, G. & von Stechow, A. (Eds.), *Wh-scope marking,* (pp. 249-270). Amsterdam: John Benjamins.

Hyams, N. 1986. *Language acquisition and the theory of parameters*. Dordrecht: Kluwer.

Jakubowicz, C. 1984. On markedness and binding principles. *Proceedings of the 14th Annual Meeting of the Northeast Linguistics Society (NELS),* (pp. 154-182). Amherst, MA: GLSA.

Karmiloff-Smith, A. 1992. *Beyond modularity: A developmental perspective on cognitive science* [Reprinted 1995]. Cambridge, MA: MIT Press/Bradford Books.

Kirjavainen, M. & Theakston, A. (2009). Can input explain children's me-for-I errors? *Journal of Child Language 36*, 1091-1114.

Klima, E. & Bellugi, U. 1966. Syntactic regularities in the speech of children. In J. Lyons & R. Wales (Eds.), *Psycholinguistic papers*, (pp. 183-208). Edinburgh: Edinburgh University Press.

Koster, C. 1993. *Errors in anaphora acquisition*. Utrecht: Led, Utrecht: Onderzoeksinstituut voor Taal en Spraak Rijksuniversiteit Utrecht.

Lieven, E. V. M. 2010. Input and first language acquisition: Evaluating the role of frequency. *Lingua 120*, 2546-2556.

Lieven E, V. M. & Tomasello M. 2008. Children's first language acquisition from a usage-based perspective. In: Robinson P, Ellis NC, (Eds.) *Handbook of Cognitive Linguistics and Second Language Acquisition.* New York: Rutledge; 2008.

MacWhinney, B. 2000. *The CHILDES project: Tools for analyzing talk.* Mahwah, NJ: Lawrence Erlbaum Associates.

MacWhinney, B. (2004). A multiple process solution to the logical problem of language acquisition. *Journal of Child Language, 31*, 883-914.

Marcus, G. F. 1993. Negative evidence in language acquisition. *Cognition, 46*, 53-85.

Matthews, D., Lieven, E., Theakston, A., & Tomasello, M. 2009. Pronoun co-referencing errors: Challenges for generativist and usage-based accounts. *Cognitive Linguistics 20,* 599-626.

McDaniel, D. 1986. Conditions on wh-chains. Unpublished doctoral dissertation, City University of New York, New York.

Morgan, J. & Travis, L. 1989. Limits on negative information in language input. *Journal of Child Language 16*, 531–552.

Moscati, V., & Crain, S. 2014. When negation and epistemic modality combine: The role of information strength in child language. *Language Learning and Development*, 10(36), 345-380. doi:10.1080/15475441.2014.880640

Musolino, J. 1998. Universal Grammar and the acquisition of semantic

knowledge. Unpublished doctoral dissertation, University of Maryland, College Park.

Musolino, J. 2006. 'On the Semantics of the Subset Principle'. *Language Learning and Development*, *2*(3), 195-218.

Musolino, J. and Lidz, J. 2006. Why children aren't universally successful with quantification. *Linguistics*, *44*(4), 817-852.

Musolino, J., Crain, S., & Thornton, R. 2000. Navigating negative semantic space. *Linguistics and Philosophy*, *38*, 1-32.

Newport, E. L. Gleitman, H. and Gleitman, L. R. 1977. Mother I'd rather do it myself: The contribution of selected child listener variables. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to Children*. Cambridge: Cambridge University Press.

Notley, A., Zhou, P., & Crain, S. 2016. Children's interpretation of conjunction in the scope of negation in English and Mandarin: New evidence for the Semantic Subset Maxim. *Applied Psycholinguistics 37, 867-900.*

O'Leary, C. & Crain, S. 1994. Negative polarity (a positive result) and positive polarity (a negative result). Paper presented at the 18th Annual Boston University Conference on Language Development, Boston, MA.

Philip, W. & Coopmans, P. 1996. The role of lexical feature acquisition in the development of pronominal anaphora. in W. Philip and F. Wijnen, (Eds.), *Amsterdam Series on Child Language Development,* Vol. 5, Instituut Algemene Taalwetenschap 68, Amsterdam, The Netherlands.

Piattelli-Palmarini, M., Uriagereka, J., & Salaburu, P. (Eds.). 2009. *Of minds and language: A dialogue with Noam Chomsky in the Basque Country: A Dialogue with Noam Chomsky in the Basque Country*. Oxford: OUP.

Pinker, S. 1984. *Language Learnability and Language Development*.

Cambridge, MA: Harvard University Press.

Pinker, S. 1990. Language acquisition. In D. N. Osherson and H. Lasnik (Eds.), *An invitation to cognitive science*, Vol 1. (pp. 199-241). Cambridge, MA: MIT Press

Pullum G. & Scholtz, B. 2002. Empirical assessments of stimulus poverty arguments. *The Linguistic Review*, *19*:9–50.

Reinhart, T. & Reuland, E. 1993. Reflexivity. *Linguistic Inquiry, 24*, 657-720.

Reuland, E. 2011. *Anaphora and language de*sign. Cambridge, MA: MIT Press.

Rizzi, L. 2006. Grammatically-based target-inconsistencies in child language. In K.U. Deen, J. Nomura, B. Schulz, & B.D. Schwartz (Eds.), *Proceedings of the Inaugural Conference on Generative Approaches to Language Acquisition–North America, Honolulu, HI* (pp 19–49). Storrs, MA: University of Connecticut Occasional Papers in Linguistics, 4.

Saffran, J., Aslin, R. & Newport, E. Statistical learning by 8-month-old infants. *Science, 274*, 1926-1928.

Saxton, M. 2010. *Child language: Acquisition and development*. London: Sage Publications.

Schütze, C. 2010. The status of nonagreeing don't and theories of optional infinitives. *Language Acquisition 17*, 235- 271, DOI: 10.1080/10489223.2010.509270

Slobin, D. 1972. Children and language: They learn the same way all around the world. *Psychology Today*, 6, 71-82.

Sportiche, D. 2006. Reconstruction, binding and scope. In Everaert, M., H, & H. van Riemsdijk (Eds.)*The Blackwell Companion to Syntax*, Volume I-V, Oxford: Blackwell.

Szabolcsi, A. 1983/1984. The possessor that ran away from home. *The Linguistic Review 3*, 89–102.

Thornton R. 1990. Adventures in long-distance moving: the acquisition of complex Wh-questions. Unpublished doctoral dissertation, University of Connecticut, Storrs.

Thornton, R. & Crain, S. 1994. Successful cyclic movement. In T. Hoekstra & B. Schwartz (Eds.] *Language Acquisition Studies in Generative Grammar*. (pp. 215-253). John Benjamins Publishing Company, Amsterdam/Philadelphia. doi: 10.1075/lald.8.11tho

Thornton, R., Kiguchi, H. & D'Onofrio, E. 2015. Clefts and reconstruction in English-speaking children's grammars. Paper presented at the 40th Boston University Conference on Child Language Development, November 13-15.

Thornton, R. and Rombough, K. 2015. The syntax-PF interface in children's negative sentences. *Language Acquisition 22,* 132-157. dOI: 10.1080/10489223.2014.943901

Thornton, R. & Tesan, G. 2007. Categorical acquisition: parameter setting in Universal Grammar. *Biolinguistics 1*, 49-98.

Thornton, R. & Tesan, G. 2013. Sentential negation in early child English. *Journal of Linguistics 49(2),* 367-411.

Thornton, R. & Wexler, K. 1999. *Principle B, VP ellipsis and interpretation in child grammar*. Cambridge, MA: MIT Press.

Tomasello, M. 2000a. Do young children have adult syntactic competence? *Cognition*, *74*, 209–253.

Tomasello, M. 2000b. First steps toward a usage based account of language acquisition. *Cognitive Linguistics 11*, 61-82.

Tomasello M. 2003. *Constructing a language: A usage-based theory of language acquisition*. Cambridge, MA: Harvard University Press.

Tomasello, M. 2008. How are humans unique? *New York Times Magazine*, May 25,

2008.

Valian, V., Solt, S., and Stewart, J. 2009. Abstract categories or limited-scope formulae? The case of children's determiners. *Journal of Child Language*, *36*(04), 743-778.

Yang, C. D. 2002. *Knowledge and learning in natural language*. Oxford University Press on Demand.

Yang, C. 2013. Ontogeny and phylogeny of language. *Proceedings of the National Academy of Sciences*, *110*(16), 6324-6327.

Yang, C. 2015. For and against frequencies. *Journal of Child Language*, 42, 287-293. doi:10.1017/S0305000914000683 Zanuttini, Rafaella. 2001. Sentential negation. In Mark Baltin & Chris Collins (Eds.), *The handbook of contemporary syntactic theory*, (pp. 511–535). Malden, MA: Blackwell.

Zeijlstra, H. H. 2004. *Sentential negation and negative concord*. Unpublished doctoral dissertation, University of Amsterdam, Amsterdam, The Netherlands.

Zeijlstra, H. H. 2007. On the syntactic flexibility of formal features. In T. Biberauer (Ed.), *The limits of syntactic variation*, (pp.143-174). Amsterdam: John Benjamins.

Figure 1: Structure-dependent Yes/No Questions

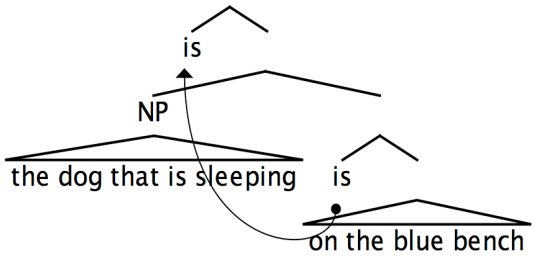


Figure 2: Forming *wh*-questions

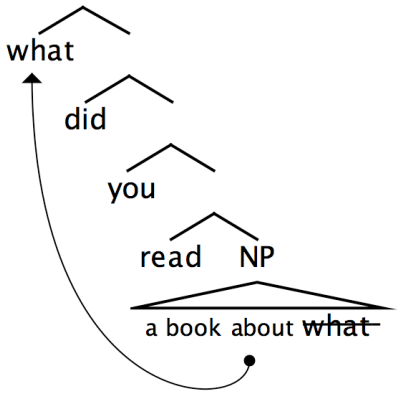
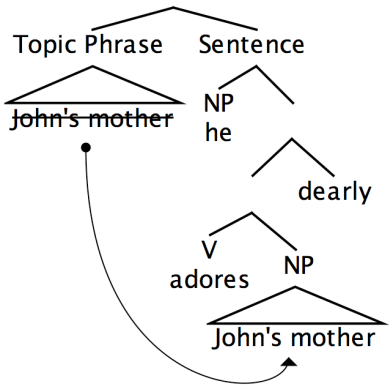


Figure 3: Reconstruction of the topic phrase ‘John’s mother’



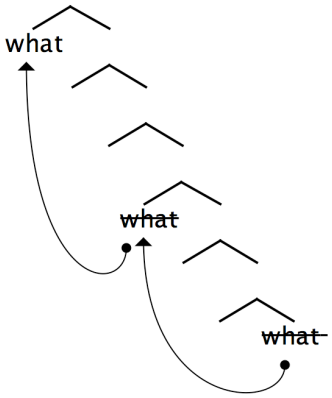


Figure 4: Derivation of long-distance *wh*-questions

Figure 5**.** Child and adult patterns of rejection in [+PPI] and in [-PPI] languages.