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Child language acquisition:

Why Universal Grammar doesn't help

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Short Abstract:

In many different domains of language acquisition, there exists an apparent learnability problem to which innate knowledge of some aspect of Universal Grammar (UG) has been proposed as a solution. The present article reviews these proposals in the core domains of (a) identifying syntactic categories, (b) acquiring basic morphosyntax, (c) structure dependence, (d) subjacency and (e) the binding principles. We conclude that, in each of these domains, the innate UG-specified knowledge posited does not, in fact, simplify the task facing the learner.

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In many different domains of language acquisition, there exists an apparent learnability problem to which innate knowledge of some aspect of Universal Grammar (UG) has been proposed as a solution. The present article reviews these proposals in the core domains of (a) identifying syntactic categories such as NOUN and VERB (distributional analysis, prosodic/semantic bootstrapping), (b) acquiring basic morphosyntax (semantic bootstrapping, parameter setting), (c) structure dependence (subject-auxiliary inversion in complex questions; e.g., *Is the boy who is smoking crazy?*), (d) subjacency (e.g., *$*What_i$ did Bill read the report that was about t_i?*) and (e) the binding principles (e.g., *$Goldilocks_i$ said that Mama $Bear_j$ is washing $her_{i/*j}$*; *She_i listens to music when $Sarah_{*i}$ reads poetry*). We conclude that, in each of these domains, the innate UG-specified knowledge posited does not, in fact, simplify the task facing the learner: Particular UG constraints succeed only to the extent that they correlate with semantic, cognitive, and discourse processing constraints that are necessarily assumed by all accounts of language acquisition, whether or not they additionally assume UG.

Keywords: binding principles; child language acquisition; frequent frames; parameter setting; prosodic bootstrapping; semantic bootstrapping; structure dependence; subjacency; syntax; morphosyntax; Universal Grammar.

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1.0 Introduction

Many leading theories of child language acquisition assume innate knowledge of Universal Grammar (e.g., of syntactic categories such as NOUN and VERB, constraints/principles such as structure dependence and subjacency, and parameters such as the head-direction parameter). Many authors have argued either for or against Universal Grammar (UG) on *a priori* grounds such as learnability (e.g., whether the child can acquire a system of infinite productive capacity from exposure to a finite set of utterances generated by that system) or evolutionary plausibility (e.g., linguistic principles are too abstract to confer a reproductive advantage).

Our goal in this article is to take a step back from such arguments, and instead to consider the question of whether the individual components of innate UG knowledge proposed in the literature (e.g., a NOUN category, the binding principles) would help the language learner. We address this question by considering the main domains for which there exists an apparent learnability problem and where innate knowledge has been proposed as a critical part of the solution: (S2) identifying syntactic categories, (S3) acquiring basic morphosyntax, (S4) structure dependence, (S5) subjacency and (S6) binding principles. We should emphasise that the goal of this article is not to contrast UG accounts with alternative constructivist or usage-based accounts of acquisition (for recent attempts to do so, see Saxton, 2010; Ambridge & Lieven, 2011). Rather, our reference point for each domain is the set of learning mechanisms that must be assumed by all accounts, whether generativist or constructivist. We then critically evaluate the claim that adding particular innate UG-specified constraints posited for that domain simplifies the task facing the learner.

Before we begin, it is important to clarify what we mean by "Universal Grammar" (UG), as the term is often used differently by different authors. We do not use the term in its most general sense, in which it means simply 'the ability to learn language'. The claim that humans possess Universal Grammar in this sense is trivially true, in the same way that humans could be said to possess universal mathematics or universal baseball (i.e., the ability to learn mathematics or baseball).

Similarly, we do not use the term "Universal Grammar" to mean Hauser, Chomsky and Fitch's (2002) faculty of language in either its broad sense (general learning mechanisms; the sensorimotor and conceptual systems) or its narrow sense (including only recursion). Neither do we use the term to mean something like a set of properties or design features shared by all languages. It is almost certainly the case that there *are* properties that are shared by all languages. For example, all languages combine meaningless phonemes into meaningful words, instead of having a separate phoneme for each meaning (Hockett, 1960), though there is much debate as to whether these constraints are linguistic or arise from cognitive and communicative limitations (e.g., Evans & Levinson, 2009). Finally, while we acknowledge that most - probably all - accounts of language acquisition will invoke at least *some* language-related biases (e.g., the bias to attend to speech sounds and to attempt to discern their communicative function), we do not use the term UG to refer to an initial state that includes only this very general type of knowledge.

None of these definitions seem to capture the notion of UG as it is generally understood amongst researchers of child language acquisition. It is in this sense that we use the term "Universal Grammar"; a set of categories (e.g., NOUN, VERB), constraints/principles (e.g., structure

dependence, subjacency, the binding principles) and parameters (e.g., head direction, V2) that are innate (i.e., that are genetically encoded and do not have to be learned or constructed through interaction with the environment). Our aim is not to evaluate any particular individual proposal for an exhaustive account of the contents of UG. Rather we evaluate specific proposals for particular components of innate knowledge (e.g., a VERB category; the subjacency principle) that have been proposed to solve particular learnability problems, and leave for others the question of whether or how each could fit into an overarching theory of Universal Grammar. Many generativist-nativist theories assume that, given the under-constraining nature of the input, this type of innate knowledge is necessary for language learning to be possible. In this article, we evaluate the weaker claim that such innate knowledge is helpful for language learning. We conclude that, while the in-principle arguments for innate knowledge may seem compelling at first glance, careful consideration of the actual components of innate knowledge often attributed to children reveals that none simplify the task facing the learner.

Specifically, we identify three distinct problems faced by proposals that include a role for innate knowledge – *linking,* inadequate *data-coverage* and *redundancy* – and argue that each component of innate knowledge that has been proposed suffers from at least one. Some components of innate knowledge (e.g., the major lexical syntactic categories and word order parameters) would appear to be useful in principle. In practice, however, there is no successful proposal for how the learner can link this innate knowledge to the input language (the ***linking*** problem; e.g., Tomasello, 2005). Other components of innate knowledge (e.g., most lexical syntactic categories, and rules linking the syntactic roles of SUBJECT and OBJECT to the semantic categories of AGENT and PATIENT) yield inadequate ***data-coverage***: the knowledge proposed would lead to incorrect conclusions for certain languages and/or certain utterance types within a particular language. A third type of innate knowledge (e.g., subjacency, structure

dependence, the binding principles) would mostly lead the learner to correct conclusions, but suffers from the problem of *redundancy*: Learning procedures that must be assumed by all accounts – often to explain counterexamples or apparently unrelated phenomena – can explain learning, with no need for the innate principle or constraint. We argue that, given the problems of linking, data-coverage and redundancy, there exists no current proposal for a component of innate knowledge that would be useful to language learners.

Before we begin, it is important to ask whether are setting up a straw man. Certainly, our own – of course, subjective – impression of the state of the field is that UG-based accounts (as defined above) do not enjoy broad consensus or even, necessarily, represent the dominant position. Nevertheless, it is undeniably the case that many mainstream child language acquisition researchers are currently publishing papers that argue explicitly for innate knowledge of one or more of the specific components of Universal Grammar listed above. For example, in a review article on *Syntax Acquisition* for a prestigious interdisciplinary cognitive science journal, Crain and Thornton (2012) argue for innate knowledge of structure dependence and the binding principles. Valian, Solt and Stewart (2009) recently published a study designed to provide evidence for innate syntactic categories (see also Yang, 2009). Lidz and colleagues (Viau & Lidz, 2011; Lidz & Gleitman, 2004; Lidz, Waxman & Freedman, 2003; Lidz, Gleitman & Gleitman, 2003; Lidz & Musolino, 2002) have published several articles - all in mainstream interdisciplinary cognitive science journals - arguing for UG-knowledge of syntax. Virginia Valian, Thomas Roeper, Kenneth Wexler and William Synder have all given plenary addresses emphasizing the importance of Universal Grammar at recent meetings of the leading annual conference in the field (the *Boston University Conference on Language Development*); indeed there are entire conferences devoted to UG approaches to language acquisition (e.g., GALANA). The UG hypothesis is defended in both recent child language textbooks (Guasti, 2004; Lust,

2006) and books for the general reader (e.g., Yang, 2006; Roeper, 2007). This is to say nothing

of the many studies that incorporate certain elements of Universal Grammar (e.g., abstract

syntactic categories, an abstract TENSE category) as background assumptions (e.g., Rispoli,

Hadley & Holt, 2009), rather than as components of a hypothesis to be tested as part of the study.

Many further UG-based proposals are introduced throughout the present article. In short, while

controversial, Universal Grammar – in the sense that we use the term here – is a current, live

hypothesis.

2.0 Identifying syntactic categories.

One of the most basic tasks facing the learner is that of grouping the words that are encountered

into syntactic categories (by which we mean lexical categories such as NOUN, VERB and

ADJECTIVE; syntactic roles such as SUBJECT and OBJECT will be discussed in the section on

acquiring basic word order). This is a very difficult problem because the definitions of these

categories are circular. That is, the categories are defined in terms of the system in which they

participate. For example, arguably the only diagnostic test for whether a particular word (e.g.,

situation, *happiness, party*) is a NOUN is whether or not it occurs in a similar set of syntactic

contexts to other NOUNs such as *book* (e.g., after a determiner and before a main or auxiliary

verb, as in *the_is*). Given this circularity, it is unclear how the process of category formation can

get off the ground.

The traditional solution has been to posit that these syntactic categories are not formed on the

basis of the input, but are present as part of UG (e.g., Chomsky, 1965; Pinker, 1984; Valian,

1986). The advantage of this proposal is that it avoids the problem of circularity, by providing a

potential way to break into the system. If children know in advance that there will be a class of

(for example) NOUNs and are somehow able to assign just a few words to this category, they can then add new words to the category on the basis of semantic and/or distributional similarity to existing members. The question is how children break into these syntactic categories to begin with. This section considers three approaches: *distributional analysis*, *prosodic bootstrapping* and *semantic bootstrapping*.

2.1 Distributional analysis. In the adult grammar, syntactic categories are defined distributionally. Thus it is almost inevitable that accounts of syntactic category acquisition – even those that assume innate categories - must include at least some role for distributional analysis (the *prosodic bootstrapping* account, discussed below, is a possible exception). For example, as Yang (2008: 206) notes "[Chomsky's] LSLT [*Logical Structure of Linguistic Theory*] program explicitly advocates a probabilistic approach to words and categories 'through the analysis of clustering … the distribution of a word as the set of contexts of the corpus in which it occurs, and the distributional distance between two words' (LSLT: section 34.5)". Pinker (1984: 59) argues that "there is good reason to believe that children from 1½ to 6 years can use the syntactic distribution of a newly heard word to induce its linguistic properties" (although famously arguing against deterministic distributional analysis elsewhere; e.g., Pinker, 1979: 240). Similarly, Mintz (2003: 112), while assuming a "pre-given set of syntactic category labels" advocates, and provides evidence for, one particular form of distributional analysis (frequent frames). Finally, arguing for an account under which "the child begins with an abstract specification of syntactic categories", Valian, Solt and Stewart (2009: 744) suggest that "the child uses a type of pattern learning based on distributional regularities…in the speech she hears".

Thus the claim that learners use distributional learning to form clusters that correspond roughly to syntactic categories (and/or subcategories thereof) is relatively uncontroversial (for computational implementations see, e.g., Redington, Chater & Finch, 1998; Cartwright & Brent, 1997, Clark, 2000; Mintz, 2003; Freudenthal, Pine & Gobet, 2005; Parisien, Fazly & Stevenson, 2008; see Christodoulopoulos, Goldwater & Steedman, 2010, for a review). The question is whether, having formed these distributional clusters, learners would be helped by the provision of innate pre-specified categories to which they could be linked (e.g., Mintz, 2003). We argue that this is not the case, and that a better strategy for learners is simply to use the distributionally-defined clusters directly (e.g., Freudenthal et al, 2005).

Although, as we have seen above, many accounts that assume innate syntactic categories also assume a role for distributional learning, few include any mechanism for linking the two. Indeed we are aware of only two such proposals. Mintz (2003) suggests that children could assign the label NOUN to the category that contains words for concrete objects, using an innate linking rule. The label VERB would then be assigned either to the next largest category or, if this does not turn out to be cross-linguistically viable, to the category that takes NOUNs as arguments (for which a rudimentary, underspecified outline of the sentence's argument structure would be sufficient). Similarly, Pinker's (1984) *semantic bootstrapping* account (subsequently discussed more fully in relation to children's acquisition of syntactic roles such as SUBJECT and OBJECT) assumes innate rules linking "name of person or thing" to NOUN, "action or change of state" to VERB and "attribute" to ADJECTIVE (p.41). Once the child has used these linking rules to break into the system, distributional analysis largely takes over. This allows children to assimilate non-actional verbs and nouns that do not denote the name of a person/thing (as in Pinker's example, *The situation justified the measures*) into the VERB and NOUN category on the basis of their distributional overlap with more prototypical members.

A problem facing both Mintz's (2003) and Pinker's (1984) proposals is that they include no mechanisms for linking distributionally-defined clusters to the other innate categories that are generally assumed as a necessary part of UG, such as DETERMINER, WH-WORD, AUXILIARY and PRONOUN. Pinker (1984: 100), in effect, argues that these categories will be formed using distributional analysis, but offers no proposal for how they are linked up to their innate labels. Thus it is only for the categories of NOUN, VERB and (for Pinker) ADJECTIVE that these proposals offer any account of linking at all. This is not meant as a criticism of these accounts, which do not claim to be exhaustive and – indeed – are to be commended as the only concrete proposals that attempt to link distributional and syntactic categories at all. The problem is that, despite the fact that virtually all UG accounts assume innate knowledge of a wide range of categories, there exist no proposals at all for how instances of these categories can be recognized in the input; an example of the linking problem.

In fact, this is not surprising, given the widespread agreement amongst typologists that - other than a NOUN category containing at least names and concrete objects - there are no viable candidates for cross-linguistic syntactic categories (e.g., Nida, 1949; Lazard, 1992; Dryer, 1997; Croft, 2001, 2003; Haspelmath, 2007; Evans & Levinson, 2009). For example, Mandarin Chinese has property words that are similar to adjectives in some respects, and verbs in others (e.g., McCawley, 1992; Dixon, 2004). Similarly, Haspelmath (2007) characterizes Japanese as having two distinct adjective-like parts of speech, one a little more noun-like, the other a little more verb-like. Indeed, even the NOUN/VERB distinction has been disputed for languages such as Salish (Kinkade, 1983; Jelinek & Demers, 1994), Samoan (Rijkhoff, 2003) and Makah (Croft, 2001; Jacobson, 1979), in which (English) verbs, nouns, adjectives and adverbs may all be inflected for person/aspect/mood (usually taken as a diagnostic for verbs in Indo-European

languages). Such considerations led Maratsos (1990:1351) to conclude that the only candidate

for a universal lexical category distinction "is between 'noun and Other'", reflecting a distinction

between things/concepts and properties/actions predicated of them.

Pinker (1984: 43) recognizes the problem of the non-universality of syntactic categories, but

argues that it is not fatal for his theory, provided that different cross-linguistic instances of the

same category share at least a "family resemblance structure". Certainly an innate rule linking

"name of person or thing" to NOUN (Pinker, 1984:41) would probably run into little difficulty

cross-linguistically. It is less clear whether the same can be said for the rules linking "action or

change of state" to VERB and "attribute" to ADJECTIVE. But even if these three linking rules

were to operate perfectly for all languages, cross-linguistic variation means that it is almost

certainly impossible in principle to build in innate rules for identifying other commonly-assumed

UG categories, whether these rules make use of semantics, distribution or some combination of

the two (the problem of data-coverage).

In summary, Pinker's (1984) and Mintz's (2003) proposals are useful in that they capture the

insight that, in order to form syntactic categories, learners will have to make use of both

semantic and distributional information. Where they falter is in their assumption that these

distributional clusters must be linked to innate syntactic categories. The reason for the failure of

UG accounts to propose mechanisms by which distributional clusters can be linked to innate

universal syntactic categories other than NOUN is that (with the possible exception of

VERB/ADJECTIVE) there *are* no good candidates for innate universal syntactic categories other

than NOUN. Given that syntactic categories are language specific, there is no alternative but for

children to acquire them on the basis of semantic and distributional regularities. Indeed, even

categories as (relatively) uncontroversial as English NOUN and VERB are made up of

semantically and distributionally coherent subcategories such as *proper* vs *count* vs *mass* and *intransitive* vs *monotransitive* vs *ditransitive*. Thus even if a learner could instantaneously assign every NOUN or VERB that she hears into the relevant category, this would not obviate the need for a considerable degree of clustering based on semantic and distributional similarity. Given that such clustering yields useful syntactic categories, innate categories are redundant.

We end this section by addressing two possible objections to the claim that distributional analysis can obviate the need for innate syntactic categories. The first is that the notion of "distributional analysis" as discussed here is ill defined. For example, it is sometimes asked how the child knows in advance that distributional analysis must take place at the level of the word, as opposed to the phone, phoneme, syllable, *n*-syllable sequence and so on. The answer is that the child does not know. In fact, she will have to conduct distributional analysis at many of these levels simultaneously to solve other problems such as speech segmentation, constructing an inventory of phonemes, and learning the phonotactic constraints and stress patterns of her language. As a result of this many-layered distributional analysis, it will be noted that units of a certain size – "words" – occur more often than would be expected if speakers produced random sequences of phones (and, crucially, co-occur with concrete or functional referents in the world (e.g., 'cat', 'past-ness'). It will be further noted that these units share certain distributional regularities with respect to one another; the type of distributional analysis required for syntactic-class formation. There is no need to build in innate constraints to rule out every theoretically possible distributional-learning strategy: Let the child try to perform distributional analysis based on, for example, 3-syllable strings. She will learn after a handful of exposures that these units are neither distributionally nor semantically/functionally coherent. Of course, it might turn out to be necessary to assume general constraints such as "pay particular attention to sounds make by humans" or "note correlations between speakers' sounds and their probable intentions", but these

are not the types of constraints posited by typical UG accounts, almost all of which assume innate syntactic categories.

Note that even if one rejects these arguments entirely, the question of how the child knows to perform distributional analysis at the word level, as opposed to some other level, is equally problematic for accounts that do and do not posit innate syntactic categories, given that accounts of the former type still require word-level distributional analysis in order to assign words to the pre-specified categories. This point relates to the second possible objection: that none of the distributional analysis algorithms outlined above are unequivocally successful in grouping words into categories. While this is true, it is no argument for innate syntactic categories, as – again – accounts that posit such categories still require distributional analysis working at the single-word level (as explicitly advocated by Chomsky; see Yang, 2008) in order to identify instances of these categories. Finally, note that tacit in the argument that "distributional categories don't work" is the assumption that the categories commonly assumed by UG theories do work; an assumption that – with the possible exception of NOUN – enjoys little support cross-linguistically.

2.2. Prosodic Bootstrapping. The prosodic bootstrapping hypothesis (e.g., Christophe, Millotte, Bernal & Lidz, 2008) differs from the proposals above in that it does not assume that learners initially use either semantics or distributional clustering to break into the syntactic category system. Rather children use prosodic information to split clauses into syntactic phrases (e.g., [*The boy*] [*is running*])[1]. For example, the end of a phrase is often signalled by final syllable lengthening, a falling pitch contour and/or a short pause. Having split the clause into syntactic phrases, the child then uses 'flags' to label each phrase, and hence to assign the items to the relevant categories. For example, in this case, the child uses determiner *the* and auxiliary *is* to

label the phrases as NOUN PHRASE and VERB PHRASE respectively, and hence to assign *boy* to the NOUN class and *running* to the VERB class. The advantage of the prosodic bootstrapping account is that, by using non-distributional (i.e., prosodic) information to break into the distributionally-defined system, it avoids both circularity, and the problem of linking distributional clusters to UG-specified categories. Furthermore, there is evidence to suggest that even 6-month-old infants are sensitive to the relevant prosodic properties. Using a conditioned-head-turn paradigm, Soderstrom, Seidl, Kemler Nelson and Jusczyk (2003) showed that infants could discriminate between two strings that were identical in terms of their phonemes, but only one of which contained an NP/VP boundary, marked by final syllable lengthening and pitch drop:

No phrase boundary: At the discount store **new watches for men** are simple...

NP/VP boundary: In the field, the old frightened **gnu // watches for men** and women...

One problem facing this account is that, even looking only at the case of the NP/VP boundary in a single language (i.e., English), such a strategy would probably lead to incorrect segmentation in the majority of cases. For sentences with unstressed pronoun subjects (e.g., *He kissed the dog*) as opposed to full NPs (e.g., *The boy kissed the dog*), prosodic cues place the NP/VP boundary in the wrong place (e.g., *[NP *He kissed*] [VP *The dog*]; Gerken, Jusczyk & Mandel, 1994; Nespor & Vogel, 1986). In an analysis of spontaneous speech to a child aged 1;0, Fisher and Tokura (1996) found that 84% of sentences were of this type. Of course, we have no idea how reliable a cue must be for it to be useful (almost certainly less than 100%). Nevertheless, it would seem difficult to argue that a cue that is not simply uninformative but actively leads to incorrect segmentation in the vast majority of cases is anything other than harmful.

The problem of the non-existence of universal syntactic categories also clearly constitutes a problem for Christophe et al.'s (2008) approach. But even if it were somehow possible to come up with a list of universal categories (as well as reliable prosodic cues to phrase boundaries), the proposal would still fail unless it were possible to identify a 'flag' for every category in every language. The outlook does not look promising, given that the possible flags proposed by Christophe et al. (2008) for the English NOUN and VERB categories - DETERMINER and AUXILIARY – are by no means universal. Yet even with a universal list of syntactic categories and flags to each one, children would still need an additional mechanism for recognizing concrete instances of these flags (e.g., children hear *the* and *is*, not DETERMINER and AUXILIARY). Given that there exists no proposal for a universal set of flags, Christophe et al's (2008) account suffers from the linking problem. It also suffers from an additional problem that is common to many UG approaches. While the proposal, at its core, proposes one or two critical elements of innate knowledge (here, knowledge of prosodic cues to phrase boundaries), it requires a cascade of further assumptions that are rarely made explicit (here observable flags for every category for every language), before it can be said to provide a potentially workable solution (e.g., Tomasello, 2003; 2005).

2.4. Conclusion. In conclusion, our goal is not to argue for an alternative account of syntactic category acquisition. Indeed, the proposals outlined here seem to us to be largely along the right lines. Learners will acquire whatever syntactic categories are present in the particular language they are learning, making use of both distributional (e.g., Mintz, 2003) and semantic similarities[2] (e.g., Pinker, 1984) between category members. Indeed, although there is only weak evidence for prosodic/phonological cues to category membership in English, there would seem to be no reason to doubt that, if particular languages turn out to contain such cues, then learners will use them. Where these theories falter is in their attempt to squeeze fine-grained language-specific

categories, defined by distribution and semantics (and possibly also function and prosody), into a rigid framework of putative innate universal categories, derived primarily from the study of Indo-European languages. Even if these cross-linguistic categories were useful, there are essentially no proposals for how children could identify instances of them, other than by using distributional and semantics-based learning; a procedure that yields the target categories in any case. Consequently, nativist proposals for syntactic category acquisition suffer from problems of data-coverage, linking and redundancy.

3.0 Acquiring basic morphosyntax[3]

Another task facing children is to learn how their language marks 'who did what to whom' in basic declarative sentences. For syntactic word order languages such as English, this involves learning the correct ordering of SUBJECT, VERB and OBJECT. For other languages, this involves learning how these categories (or the equivalent) are indicated by means of morphological noun and/or verb marking. The problem is a difficult one because the notions of SUBJECT, VERB and OBJECT are highly abstract. For example, while learners of English could parse simple sentences such as *The dog bit the cat* using a basic semantic AGENT ACTION PATIENT schema, this will not work for non-actional sentences such as *The situation justified the measures*, or sentences where the SUBJECT is more patient-like than agentive (e.g., *He received a slap [from Sue]*; examples from Pinker, 1984). Note also that in these non-agentive examples the SUBJECT still receives SUBJECT as opposed to OBJECT case marking (i.e., nominative *he*, not accusative *him*). This means that, just like syntactic categories such as NOUN and VERB, syntactic roles such as SUBJECT and OBJECT cannot be defined in terms of semantics, and are defined instead in terms of their place within the grammatical system of which they form a part. The only way to determine whether a particular NP is a SUBJECT is to

determine whether or not it displays the constellation of properties displayed by other subjects

(e.g., bearing nominative case, appearing first in canonical declaratives, etc.). Consequently, it

has often been argued that syntactic roles (like lexical categories) are too abstract to be learned,

and must therefore be innately specified as part of Universal Grammar. This assumption is

shared by the *semantic bootstrapping* account and *parameter-setting* approaches, the latter of

which additionally assume that the different word-order possibilities are, in effect, also known in

advance as part of UG.

3.1 Semantic Bootstrapping. Pinker's (1984) *semantic bootstrapping* account assumes that

Universal Grammar contains not only syntactic roles (e.g., SUBJECT, VERB and OBJECT), but

also innate rules that link each to a particular semantic role (e.g., AGENT→SUBJECT,

VERB→ACTION, PATIENT→OBJECT)[4]. Assume, for example, that the child hears an

utterance such as *The dog bit the cat* and is able to infer (for example, by observing an ongoing

scene) that *the dog* is the AGENT (the biter), *bit* the ACTION and *the cat* the PATIENT (the one

bitten). By observing in this way that English uses AGENT ACTION PATIENT order, and using

the innate rules linking these semantic categories to syntactic roles, the child will discover (in

principle from a single exposure) that English uses SUBJECT VERB OBJECT word order. As

noted in the previous section, innate rules also link "names for people or objects" (here *dog* and

cat) to an innate NOUN category.

An important, but often overlooked, aspect of Pinker's (1984) proposal is that once basic word

order has been acquired in this way, the linking rules are abandoned in favour of

(a) the recently-acquired word-order rules and (b) distributional analysis. Thus the child will be

able to parse a subsequent sentence that does not conform to these linking rules, for example,

The situation justified the measures, by using (a) the SUBJECT VERB OBJECT rules inferred

on the basis of *The cat bit the dog* and (b) distributional similarity (e.g., if **the cat** is a NOUN

PHRASE and *cat* a NOUN, then **the situation** must also be a NOUN PHRASE and *situation* a

NOUN).

The advantage of Pinker's (1984) account is that it avoids the problems inherent in the circularity

of syntactic roles by using non-syntactic (i.e., semantic) information to break into the system.

Since this semantic information is used only as a bootstrap and then discarded, sentences that do

not conform to the necessary pattern (e.g., *He received a slap from Sue; The situation justified*

the measures) do not present a problem. Although questions, passives and other non AGENT-

ACTION-PATIENT sentences would yield incorrect word-order rules (e.g., Pinker, 1984: 61

discusses the example of *You will get a spanking off me* yielding OVS), the suggestion is that

learning is probabilistic and hence that occasional sentences of this type do not disrupt learning

of the canonical pattern (Pinker, 1987).

One basic problem facing Pinker's proposal is that it is unclear how the child can identify which

elements of the utterance *are* the semantic arguments of the verb (AGENT and PATIENT), and

hence are available for linking to SUBJECT[5] and OBJECT, given the way that the particular

target language carves up the perceptual world (Bowerman, 1990). Consider, for example, the

English sentence *John hit the table with a stick*. The AGENT (*John*) links to SUBJECT and the

PATIENT (*the table*) to OBJECT. As an INSTRUMENT, *the stick* links to OBLIQUE OBJECT.

For English, non-canonical variations of such sentences (e.g., *John hit the stick against the table*)

are presumably sufficiently rare to be disregarded. For some languages, however, the equivalent

is the canonical form. Thus a learner of, for example, Chechen-Ingush could perform the correct

linking only if she parsed the same scene such that *the stick* (as opposed to *the table*), is the

PATIENT, and hence links to OBJECT (the table links to OBLIQUE OBJECT):

English, *Chechen-Ingush: John=SUBJ, hit=VERB, the table=OBJ, stick=OBL

*English, Chechun-Ingush: John=SUBJ, hit=VERB, the table=OBL, stick=OBJ

It is important to emphasise that this problem is more fundamental than the problem that some languages do not map AGENT and PATIENT onto SUBJECT and OBJECT in the same way as English (see below). The problem raised by Bowerman (1990) is that some languages do not map what English conceptualizes as PATIENTS onto *either* SUBJECT or OBJECT position (but rather to OBLIQUE OBJECT); a version of the linking problem.

It has been argued (e.g., by Pye, 1990) that the existence of morphologically ergative(-absolutive) languages (e.g., Dyirbal) constitutes a problem for Pinker's (1984) proposal, as such languages do not map semantic roles onto syntactic roles in the same way as (nominative-)accusative languages such as English (and the majority of Indo-European languages). Languages differ in the way that they map the following semantic roles onto the morphological case-marking system:

- A = The AGENT of a transitive verb (***The man*** *kissed the woman*)
- P^6 = The PATIENT of a transitive verb (*The woman kissed **the man***)
- S = The SINGLE argument of an intransitive verb (***The man*** *danced*)

Accusative languages (e.g., English) use one type of case-marking (NOMinative) for A and S, and a different type of case-marking (ACCusative) for P. This can be seen in English, which marks case on pronouns only, by substituting pronouns for *the man* in the sentences above: A = ***He*-NOM** *kissed the woman*, S=***He*-NOM** *danced*, but P = *The woman kissed* **him-ACC**.

Ergative languages (remember that, for the moment, this discussion is restricted to *morphological* ergativity) use one type of case-marking (ergative) for A and another (absolute) for P and S.

Van Valin (1992), Siegel (2000) and Tomasello (2005) argue that particularly problematic for semantic bootstrapping are *split-ergative* languages, which use the nominative-accusative system in some contexts and the ergative-absolutive system in others. Languages may split according to tense (e.g., Jakaltek; Craig, 1977), aspect (e.g., Hindi; Bhat, 1991), an animacy hierarchy (e.g., Dyirbal; Dixon, 1972), whether the morphological marking is realised on the noun or verb (e.g., Enga, Kaluli, Walpiri, Georgian, Mparntwe Arrernte; Van Valin & La Polla, 1997) or even the particular lexical item being inflected (e.g., Tsova-Tush; Holisky, 1987). Consequently, split-ergative languages have no mapping between semantic and syntactic categories that is consistent across the entire grammar.

So far we have discussed only *morphological* ergativity. Also argued to be problematic for semantic bootstrapping (e.g, by Van Valin, 1992) are languages that exhibit true *syntactic* ergativity (e.g., Dixon, 1972; Woodbury, 1977; Pye, 1990). In such languages, the P role (PATIENT of a transitive verb) is the syntactic SUBJECT[7], passing many traditional tests for subjecthood such as appearing in an oblique phrase in antipassives (in Dyirbal and K'iche') and being controlled by an NP in a matrix clause (in Dyirbal and Yup'ik Eskimo). The advantage of syntactic ergativity is that it allows morphologically ergative languages to maintain a consistent mapping between case-marking and syntactic roles (similarly to nominative-accusative languages see Pinker, 1989: 253). The disadvantage is that any innate rule linking PATIENT to OBJECT (as for English) would have to be overridden in a great many cases. One cannot solve this problem by, for example, having the learner set a parameter such that the transitive

PATIENT links to SUBJECT rather than OBJECT: All syntactically ergative languages are split-ergative (Dixon, 1994; Van Valin & LaPolla, 1997:282-285), meaning that they employ nominative-accusative syntax in some parts of the system. Thus, as discussed above with regard to morphological split ergativity, linking rules must be learned on a construction-by-construction basis.

Nevertheless, the solution proposed by Pinker (1984) for non-canonical English sentences (e.g., *He received a slap off Sue*) can, in principle, be extended to deal with all types of ergativity. The solution (developed most fully in Pinker, 1987) is to relegate innate linking rules to a probabilistic cue to syntactic roles that can be overruled by other competing factors, including – explicitly – distributional learning (e.g., Pinker, 1987: 430; Pinker, 1989: 253).

While this solution potentially achieves better data-coverage, it does so at the expense of redundancy, by effectively obviating the need for any innate learning mechanism (Braine, 1992). This is perhaps best illustrated by split ergativity (the same problem holds for both the morphological and syntactic versions of this phenomenon). Since the mapping between semantic roles and morphological/syntactic marking changes depending on animacy, tense, aspect, and so on, there is no alternative but for children to *learn* the particular mapping that applies in each part of the system, using whatever probabilistic semantic or distributional regularities hold in that domain (e.g., animate agents are marked by a particular morpheme/word-order position, inanimate agents by another). The links between semantics and morphology/syntax that must be learned are not only complex and fine-grained but context-dependent, varying from verb to verb, tense to tense or human to animal. Thus any particular set of innate linking rules would not only lead to the wrong solution in many cases, but would be largely arbitrary (which links should we build in?; those that hold for present- or past-tense marking; for humans or for animals?).

Let us conclude this section by examining which parts of Pinker's (1984) account succeed and which fail. Its first key strength is the assumption that children exploit probabilistic, though imperfect, correlations between semantic roles (e.g., AGENT) and morpho-syntactic marking, whether realised by word order (e.g., **[SUBJECT]** [VERB] [OBJECT]) or morphology (e.g., nominative or ergative case marking). Its second key strength (as noted by Braine, 1992) is the principle that 'old rules analyse new material', which allows the initial semantically-based categories (e.g., AGENT) to expand into syntactic categories via distributional analysis. For example, the distributional similarity between the first NPs in ***The cat*** *bit the dog* and ***The situation*** *justified the measures* allows *the situation* to be assimilated into the category containing *the cat*, even though the former is not an AGENT. Although the situation is more complex for morphologically-ergative languages, the 'old rules analyse new material' principle still applies, just with slightly more restrictive rules (i.e., different rules for clauses with perfective and imperfective aspect). Both of these learning procedures are extremely useful and presumably will have to be assumed, in some form or other, by any theory of acquisition. The problem for Pinker's proposal is that these learning procedures are so powerful that they obviate the need for innate linking rules (as indeed they must, given that there can be no set of rules that is viable cross-linguistically).

3.2 Parameter setting. An alternative UG-based approach to the acquisition of basic word order is parameter setting (Chomsky, 1981b). Parameter setting accounts assume that learners acquire the word order of their language by setting parameters on the basis of input utterances. Although perhaps as many as 40 binary parameters are required to capture all cross-linguistic variation assumed within Universal Grammar (Clark, 1992; Baker, 2001), three are particularly relevant for determining basic word order. The *specifier-head* parameter determines, amongst other

things, whether a language uses SV (e.g., English) or VS (e.g., Hawaiian) order. The

complement-head parameter - sometimes known simply as the *head-direction* parameter –

determines, amongst other things, whether a language uses VO (e.g., English) or OV (e.g.,

Turkish) order. The V2 parameter determines whether a language additionally stipulates that a

tensed verb must always be the second constituent of all declarative main clauses, even if this

means overriding the word order specified by the other parameters. Languages for which this is

the case, such as German and Swedish, are said to have a +V2 setting, as opposed to the –V2

exhibited by languages such as English.

A potential problem facing parameter-setting approaches is parametric ambiguity: Certain

parameters cannot be set unless the child has previously set another parameter, and knows this

setting to be correct (Clark, 1989, 1992; Gibson & Wexler, 1994). For example, suppose that a

German child hears *Gestern kaufte* **(V)** *Hans* **(S)** *das Buch* **(O)** ('Yesterday bought **(V)** Hans **(S)**

the book **(O)**'). Should this be taken as evidence that German has the VS and SO setting of the

relevant parameters, or that the correct settings are in fact SV and VO and that the VSO word

order is simply a consequence of the V2 rule? In fact, the second possibility is the correct one,

but a child cannot know this unless she has already correctly and definitively set the V2

parameter to +V2. In a formal mathematical analysis, Gibson and Wexler (1994) demonstrated

that, in the face of ambiguous sentences of this type, there are many situations in which the

learner can never arrive at the correct settings for all three parameters. This is due to the

existence of *local maxima*: states from which the learner could never reach the target grammar

given the learning process assumed (or even "archipelagos" of non-target grammars, between

which learners can move, but never escape; Frank & Kapur, 1996).

Although this problem is shared by many older *error-driven-learning* approaches (e.g., Wexler & Cullicover, 1980, Berwick, 1985; Hyams, 1986), it has largely been solved by more recent work. The first solution is to propose that each parameter has a default initial state (Gibson & Wexler, 1994; Clark, 1989; Bertolo, 1995)[8] and/or to relax the restrictions that (a) only changes that allow for a parse of the current sentence are retained (*greediness*) and (b) only one parameter may be changed at a time (the *single-value* constraint) (e.g., Berwick & Niyogi, 1996; Frank & Kapur, 1996). While these solutions work well for Gibson and Wexler's three-parameter space, they do not scale up to spaces with 12 or 13 parameters (Bertolo et al, 1997; Kohl, 1999; Fodor & Sakas, 2004) - the approximate number generally held to be necessary for simple sentences – and/or require a prohibitively large number of utterances (Fodor & Sakas, 2004). A much more successful strategy (e.g., see Sakas & Fodor, 2012) is to have the parser detect ambiguous sentences. For example, Fodor's (1998a,b) *structural triggers learner* attempts to parse input sentences with multiple grammars simultaneously, and discards (for the purposes of parameter setting) strings that can be successfully parsed by more than one.

The third possible solution rejects triggering (or *transformational learning*) altogether in favour of *variational learning* (Yang, 2002: 17; Pearl, 2007). At any one point in development, instead of a single grammar (=array of parameter settings) that changes as each parameter is set, the learner has a population of competing grammars. When presented with an input sentence, the learner selects a grammar with probability p and attempts to analyse the sentence using this grammar, increasing p (i.e., the probability of future selection) if successful and decreasing p if not. Although it requires a relatively large number of utterances to succeed (Sakas & Nishimoto, 2002), the variational learning model enjoys the advantages of being robust to noise (i.e., non-canonical or ungrammatical utterances) and avoiding having children lurch between various

incorrect grammars as they flip parameter settings (as opposed to gradually

increasing/decreasing their strength).

In short, there can be no doubt that modern parameter-setting approaches provide well-specified,

computationally tractable accounts of word-order acquisition that converge quickly on the target

grammar when implemented as computational models. The problem is that their success depends

crucially on the assumption that the learner is able to parse input sentences as sequences of

syntactic roles (e.g., SUBJECT VERB OBJECT). Indeed, as these sequences constitute the input

to computational implementations of parameter-setting models, this point is unequivocal:

> In effect, then, the [simulated] learner knows all word categories and grammatical roles
>
> in advance. In real life, such knowledge would be attained with some effort, perhaps
>
> through semantic bootstrapping and/or distributional learning (Pinker, 1984). On the
>
> other hand [real learners receive] helpful cues to syntactic phrase boundaries such as
>
> might result from prosodic bootstrapping (Fodor & Sakas, 2004:12).

The problem is that there are no successful accounts of how this knowledge could be obtained.

As we argued above, semantic bootstrapping (Pinker, 1984), distributional learning linked to

innate syntactic categories (Mintz, 2003) and prosodic bootstrapping (Christophe, 2008) do not

work. In a variant of the prosodic bootstrapping approach, Mazuka (1996) proposed that children

could set the head-direction (VO/OV) parameter on the basis of a cross-linguistic correlation

between head direction and branching direction. VO languages (e.g., English) tend to be right-

branching, meaning that each successive clause is added to the right of the sentence, while OV

languages (e.g., Japanese) tend to be left-branching, with each successive clause added to the

left. Of course, children who have yet to set the word-order parameters of their language cannot

determine branching direction by parsing complex sentences syntactically. Mazuka's (1996) claim is that children can determine branching direction on the basis of purely phonological factors. For example, pitch changes are greater for subordinate→main clause boundaries than main→subordinate clause boundaries, and this could form part of children's innate knowledge. Similarly, Christophe et al. (2003) propose that children set the head-direction parameter using a correlation with phonological prominence. VO languages (e.g., English) tend to emphasise the rightmost constituent of a phrase (e.g., [*The **man***] [*kicked **the ball***]), and OV languages (e.g., Turkish) the leftmost.

However, it is far from clear that either correlation is universal (raising the problem of poor coverage). For example, Mazuka (1996) concedes that at least some sentence types in German and Chinese do not exhibit the phonological properties necessary for her proposed learning procedure to succeed. With regard to the proposal of Christophe et al. (2003), Pierrehumbert (2003) notes that maintaining this correlation would require somehow assigning different phonological analyses to English (SVO) and Japanese (SOV) sentences that have almost identical contours when measured objectively. Neither is there any evidence that children are aware of such correlations where they exist. Indeed, Christophe et al. (2003) found that even *adult* native French speakers were able to select sentences with right- as opposed to left-hand prominence as sounding more French-like on only 65% of trials, despite an intensive training session with feedback. Note too that both proposals relate only to the setting of the VO/OV parameter and are silent on the setting of the SV/VS parameter. With regard to the third major word-order parameter, V2, prosodic bootstrapping (or, indeed, semantic bootstrapping) can offer no clue as to whether ambiguous SVO sentences (e.g., *John bought the book*) reflect the +V2 or –V2 setting (Fodor, 1998b: 342). Finally, Gervain et al (2008) provided some preliminary evidence for the prosodic bootstrapping approach by demonstrating, using a novel grammar

learning task, that Italian and Japanese 8-month-olds prefer prosodic phrases with frequent items phrase-initially and phrase-finally respectively. Given that function-words are more frequent than content words, the claim is that Italian and Japanese infants have learned that their language prefers to place function words at the left versus the right edge of the phrase respectively, and can make use of a crosslinguistic correlation between this property and various word-order phenomena (e.g., VO vs OV respectively) to set the relevant parameters. However, as discussed with regard to syntactic category acquisition (Section 2.2) there is an important difference between demonstrating that infants exhibit a *preference* for a particular type of stimulus (e.g., a phrase with more frequent words at the beginning) and demonstrating (a) that there exists a sufficiently robust cross-linguistic correlation between the presence of this cue and the setting of a particular parameter (e.g., VO) and (b) that children are aware of this correlation. To our knowledge, no study has provided evidence for either of these claims.

3.3. Conclusion.

Given the problems with prosodic bootstrapping, parameter setting accounts have never adequately addressed the linking problem. This leaves only Pinker's (1984) semantic bootstrapping account. However, as we argued above, this account also suffers from the linking problem, unless one largely abandons the role of innate semantics-syntax linking rules in favour of some form of probabilistic input-based learning mechanism. For example, children could (1) group together items that share certain semantic regularities (e.g., acting as agents) and certain distributional regularities, and (2) observe the ordinal positions in which these categories appear, and how this varies depending on factors such as tense, aspect and animacy. But, as has previously been noted (e.g., Mazuka, 1996; Tomasello, 2003; 2005), once this has been done, the child has effectively learned the word order of her language, and parameters become redundant.

As for Section 2 (Syntactic Categories), we end this section by considering the objection that, by invoking semantic and distributional analysis, we are bringing in innate knowledge by the back door. Might it be necessary, for example, to build in an innate bias to be more sensitive to certain semantic properties (e.g., AGENT/PATIENThood) than others (e.g., colour), or to pay particular attention to the relative ordering of words, as opposed to, say, being the *n*-th word? Perhaps. Certainly, it is not self-evident that this is the case. It is possible that children track all kinds of semantic and distributional properties that are rapidly discovered to be irrelevant (i.e., not to correlate with any communicative function). Indeed, given the wide range of semantic distinctions that may be encoded syntactically (e.g., humanness, animacy, evidentiality), it may be necessary for children's initial expectations to be relatively unconstrained. But even if it does turn out to be necessary to build in a bias for children to care especially about, for example, causation, this is a very different type of innate knowledge to that assumed under UG theories; in particular innate semantics-syntax linking rules and word-order parameters.

4.0 Structure dependence

Structure dependence has been called the "parade case" (Crain, 1991: 602) of an innate principle; an "innate schematism applied by the mind to the data of experience" (Chomsky, 1971:28; see also Crain & Nakayama, 1987; Boeckx, 2010). Indeed, illustrations of the principle of structure dependence are often taken as the single best argument in favour of innate knowledge (e.g., Yang, 2002: 2). Although structure dependence applies across the entire grammar, we will focus here on one domain that constitutes a particularly well-studied example of Chomsky's argument from the poverty of the stimulus[9].

Chomsky (1980) argued that it is impossible for children to acquire the structure of complex

yes/no questions from the input as they are virtually absent. Complex questions are those that

contain both a **main clause** and a <u>relative clause</u> (e.g., ***Is the boy*** <u>*who is smoking*</u> ***crazy?***).

Chomsky's argument runs as follows. Suppose that a child hears simple declarative/question

pairs such as

The boy is crazy→Is the boy crazy?

In principle, she could formulate a rule such as 'to form a question from a declarative, move the

first auxiliary to the front of the sentence'. However, this rule would generate incorrect questions

from declaratives with more than one auxiliary:

The boy who is smoking is crazy→*Is the boy who smoking is crazy?

The adult rule is 'move the auxiliary *in the main clause* to the front of the sentence [or, strictly

speaking, to the functional head C]'. The correct rule is *structure dependent* because it is

formulated in terms of syntactic structure ("the auxiliary in the main clause") as opposed to

linear order ("the first auxiliary"). Chomsky (1980: 114-115) claims that children cannot learn

that the structure-dependent rule, as opposed to the linear-order rule, is the correct one as "a

person might go through much or all of his life without ever having been exposed to relevant

evidence [presumably complex questions, or even question/declarative pairs]". Although this is

probably an exaggeration (Pullum & Scholz, 2002, find some complex *yes/no* questions in

corpora of child-directed speech), we do not dispute the claim that they are too rare to constitute

sufficient direct evidence of the correct structure (e.g., Legate & Yang, 2002). Despite this

paucity of evidence, even young children are able to produce correctly formed questions and

avoid errors (e.g., Crain & Nakayama, 1987). Chomsky (1980) therefore argues that children's knowledge of UG contains the principle of *structure dependence* (i.e., knowledge that rules must make reference to syntactic structure, not linear order).

4.1 Complex *yes/no* questions. There are two questions at issue here. The first is how children avoid structure dependence errors and acquire the correct generalization in the particular case of complex *yes/no* questions in English. The second is how children know that *all* linguistic generalizations[10] are structure dependent.

Considering first the particular case of complex *yes/no* questions, there are three potential solutions that do not assume an innate principle. The first is to posit that questions are not formed by movement rules at all, which renders moot the question of whether children might move the wrong auxiliary. Movement rules are eschewed not only by construction-based approaches (for question formation see Rowland & Pine, 2000; Dabrowska & Lieven, 2005; Ambridge, Theakston, Rowland & Tomasello, 2006) but also by many more traditional grammars (see Clark & Lappin, 2011: 36 for a list). The second solution assumes that learners are sensitive to the pragmatic principle that one cannot extract elements of an utterance that are not asserted, but constitute background information (e.g., Van Valin & La Polla, 1997; a proposal that Crain & Nakayama, 1987:526, also discuss, attributing it to Steven Pinker). This pragmatic principle will be discussed in more detail in the following section on subjacency. For now, it will suffice to note that a main clause, but not a subordinate clause, contains an assertion (which a second speaker may straightforwardly deny)

Speaker 1: The boy [who is smoking] is crazy.
Speaker 2: No, sane. *No, drinking beer.

and hence, that only elements of a main clause may be extracted or questioned:

Is the boy [who is smoking] _ crazy? vs *Is the boy [who _ smoking] is crazy?

While this solution in terms of a pragmatic principle is successful for complex questions (and perhaps other relative clause constructions; see Section 5) it has little to say about how children come to behave in accordance with the principle of structure dependence more generally.

The third potential solution, for this particular case of complex English *yes/no* questions, is that children make use of bi-/tri-gram statistics in their input. Reali and Christiansen (2005) demonstrate that, where the correct and erroneous question forms deviate, the former contains a high-probability bigram (*Is the boy **who is***) while the latter contains a very low-probability bigram (**Is the boy **who smoking***). Consequently a computer simulation sensitive to *n*-gram statistics predicts the correct form with higher probability than the error (Ambridge, Pine & Rowland, 2008, also showed that this account could predict the question types for which children do, occasionally, produce such errors). However, Kam, Stoyneshkaa, Tornyova, Fodor and Sakas (2008) and Berwick, Pietroski, Yankama and Chomsky (2011) showed that the model's success was due almost entirely to the fortuitous frequent occurrence of the relevant bigrams (*who+is, that+is*) in unrelated contexts (e.g., *Who's that? That's a rose*). That is, the bigram model succeeds only because English happens to use some homophonous forms for complementizers and *wh*-words/deictic pronouns. Since this is by no means a cross-linguistic requirement, Reali and Christiansen's (2005) solution is specific not only to complex *yes/no* questions, but also to English.

4.2 Structure dependence in general. This brings us to the more important question of how children know that syntactic rules are structure dependent *in general*. We argue that there is abundant evidence for the general principle of structure dependence not only in the language that children hear, but also in the conceptual world. With regard to the former, suppose that a child hears the following conversational fragments:

John is smiling. Yes, he is happy.

The (/that/this/a etc.) boy is smiling. Yes, he is happy.

The tall boy is smiling. Yes, he is happy.

The boy who is tall is smiling. Yes he is happy.

Such extremely simple exchanges, which occur whenever a pronoun refers back to an NP – presumably thousands of times a day – constitute evidence that strings of arbitrary length that share distributional similarities can be substituted for one another (i.e., evidence for the structure dependent nature of syntax). Computer models that use distribution in this way can simulate many structure-dependent phenomena, including the specific example of complex *yes/no* questions in English (Clark & Lappin, 2011; Clark & Eyraud, 2007; Elman, 1993; 2003; Lewis & Elman, 2001), at least to some extent. This qualification reflects the fact that a model that blindly substitutes distributionally-similar strings for one another will inevitably produce a good deal of "word salad" and uninterpretable sentences (Berwick et al., 2011).

But children – and the speakers who provide their input – are not blindingly substituting phrases for one another on the basis of distributional similarity. The reason that *John*, *the boy, the tall boy* and *the boy who is tall* can be substituted for one another is that all refer to entities in the world upon which the same kinds of semantic operations (e.g., predicating an action or property;

being denoted as the causer of an event/state of affairs) can be performed (Tomasello, 2005). The fact that, in cases such as those above, these strings may refer to the same entity presumably aids learners, but it is not crucial. The reason that languages group together concrete objects (*John, the boy*) with more abstract entities (e.g., *war, happiness, fighting each other*) is that all are subject to the same kinds of functional operations (e.g., predication of a property). Thus to acquire a structure-dependent grammar, all a learner has to do is to recognize that strings such as *the boy*, *the tall boy, war* and *happiness* share both certain functional and – as a consequence – distributional similarities. Whatever else one does or does not build into a theory of language acquisition, some kind of pre-linguistic conceptual structure that groups together functionally-similar concepts is presumably inevitable. This conceptual structure, when mapped onto language yields a structure dependent grammar.

This idea is not new. Returning to complex *yes/no* questions, Crain and Nakayama (1987; Experiment 3) conducted an elicited-production study designed to test a version of this proposal formulated by Stemmer (1981). Crain and Nakayama found that children (aged 2;9-4;8) showed identical performance for questions with contentful lexical subjects (e.g., *Is **rain** falling in this picture?*) and semantically-empty expletive subjects (e.g., *Is **it** raining in this picture?*), which they took as evidence against Stemmer's (1981) account. However, this finding constitutes evidence against the claim that we have outlined here only if one assumes that it is not possible that 3-year old children have done any of the following[11]

(a) learned the formulaic questions *Is it raining*?, *Is there a(n) [THING]?* and *Is it easy to [ACTION]?* (the only three items in this part of Crain & Nakayama's study)

(b) learned that *Is it* and *Is there* are common ways to start a question. We counted 38 questions beginning *Is it* and 30 beginning *Is there* (excluding a similar number where these strings

constituted the entire question) in the maternal section of the Thomas corpus (Dąbrowska &

Lieven, 2005; available on CHILDES). The issue is not whether or not this constitutes a high

proportion of questions (or of all utterances) but simply whether the absolute number of these

questions (which can be estimated at around 300 and 380 respectively under realistic sampling

assumptions) is sufficient for children to learn these forms.

(c) generalized between dummy and lexical subjects on the basis of distributional and functional

overlap (e.g.,, *he/it is cold*).

It is pertinent here to respond to a reviewer who asked where phrasal categories (e.g., NP, N',

V', VP, CP etc.) come from if not from UG. Although we do not wish to advocate any particular

non-UG account of acquisition, if nothing else, our own informal use of such terms demands an

explanation. It should be clear from the above that we use syntactic category labels (e.g., NOUN,

VERB) as nothing more than a convenient shorthand for items sharing a certain degree of

(sometimes) semantic, distributional and – perhaps most importantly – functional similarity. The

same is true for intermediate-level categories. For example, "N-bar" structures like *yellow bottle*

or *student of psychology* (e.g., Pearl & Lidz, 2009) share a particular level of distributional

similarity (e.g., *the_is*) and functional similarity (e.g., ability to have a property predicated of

them), in exactly the same way as for the simple and complex "NPs" discussed above. We make

analogous assumptions for other single and double-bar categories (e.g., "V-bar" structures such

as *chases the cat* and *causes cancer* share functional similarity in that both can be predicated of

"NOUNs"[12]). As should become clear in Sections 5 and 6 we view "CP" (or clause) as reflecting

an informational unit such as an assertion (main clause) or background/pre-supposed information

(subordinate clause): Hierarchical syntactic structure is a reflection of hierarchical conceptual

structure.

These assumptions are less controversial than they might at first appear. Regardless of the particular theoretical background assumed, is hard to imagine any account of how children learn that (for example) *John, he* and *the boy* may refer to the same entity that includes no role for semantic, distributional or functional similarity. Indeed, many of the generativist accounts discussed in Sections 2 and 3 make such assumptions. Given that this type of learning yields structure-dependent generalizations, it does not seem to be such a huge step to dispense with structure dependence as an innate syntactic principle. In response to the charge that, by dispensing with innate categories (e.g., VERB) and their projections (e.g., VP, V'), we are replacing a perfectly good system with something that does not work, we would suggest that it is traditional categories (and therefore their projections) that do not work cross-linguistically (see Section 2), and these types of language-specific generalizations the only candidates to replace them

Finally, we again end this section by considering the suggestion these assumptions constitute bringing in innate knowledge by the back door. Children must learn that strings of arbitrary length upon which similar kinds of semantic/functional operations can be performed (e.g., predicating an action or property) can be substituted for one another in many contexts. Does this require innate knowledge? Again, we would suggest that while it may or may not be necessary to assume certain very general biases (e.g., a propensity to conceptualize objects' actions and their properties as somehow similar, or to attempt to associate word strings with concepts in the world), this type of innate knowledge is qualitatively different from an innate principle of structure dependence, or an innate CP.

5.0 Subjacency.

Both Newmeyer (1991) and Pinker and Bloom (1990) cite subjacency (Chomsky, 1973), another constraint on syntactic movement, as a prime example of an arbitrary linguistic constraint that is part of children's knowledge of Universal Grammar. The standard UG assumption is that *Wh*-questions are formed from an underlying declarative (or similar) by movement of the auxiliary (as discussed in the previous section) and, more relevant for subjacency, the *Wh*-word (see Box 1). The phenomenon to be explained here is as follows. *Wh*-words can be extracted from both simple main clauses and object complements:

Bill bought a book → What did Bill buy t_i?

Bill said [that Sue bought a book] → What did Bill say [that Sue bought t_i]?

However, many other syntactic phrases are "islands" in that *wh*-words (and other constitutents) cannot be extracted from them (the metaphor is that the *wh*-word is stranded on the <island>). These include:

(Definite) Complex NPs

NP complements: *What$_i$ did Bill hear the rumour <that Sue stole t_i?>

                         (cf. Bill heard the rumour <that Sue stole the files>)

Relative clauses: *What$_i$ did Bill interview the witness <who saw t_i?>

                         (cf. Bill interviewed the witness <who saw the files>)

Adjuncts: *What$_i$ did Bill walk home <after Sue took t_i?>

                         (cf. Bill walked home <after Sue took his car keys>)

Subjects: *What$_i$ did <Bill's stealing t_i > shock Sue?

(cf. <Bill's stealing the painting> shocked Sue)

Sentential subjects: *What$_i$ did <that Bill stole t_i?> shock Sue

(cf. <That Bill stole the painting> shocked Sue)

Since Chomsky (1973; though see Ross, 1967, for an earlier formulation), the standard account

has been the subjacency constraint, which specifies that movement may not cross more than one

"bounding node". For English, bounding nodes are NP and S (or DP and IP), though this may

vary between languages (e.g., NP/DP and S2/CP for Italian). An example of a subjacency

violation is shown in Box 1. Although this proposal has undergone some modifications (e.g.,

Chomsky, 1986, reconceptualizes bounding nodes as *barriers* and offers an explanation of why

only certain nodes are barriers), the claim remains that some form of innate UG island constraint

aids learners by allowing them to avoid the production of ungrammatical sentences (or, in

comprehension, interpretations that the speaker cannot have intended).

Box 1. Subjacency

Extraction from a definite complex (NP/)DP (e.g., *What$_i$ did Bill hear <the rumour that Sue stole t_i?>*) is ruled out by the subjacency constraint, because the *Wh-* word *what* crosses two bounding nodes (circled): (NP/)DP and IP. Note that, for clarity, movement of the subject and auxiliary is not shown.

```
           V              DP
           |             /  \
         hear     the rumour that
                     Sue stole t_i
       |_____|
```
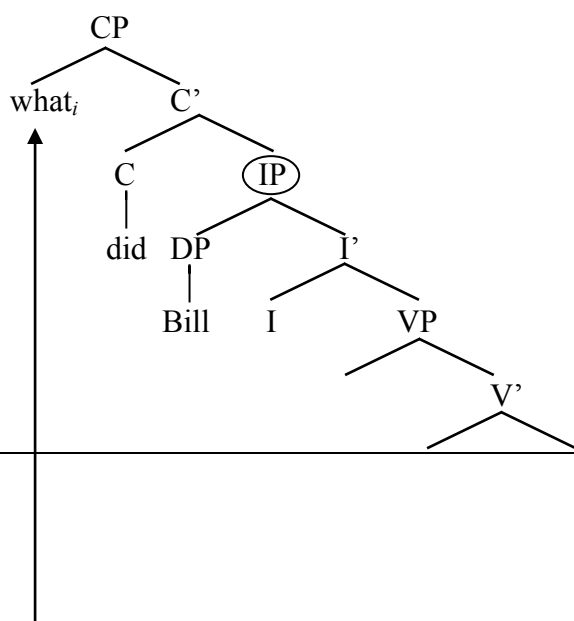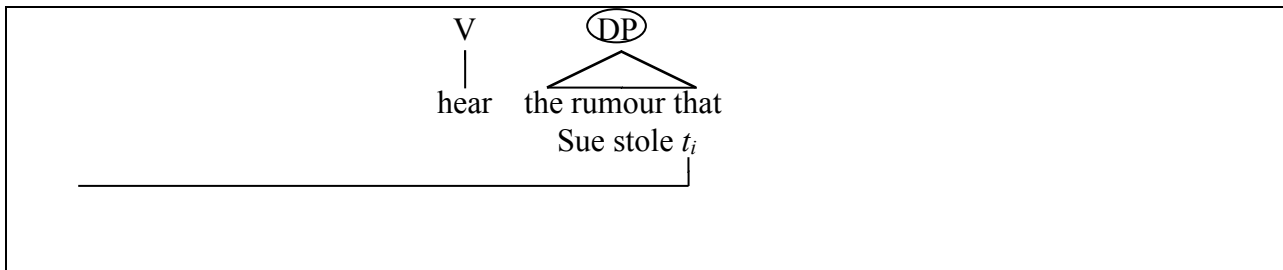
Our goal is not to dispute the facts regarding island constraints, which are generally well supported empirically. Neither do we argue that island constraints can be reduced to processing phenomena[13] (see the debate between Sag, Hofmeister & Snider, 2007; Hofmeister & Sag, 2010; Hofmeister, Casasanto & Sag, 2012a,b and Sprouse, Wagers & Phillips, 2012a,b; Yoshida, Kazanina, Pablos & Sturt, in press). While all sides in this debate acknowledge that processing-factors "modulate the acceptability of island-violating sentences" (e.g., Sprouse et al., 2012b: 404-405), processing-based accounts cannot explain equivalent constraints in *wh*-in-situ languages (e.g., Mandarin Chinese and Lakhota; Huang, 1982; Van Valin & La Polla, 1997), where questions have the same surface structure as declaratives. (The absence of apparent movement is not a problem for grammatical accounts, however, on the assumption that movement – and hence subjacency - applies at the covert level of Logical Form, as opposed to the surface level of Syntax; see Huang, 1982). We argue, however, that an innate subjacency constraint is redundant: Island constraints can be explained by discourse-pragmatic principles that apply to all sentence types, and hence that will have to be learned anyway.

The claim (see Erteschik-Shir 1979, 1998; Erteschik-Shir & Lappin, 1979; Cattell, 1984; Takami 1989; Deane 1991; Kluender, 1992, 1998; Kluender & Kutas, M, 1993; Kuno & Takami, 1993; Van Valin 1995, 1998, 2005; Van Valin & LaPolla, 1997; Goldberg, 2006) is that the constituents above are islands because they lie outside the *potential focus domain* of the sentence. To understand this claim, a brief introduction to the notion of information structure is

required (Mathesius, 1928; Halliday, 1967; Jackendoff, 1972; Gundell, Hedberg & Zacharski, 1993; Lambrecht, 1994, 2000). Most utterances have a *topic* (or *theme*) about which some new information (the ***focus***, *comment* or *rheme*) is asserted. In a basic declarative sentence, the *topic* is usually the subject.

Bill bought a book.

The ***potential focus domain*** is the predicate phrase, and, under the default interpretation, is the ***actual focus*** as well (Bill ***bought a book***, rather than, say, ***ran a marathon***). However, provided that a cue such as vocal stress is used to overrule this default interpretation, the ***actual focus*** can actually be anywhere within the ***potential focus domain***:

*Bill **bought a book***   (He didn't steal or borrow one)

*Bill **bought a book***   (He didn't buy the particular book we had in mind, or two books)

*Bill **bought a book***   (He didn't buy a newspaper)

This much is uncontroversial. Also uncontroversial is the claim that children will have to learn about information structure in order to formulate even the most basic utterances. For example, most utterances require a noun phrase of some kind, and, for each, speakers must decide whether to use an indefinite NP, a definite NP, a proper name, a pronoun or zero marking (Givon, 1983; Ariel, 1990; Gundel, Hedberg & Zacharski, 1993):

[a man/the man/Bill/he/Ø] bought [a book/the book/*War and Peace*/it]

This requires an understanding of information structure. An established topic will usually be

expressed by zero-marking or a pronoun, and new, focal information with an indefinite NP.

Violations of these information structure principles yield infelicitous or even uninterpretable

utterances:

Speaker 1: So what did Bill do last night?

Speaker 2: Ate a cake / *Bill ate it.

Although young children are often assumed to have poor discourse pragmatic skills, it has been

demonstrated experimentally that even three-year-olds overwhelmingly use pronouns rather than

lexical NPs to refer to a discourse topic established by an interlocutor (Matthews, Lieven,

Theakston & Tomasello, 2006).

Returning to questions, it is clear that the questioned element is the focus of both a question and

the equivalent declarative (we continue to use *italics* for the topic, ***bold italics*** for the potential

focus domain and additional ***underlining*** for the actual focus):

*Bill **bought <u>a book</u>***   ***<u>What</u>*** did *Bill **buy** t_i*?

The functional account of island constraints, then, is as follows: Since the *wh*-word is the focus,

it cannot replace constituents that are not in the potential focus domain. What all island

constructions have in common is that the <islands> contain information that is old, incidental,

presupposed or otherwise backgrounded in some way[14] As Van Valin (1998:232) argues

Questions are requests for information, and the focus of the question signals the information desired by the speaker. It makes no sense, then, for the speaker to place the focus of the question in a part of the sentence which is presupposed, i.e., which contains information which the speaker knows and assumes the hearer knows or can deduce easily.

Perhaps the clearest examples are complex NPs. Both

Bill *heard the rumour* <that Sue stole the files>   and

Bill interviewed the witness <who saw the files>

presuppose the existence of a rumour/witness, with the relative clause providing background information thereon (note that one *can* ask *What did Bill hear?* or *Who did Bill interview?* because the *rumour/the witness* is in the potential focus domain; indeed, the default focus). Similarly the constructions exemplified by

<Bill's stealing the painting> **shocked Sue**   and

<That Bill stole the painting> **shocked Sue**

have the very function of emphasizing the presupposition that Bill did indeed steal the painting (more so than more usual formulations such as *Sue was shocked that Bill stole the painting*). Adjuncts, by definition, provide background, non-focal information (which may also be presupposed to some degree)[15]:

(cf. *Bill **walked home*** <after Sue took his car keys>)

There is a simple independent test for whether or not a particular constituent falls within the

potential focus domain: whether or not it can be denied (without recasting the entire phrase).

The logic of the test is that it is only possible to deny assertions (not background information,

presuppositions etc.) and that assertions, by definition, constitute the potential focus domain.

This test correctly predicts that the following will not be an island in question form

*Bill **bought a book*** ➔ No, he didn't.

and that the following will be[16]

*Bill **heard the rumour*** <that Sue stole the files> ➔ No, he/*she didn't

*Bill **interviewed the witness*** <who saw the files> ➔ No, he/*she didn't

*Bill **walked home*** <after Sue took his car keys> ➔ No, he/*she didn't

*<Bill's stealing the painting> **shocked Sue***) ➔ No, it/*he didn't

*<That Bill stole the painting> **shocked Sue***) ➔ No it/*he didn't

At first glance, this test – and hence the backgrounding account – appears to fail for questions

with sentential complements such as **What*i* did Bill say (that) Sue bought?*. Since one can deny

the fact but not the content of reported speech (*Bill said (that) Sue bought a book* ➔ No he/*she

didn't), the negation test predicts, apparently incorrectly, that such questions will be blocked. In

fact, not only does the negation test correctly predict the data here, it does so in a way that

syntactic subjacency accounts cannot. The key is that both negatability/backgrounding and island

status are matters of degree. Ambridge and Goldberg (2008) asked participants to rate, for

particular verbs, (a) the extent to which negating the sentence entails negation of the reported

speech (a measure of backgrounding) and (b) the grammaticality of the extraction question. On these measures, *say* was rated as only moderately backgrounding the reported speech, and the extraction question only moderately unacceptable. Verbs that are informationally richer than *say* (e.g., *whisper, mumble*) would be expected to be rated as (a) foregrounding the speech act, hence backgrounding its content, and thus (b) less acceptable in extraction questions. Exactly this pattern was found. Given that no subjacency violation occurs in any of these cases (and that such violations are binary, not a matter of degree), syntactic subjacency accounts cannot explain this graded pattern, or even why any of the sentences should be rated as less than fully acceptable. Neither can such accounts explain graded definiteness effects (*Who$_i$ did Bill read [a > the > ?the new >??The fantastic new history book] about?*). The functional account explains this pattern naturally: The more that is already known about the book (i.e., the more it constitutes background knowledge), the less acceptable the extraction question.

Do such cases mean that an innate subjacency principle could be actively harmful? After all, if learners were using only this principle to determine the grammaticality of such instances, they would incorrectly arrive at the conclusion that all were equally and fully acceptable. It seems that the only way to prevent an innate subjacency principle from being harmful to learners would be to allow the discourse-pragmatic principles discussed here to override it, rendering subjacency redundant.

This is not to deny that subjacency generally provides excellent coverage of the data. However, we suggest that the proposal is so successful because its primitives correspond to the primitives of discourse structure. For example, the principle that one can question an element of a main clause but not a relative clause or an adjunct is a restatement of the principle that one can question an assertion but not presupposed or incidental information. The very reason that

languages have relative clause and adjuncts is that speakers find it useful to have syntactic

devices that distinguish background information from the central assertion of the utterance. To

sum up: In order to be effective communicators, children will have to acquire principles of

discourse pragmatics and focus structure. These principles account not only for island

constraints, but also for some phenomena not covered by a formal subjacency account.

6.0 Binding Principles

Languages exhibit certain constraints on co-reference; that is, they appear to block certain

pronouns from referring to particular Noun Phrases. For example, in the sentence below, the

pronoun *she* cannot refer to Sarah, but must refer to some other (female) person who has been

previously mentioned, or is otherwise available for reference (e.g., by being present in the room).

She$_i$ listens to music when Sarah$_{*i}$ reads poetry

The standard assumption of UG-based approaches is that such principles are unlearnable (e.g.,

Guasti & Chierchia, 1999/2000:13), and must instead be specified by innate *binding principles*

that are part of Universal Grammar. The formal definition of "binding" (e.g., Chomsky, 1981;

Reinhart, 1983) is that X binds Y if (a) X c-commands Y and (b) X and Y are co-indexed (i.e.,

refer to the same entity). The notion of c-command as it relates to the three binding principles –

Principles A, B and C – is explained in Box 2.

6.1 Principle C. Principle C, which rules out the example above, states that a R(eferring)-

expression (e.g., an NP such as *Sarah*, that takes its meaning directly from the world, NOT from

another word in the sentence) must be free everywhere (i.e., NOT bound anywhere; Chomsky,

1981). Thus the example discussed above constitutes a Principle C violation because the R-expression *Sarah* is bound by the pronoun *She* (*She* c-commands *Sarah*, and they co-refer). More informally we can understand Principle C (at least for multiple-clause sentences) by saying that a pronoun may precede a full lexical NP to which it co-refers only if the pronoun is in a subordinate clause. Thus forward anaphora, where a lexical NP sends its interpretation "forwards" (i.e., left-to-right) is allowed whether the pronoun is in the main or subordinate clause:

[CP [CP When Sarah$_i$ reads poetry] she$_i$ listens to music]

[CP Sarah$_i$ listens to music [CP when she$_i$ reads poetry]]

Backward anaphora, where a lexical NP sends its interpretation "backwards" (i.e., right-to-left) is allowed only when the pronoun is in the subordinate clause (all examples from Lust, 2009: 214):

[CP [CP when she$_i$ reads poetry] Sarah$_i$ listens to music]

*[CP She$_i$ listens to music [CP when Sarah$_i$ reads poetry]]

As for subjacency, we argue that the proposed UG Principle – here Principle C – is successful only to the extent that it correlates with principles of discourse and information structure. The functional explanation (e.g., Bickerton, 1975; Bolinger, 1979; Kuno, 1987; Levinson, 1987; Van Valin & LaPolla, 1997; Van Hoek, 1995; Harris and Bates, 2001) is as follows. As we saw in the previous section, the *topic/theme* is the NP that the sentence is 'about', and about which some assertion is made (the *comment/focus/rheme*). This assertion is made in the predicate of the main clause (e.g., *Sarah listens to music*), with subordinate clauses providing some background

information. As we also saw earlier, when a particular referent is already topical (e.g., we already know we are talking about Sue), it is most natural to use a pronoun (or null reference) as topic (*She listens to music*). Thus when a speaker uses a lexical NP as topic, she does so to establish this referent as the new topic (or, at least, to re-establish a previously discussed referent as the topic of a new assertion). Having decided to use a lexical NP to establish a new topic, it is entirely natural to use a pronoun in the part of the sentence that provides some background information on this topic[17]:

[CP Sarah$_i$ listens to music [CP when she$_i$ reads poetry]]

[CP [CP when she$_i$ reads poetry] Sarah$_i$ listens to music]

Indeed, the use of a full NP (e.g., *Sarah listens to music when Sarah reads poetry*) is so unnatural, there is a strong sense that some special meaning is intended (e.g., that Sarah is particularly obstinate in her insistence that poetry-reading and music-listening must always go together). Now consider cases of ungrammatical co-reference:

*[CP She$_i$ listens to music [CP when Sarah$_i$ reads poetry]]

In these cases, the speaker has decided to use a pronoun as the topic, indicating that the referent is highly accessible. This being the case, it is pragmatically anomalous to use a full lexical NP in a part of the sentence that exists only to provide background information. If I (as speaker) am sufficiently confident that you (as listener) know who am I talking about to use a pronoun as the topic of my main assertion (*She listens to music*), I should be just as happy (if anything, more so) to use pronouns in the part of the sentence that constitutes only background information (*when she reads poetry*). The only plausible reason for my use a full lexical NP in this part of the

sentence would to identify a new referent. The situation is similar for so-called strong crossover

questions (Chomsky, 1981):

*Who$_i$ did he$_i$ say Ted criticized?

The coreferential reading (which can be paraphrased as 'Who said Ted criticized him?') is

impossible for exactly the same reason that such a reading is impossible for the equivalent

declarative:

*He$_i$ said Ted criticized Bill$_i$

The speaker has used a pronoun as the topic of the main assertion of the sentence (*He said X*)

and so cannot use a lexical NP in a clause that provides background information (what was said)

to refer to that same entity (cf. Bill$_i$ said Ted criticized him$_i$). (See the previous section for

evidence that speakers consider the content of reported speech to be backgrounded to at least

some extent). Exactly the same situation holds for sentences with quantificational expressions

(Chomsky, 1981) such as *He$_i$ said Ted criticized everyone$_i$* and *Everyone$_i$ said Ted criticized*

him$_i$ (which are the same sentences as the previous two examples with *everyone* substituted for

Bill).

      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[18]. With one

exception (which we will consider shortly), this generalization explains all the cases normally

attributed to Principle C. Furthermore, the findings of an adult judgment study not only provide

direct evidence for this backgrounding account, but suggest that it predicts the pattern of co-

reference possibilities better than a syntactic account. Harris and Bates (2002) demonstrated that

if a Principle-C-violating sentence is manipulated such that the subordinate clause contains new

information and the main clause background information (e.g., *He was threatening to leave when*

Billy noticed that the computer had died) participants accepted a coreferential reading on a

substantial majority of trials (75%).

An exception to this backgrounding account occurs in cases of forward anaphora from a

subordinate into a main clause (e.g., *When Sarah$_i$ reads poetry, she$_i$ listens to music*). However,

such examples are easily covered by the discourse-pragmatic account in general: Once the

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 (e.g., *When Sarah reads poetry, Sarah listens*

to music). Although one might object to this order-of-mention principle as an 'add-on' to the

functional account, it is equally indispensible to formal accounts, as it is necessary to account for

pronominalization between sentences or conjoined clauses, to which no binding principle can

apply (Van Hoek, 1995):

Sarah$_i$ reads poetry. She$_i$ also listens to music.

*She$_i$ reads poetry. Sarah$_i$ also listens to music.

Sarah$_i$ reads poetry, and she$_i$ also listens to music.

*She$_i$ reads poetry, and Sarah$_i$ also listens to music.

Note further that this add-on to the Principle C account[19] makes reference to the same notion of

information structure on which the functional account is based. In order to produce even simple

single-clause sentences, children need to know (and, indeed, by age three do know; Matthews et

al, 2006) certain discourse-functional principles (here when to use a lexical NP versus a

pronoun). These pragmatic principles, which must be added on to any formal account to deal

with otherwise-problematic cases, in fact explain the entire pattern of the data, leaving an innate

syntactic principle redundant. Again, the proposed syntactic principle offers good data-coverage

only to the extent that it restates these pragmatic principles. For example, the syntactic principle

that one cannot pronominalize backwards into a main clause (*She$_i$ listens to music [when Sarah$_i$

reads poetry]), restates the pragmatic principle that one cannot pronominalize from the part of

the sentence that contains the main assertion into a part of the sentence that contains only

background information. Thus, in most cases, the two accounts make the same predictions. But

the syntactic account is only a rough paraphrase of the functional account. When this paraphrase

diverges too far from the functional account – as in Harris and Bates' (2002) sentences where the

usual functions of the main and subordinate clauses are flipped – it mis-predicts the data.

Box 2: C-command and Binding

Although there exist a number of different formulations of c-command (e.g., Langacker, 1969;
Lasnik, 1976; Chomsky, 1981; Reinhart, 1983), for our purposes a simple definition will suffice:
"a constituent X c-commands its sister constituent Y and any constituent Z which is contained
within Y" (Radford, 2004:75). A simpler way to think about c-command is to use the analogy of
a train network: X c-commands any node which one can reach by 'taking a northbound train
[from X], getting off at the first station, changing trains there and then travelling one or more
stops south *on a different line* (Radford, 2004: 75). For example, in the diagram below, B c-
commands D, E and F; D c-commands A and B; E and F c-command one another; A does not c-
command any node.

```
            C
          /   \
         B      D
         |     / \
         A    E   F
```
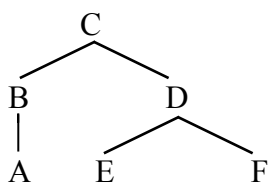
To consider some examples relevant to the binding principles, in the tree diagram on the left,
both *Goldilocks* and *Mama Bear* c-command *herself*. Principle A stipulates that *herself* must
refer to *Mama Bear*, as it is the only NP in the local domain. In the tree diagram on the right
(top), *Mama Bear* c-commands *her*, meaning that, by Principle B, the two cannot co-refer. In the
final tree diagram (bottom right) *He* c-commands *John*, meaning that co-reference is blocked by
Principle C.
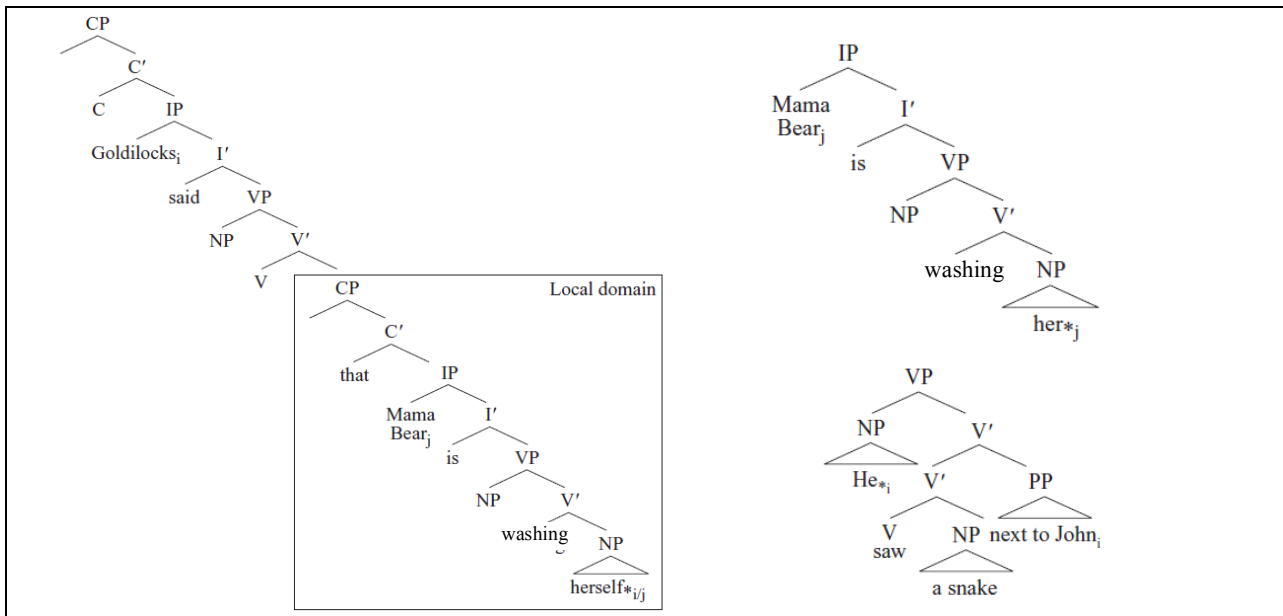
6.2. Principles A and B. Principles A and B (Chomsky, 1981; Reinhart, 1983) govern the use of reflexive (e.g., *herself*) versus non-reflexive (e.g., *her*) pronouns. Principle A states that a reflexive pronoun (e.g., *herself*) must be bound in its local domain. For all the cases we will discuss, the local domain is the clause. Essentially, then, Principle A specifies that for sentences such as *Goldilocks_i said that Mama Bear_j is washing herself*_*i/j_, the reflexive pronoun *herself* can refer only to the NP that c-commands it *in the local domain* (i.e. *Mama Bear*). It cannot refer to an NP that (a) c-commands it, but is not in the local domain (e.g., *Goldilocks*, which is in a different clause), or (b) does not c-command it at all (e.g. another character previously mentioned in the story).

Principle B states that a non-reflexive pronoun must be free (i.e., NOT bound) in its local domain. Effectively, it is the converse of Principle A: in a context where a reflexive pronoun (e.g. *herself*) must be used, one cannot substitute it with a non-reflexive pronoun (e.g. *her*) without changing the meaning. For example, for the sentence *Goldilocks_i said that Mama Bear_j is washing her_i/*j*, the pronoun (*her*) cannot take its meaning from *Mama Bear*[20]. If it did, this would constitute a Principle B violation, since the non-reflexive pronoun (*her*) would be c-

commanded in its local domain by *Mama Bear*. Note that Principle B stipulates only what the non-reflexive pronoun *cannot* refer to. The pronoun may take its meaning either from the NP *Goldilocks* or from an entity in the world (e.g. *Cinderella was covered in mud. While Goldilocks read the book, Mamma Bear washed her* [Cinderella]).

Informally, Principles A and B together reduce to a simple axiom: If a reflexive pronoun (e.g., *herself*) would give the intended meaning, a non-reflexive pronoun (e.g., *her*) cannot be used instead. Indeed, this is incorporated into UG accounts of binding (Grodzinsky & Reinhart, 1993: 79):

> Rule 1: NP A [e.g., *her*] cannot co-refer with NP B [e.g., *Mama Bear*] if replacing A with C [e.g., *herself*], C a variable A-bound by B, yields an indistinguishable interpretation. [Chien & Wexler, 1990, refer to this constraint as Principle P].

Consequently, the facts attributed to the binding principles reduce to a very simple functional explanation (Kuno, 1987: 67) "Reflexive pronouns are used in English if and only if they are direct recipients or targets of the actions represented by the sentences".

John [killed/fell in love] with himself/*him (target)

John addressed the letter to himself/*him (recipient)

John [heard strange noises/left his family] behind *himself/him (location)

John has passion in *himself/him (location; cf. John sees himself as having no passion).

A very similar formulation is that reflexive pronouns denote a referent as seen from his or her own point of view, non-reflexive pronouns from a more objective viewpoint (Cantrall, 1974):

I can understand a father wanting his daughter to be like himself but I can't understand that ugly brute wanting his daughter to be like him.

Since even UG-based accounts of Principles A and B (e.g., Grodzinsky & Reinhart, 1993; Chien & Wexler, 1990) make something very similar to this assumption, additional innate principles are redundant. Furthermore, there are again cases where only discourse-functional principles offer satisfactory data-coverage:

Q: Who did Sue say is the cleverest girl in the room?
A: Herself (*Her)

Q: Who do you think is the cleverest girl in the room?
A: Her (*Herself)

The impossible readings are not ruled out by Principles A and B, which by definition cannot apply across sentence boundaries, but by the functional considerations outlined above. Principles A and B make the correct predictions only when they align with these considerations:

Goldilocks$_i$ said that Mama Bear$_j$ is washing herself$_{*i/j}$ (=Mama bear is the target of the washing)
Goldilocks$_i$ said that Mama Bear$_j$ is washing her$_{i/*j}$ (=Mama bear is not the target of the washing)

There is another sentence type for which Principles A and B make the wrong predictions, and this is conceded even by UG-based accounts (e.g., Chien & Wexler, 1990; Grodzinsky & Reinhart, 1993). These are so-called "Evans-style" contexts (after Evans, 1980):

That must be John. At least, he looks like him

While most speakers regard this sentence as acceptable, it constitutes a Principle B violation as the non-reflexive pronoun *him* is c-commanded in its local domain by *he*, and both refer to the same entity. The only way to rescue Principle B is to appeal to the functional explanation outlined above. The non-reflexive pronoun *him* is used because the intended meaning is that he (the person who may be John) looks like **him** (John), not that he (the person who may be John) looks like **himself** (i.e., is the target of the resembling 'action'). Indeed, UG-based accounts propose essentially this very solution. For example, Thornton and Wexler's (1999) guise creation hypothesis argues that listeners create two separate guises for the referents (e.g. a person who *may be* John; and a person who *is* John).

Thus we are left with exactly the same situation as for Principle C: Discourse-functional principles that must be included in formal accounts to explain particular counterexamples can, in fact, explain the entire pattern of data. The proposed syntactic principle is successful only to the extent that it is a restatement of the discourse-based account, and fails when it does not (e.g., for both inter-sentential and Evans-style contexts).

6.3 Conclusion. For all three binding principles, there exist phenomena that - under any account, UG-based or otherwise - can be explained only by recourse to discourse-functional principles. As these principles can explain all the relevant phenomena, innately-specified binding principles are redundant.

7.0 Conclusion

Many theories assume that the process of language acquisition in the face of impoverished, under-constraining input is too complex to succeed without the aid of innate knowledge of categories, constraints, principles and parameters, provided in the form of Universal Grammar. The present article has argued that, even if no restrictions are placed on the type of innate knowledge that may be posited, there are no proposals for components of innate knowledge that would simplify the learning process for the domains considered.

This is not to say that accounts in the UG tradition offer nothing by means of explanation with regard to these domains. Many of the proposals discussed are ingenious and have the advantage that they both capture aspects of the acquisition problem that might otherwise have been overlooked and identify cues and mechanisms that are likely to form part of the solution. The problem is that, without exception, each component of innate knowledge proposed suffers from at least one of the problems of linking, data-coverage and redundancy; in some cases all three. The most widespread of these problems is redundancy. For each domain, the cues and mechanisms that actually solve the learning problem are ones that are not related to Universal Grammar, and that must be assumed by all accounts, whether or not they additionally assume innate knowledge. These types of learning procedures (e.g., clustering of semantically and/or distributionally-similar items) and discourse-pragmatic principles (e.g., when to use a full NP vs a pronoun; how to foreground/background particular informational units) do not constitute rival explanations to those offered by UG accounts. On the contrary, they are factors that are incorporated into UG accounts, precisely because they would seem to be indispensable to any comprehensive account of the relevant phenomenon (since, if nothing else, they are needed to account for particular counterexamples). The problem is that it is these factors that lend UG-based accounts their explanatory power. The innate categories/principles proposed are re-

descriptions of the outcomes of these factors. In general, they are faithful re-descriptions, and

hence merely redundant; occasionally they diverge and risk hindering the learning process.

Proponents of UG-based accounts may point to the fact that we have proposed no alternative to

such accounts and argue that, until a compelling alternative is offered, it is logical to stick to UG-

based accounts. This argument would be persuasive if there existed UG-based accounts that

explain how a particular learning problem is solved with the aid of innate constraints. If there

were a working UG-based explanation of, for example, how children acquire the syntactic

categories and word-order rules of their language, it would, of course, make no sense to abandon

this account in the absence of a viable alternative. But as we have aimed to show in this review,

there is no working UG-based account of any of the major phenomena in language acquisition;

current accounts of this type explain the data only to the extent that they incorporate mechanisms

that make no use of innate grammatical knowledge. Of course, we claim only to have shown that

none of the categories, learning procedures, principles and parameters proposed under *current*

UG-based theories aid learning; we have not shown that such innate knowledge could not be

useful *in principle*. It remains entirely possible that there are components of innate linguistic

knowledge - yet to be proposed - that would demonstrably aid learning. Our claim is simply that

nothing is gained by positing components of innate knowledge that do not simplify the problem

faced by language learners, and that this is the case for all extant UG-based proposals.

Thus, our challenge to advocates of Universal Grammar is this: Rather than presenting abstract

learnability arguments of the form 'X is not learnable given the input that a child receives',

explain precisely how a particular type of innate knowledge would help children to acquire X. In

short, "You can't learn X without innate knowledge" is no argument for innate knowledge, unless

it is followed by "...but you can learn X *with* innate knowledge, and here's one way that a child could do so".

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[1] Although these authors do not use the term "Universal Grammar" some innate basis is clearly assumed. For example, Christophe, Mehler and Sebastián-Gallés (2001: 385-386) argue that the speech stream is "*spontaneously perceived* as a string of prosodic units, roughly corresponding to phonological phrases" boundaries of which "often coincide with boundaries of syntactic constituents" (emphasis added).

[2] It would seem likely that learners make use not only of semantic but also of functional similarity between items (e.g., Tomasello, 2003). For example, although most abstract nouns (e.g., *situation*) share no semantic similarity with concrete nouns (e.g., *man*), they share a degree of functional similarity in that actions/events and properties can be predicated of both. We do not see this as a free-standing alternative account, but simply another property over which similarity-based clustering can operate. Another is the phonological properties of the word. For example, English bi-syllabic nouns tend to have trochaic stress (e.g., *monkey, tractor*) and verbs, iambic stress (*undo, repeat*) (Cassidy & Kelly, 2001; Christiansen & Monaghan, 2006).

[3] A reviewer pointed out that this section addresses two distinct, though overlapping, questions in the domain of basic morphosyntax. The first (Section 3.1) is the question of how children learn the way in which the target language marks syntactic roles such as SUBJECT and OBJECT, whether via morphology, syntax (i.e., word order) or some combination of the two. The second (Section 3.2) is the question of how children acquire the order of (a) specifier and head and (b) complement and head. In some cases, these questions overlap. For example, in word-order languages such as English, both relate to the ordering of the SUBJECT, VERB and OBJECT. In other cases, these questions are entirely distinct. For example, the ordering of specifier, head and complementizer is both (a) irrelevant to syntactic-role marking for languages where this is accomplished entirely morphologically and (b) relevant to phenomena other than syntactic-role marking (e.g., the ordering of the NOUN and DETERMINER within a DP/NP). Neverthless, because both questions relate to basic morphosyntax and, in particular, because these parameters have been discussed most extensively with regard to syntactic word order (e.g., SVO vs SOV), we feel justified in including these two separate subsections within the same overarching section.

[4] Pinker actually posits a hierarchy of linking rules (e.g., Pinker, 1989: 74), but since the first pass involves linking AGENT and PATIENT to SUBJECT and OBJECT, the facts as they relate to the discussion here are unchanged.

[5] We note in passing that, exactly as for lexical categories such as NOUN and VERB, the existence of a universal cross-linguistic SUBJECT category is disputed by many typologists (e.g., Schachter, 1976; Dryer 1997; Croft, 2001, 2003; Haspelmath, 2007; Van Valin & LaPolla, 1997; but see Keenan, 1976).

[6] Many authors use O (for OBJECT) rather than P (for PATIENT). However, since the very phenomenon under discussion is that not all languages map the semantic PATIENT role onto the syntactic OBJECT role, this seems unnecessarily confusing.

[7] Marantz (1984) additionally proposed that the A role (AGENT of a transitive verb) is the syntactic OBJECT, although such an analysis is not widely accepted.

[8] An alternative possibility is that UG specifies the order in which (some) parameters may be set (e.g., Baker, 2001), although such proposals have been fully worked out only for phonological parameters (Dresher & Kaye, 1990; Dresher, 1999).

[9] Although this argument has many different forms (Pullum & Scholz, 2002, list thirteen different ways in which the child's input has been argued to be impoverished), perhaps the clearest presentation is that of Lightfoot (1989:322) "It is too poor in three distinct ways (a) The child's experience is finite but the capacity eventually attained ranges over an infinite domain… (b) the experience consists of partly degenerate input… (c) it fails to provide the data needed to induce many principles and generalizations which hold true of the mature category". Lightfoot notes that "(c) is by far the most significant factor", and it this sense that we have in mind here.

[10] Or, at least, all syntactic generalizations ('grammatical transformations are invariably structure-dependent'; Chomsky, 1968: 61-62). There is clearly a role for linear order in, for example, phonology (e.g., the choice between *a* and *an* in English; Clark & Shalom Lappin, 2011: 37) and discourse structure (e.g., topic and focus; Pinker & Jackendoff, 2005:220).

[11] Crain and Nakayama's findings arguably count against the particular stage-based account proposed by Stemmer (1981), under which children *first* formulate a movement rule based on people, then gradually extend this to animals, objects, abstract concepts, etc. (though, in partial support of Stemmer, Crain & Nakayma observed the worst performance for questions with abstract/actional subjects; e.g., *Is **running** fun? Is **love** good or bad?*). However, neither the movement rule nor the discontinuous stages proposed by Stemmer (1981) are a necessary part of an account based on conceptual structure.

[12] The reviewer who raised this point asked why – if syntactic structure reflects conceptual/perceptual structure – in active transitive sentences (e.g., *The boy kicked the ball*), the agent "boy" seems to be a critical and inherent part of the conceptual/perceptual structure of the event, yet is absent from the VP. As we argue here, a VP (or V') (e.g., *kicked the ball*) is a conceptually coherent unit in that - like *chases the cat/causes cancer* - it can be predicated of a NOUN. But, of course, this is not to say that the agent can be entirely absent. Where an action requires an agent, the VP (or V') must indeed be combined with an obligatory NP (e.g., *the boy*), (unless it is an argument that is present in the conceptual/perceptual structure but, as an

"understood" argument can be omitted from the syntactic structure). This NP/VP division in syntax reflects the default *topic/comment* or *predicate/focus* division in information structure. Thus another way to think about the syntactic phrase VP (or V') as arising from the conceptual/perceptual structure of the event is as a grammaticalization of the focus domain (a concept discussed more fully in the following section). Indeed, it has been argued that languages that do not grammaticalize the focus domain (e.g., Malayalam; Lakhota) do not make us of VPs as a unit of clause structure (Mohanan, 1982: 524-534; Van Valin, 1987; Van Valin & LaPolla, 1997:217-218)

[13] These processing factors include the distance between the moved constituent and the gap (Kluender, 1992, 1998; Kluender & Kutas, 1993; Postal, 1998), the semantic complexity of the intervening material (Warren & Gibson 2002, 2005), item and collocational frequency (Jurafsky, 2003; Sag et al, 2007), finiteness (Ross 1967; Kluender 1992), informativeness (Hofmeister, 2007) and ease of contextualization (Kroch, 1989).

[14] Backgroundedness is a graded notion; hence different languages are free to "choose" the extent to which a constituent may be backgrounded and still permit extraction. For example, Russian permits extraction from main clauses only (Freidin & Quicoli, 1989), while Swedish has been described as showing no island constraints (Allwood, 1976, Andersson, 1982, Engdahl, 1982). Hofmeister and Sag (2010: 373) list Danish, Icelandic, Norwegian, Italian, French, Akan, Palauan, Malagasy, Chamorro, Bulgarian, Greek and Yucatec Mayan as languages that exhibit "counterexamples" to island constraints, though it may be possible to account for at least some of these cases within a subjacency framework by positing language-specific bounding nodes (as discussed in the main text with reference to Italian).

[15] *Wh*-islands are a borderline case in the subjacency literature. Huang (1982), Lasnik and Saito (1992), and Chomsky (1986) argue that weak islands (of which *wh*-islands are a subset; see Szabolcsi & den Dikken, 2002, for a review) block adjuncts (e.g., *How did Bill wonder <whether to buy the book>?*) to a greater degree than arguments (e.g., *What did Bill wonder <whether to buy>?*). This pattern can be explained by the functional account on the assumption that the information expressed by an adjunct (e.g., *using his credit card*) is more backgrounded than that expressed by an argument (e.g., *the book*)

[16] We should acknowledge that this account (and hence this test) does not make the correct predictions for coordinate structures such as *What$_i$ did Bill eat <fish and t$_i$ >?* (c.f. *Bill ate <fish and chips>*) or left-branch structures such as *Which$_i$ did Bill eat <t$_i$ cake>?* (c.f. *Bill ate <this cake>*). Such cases (particularly the second) seem to constitute violations of a different principle altogether; that informational units (e.g., this cake; which cake?) cannot be broken up (c.f. *Which cake did Bill eat t$_i$?*).

[17] For single-clause sentences, the discourse functional explanation is even simpler (though, of course, there is no backgrounded clause). 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 (examples from Lakoff, 1968; Kuno, 1987):

*He$_i$ found a snake near John$_i$ (cf. John$_i$ found a snake near him$_i$)
*Near John$_i$ he$_i$ found a snake (cf. Near him$_i$ John$_i$ found a snake)
*He$_i$ found a snake behind the girl John$_i$ was talking with (cf. John$_i$ found a snake behind the girl he$_i$ was talking with)

*He$_i$ loves John's$_i$ mother (cf. John$_i$ loves his$_i$ mother)
*John's$_i$ mother, he$_i$ adores dearly (cf. His$_i$ mother, John$_i$ adores dearly)

This also applies to quantified NPs (e.g,. *every pirate*), as in the following examples from Guasti and Chierchia (1999/2000: 131)

*He$_i$ put a gun in every pirate$_i$'s barrel (cf. Every pirate$_i$ put a gun in his$_i$ barrel)
*In every pirate$_i$'s barrel, he$_i$ put a gun (cf. In his$_i$ barrel, every pirate$_i$ put a gun)

[18] In the previous section, we discussed evidence that even 3-year-olds understand the discourse-functional constraints that govern the use of pronouns versus full NPs (Matthews et al, 2006). Thus studies that demonstrate apparent adherence to Principle C at this age (e.g., Somashekar, 1995) do not constitute evidence that children must necessarily be using this formal syntactic principle as opposed to discourse function.

[19] An alternative UG-based solution to the problem of inter-sentential pronominalization is to assume an underlying string that is present in the underlying representation, but not pronounced (Hankamer, 1979; Morgan, 1973, 1989; Merchant, 2005; Chomsky 1968; Crain & Thornton, 2012), as in the following example from Conroy & Thornton (2005):

> Q: Where did he$_i$ send the letter?
> A: ~~He sent the letter~~ To Chuckie$_{*i}$'s house

However, this solution works by assuming that the speaker is, in effect, producing a sentence containing a pronoun topic and a co-referential NP elsewhere in the same clause. Such sentences are ruled out by the discourse pragmatic principle outlined here (see previous footnote).

[20] It is perhaps also worth noting that the distinction between reflexive and non-reflexive pronouns emerged only relatively recently, at least in English. In old English (i.e., before around 1000AD), the equivalent of *Mama Bear washed her*, did indeed mean 'Mama Bear washed herself'. For example, Deutscher (2006: 296) cites an example from Beowulf, where the hero dresses himself for battle, but the pronoun used is *hine* ('him'). Thus if an innate Principle B was selected for during evolution, it is unlikely to have been because it conferred a communicative advantage; it marks a distinction that languages seem perfectly able to do without.