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The Illusion of Language Acquisition*

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1. Introduction

As Charles Darwin (1874:131) famously proposed, the ability to acquire and use language is, in some sense, an instinct: humans have 'an instinctive tendency to speak,' he wrote, 'as we see in the babble of our young children.' Time and science have confirmed Darwin's insight. Indeed, it's not just the inclination to babble that points toward an instinct. It's the fact that infants can hear every phonetic contrast possible in human language at the age of four months (Werker et al. 1996). It's the fact that 18 month olds can often learn the meaning of a new word after hearing it used just once (Carey 1978). It's the fact that two year olds know that *I don't like the dog or the cat* means 'I don't like the dog, AND I don't like the cat,' not 'I don't like the dog, OR I don't like the cat' (Crain & Khlentzos 2008). The list of marvels can be extended indefinitely, but the challenge remains: what, precisely, does the language instinct consist of?

No one knows. At best, we can talk only about approaches to the question, not actual answers. One approach, championed for decades by Noam Chomsky and many other leading linguists, equates the language instinct with Universal Grammar—an inborn system of categories and principles that defines the set of possible human languages. Another approach, with a long tradition of its own in psychology (Sawyer 2003:32ff), holds that the language instinct is best understood as a new machine fashioned out of old parts, to use Bates & MacWhinney's (1988:147) insightful metaphor. Often dubbed 'emergentist' in its recent instantiations, this view proposes that children's capacity for language can be traced to the interaction of non-linguistic forces and propensities, including those relating to processing, pattern recognition, and pragmatics. Emergentist research of this type encompasses work that goes by a variety of names, including constructivism, general nativism, and usage-based theory.

Building on earlier proposals (e.g., O'Grady 2005, 2008, 2010, 2011), I will pursue the emergentist thesis by putting forward and developing an idea about the role of processing in linguistic development. I will outline the hypothesis in the next section, and then present a series of case studies that help illustrate its predictions and implications.

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2. The Amelioration Hypothesis

Contrary to what the facts appear to show, I take the position that, at least in the case of syntax, there is no such thing as language acquisition, if we take that term to refer to a developmental process devoted specifically to the construction or growth of linguistic knowledge. Rather, I propose, what *appears* to be language acquisition is in fact an accidental side-effect of something very different and far more fundamental—attempts by the processor to facilitate its own operation. I will call this the Amelioration Hypothesis.

(1) The Amelioration Hypothesis
Language acquisition is a side-effect of processing amelioration.

Processing takes place at many levels as we produce and comprehend sentences—we deal simultaneously with sound, meaning, surroundings, interlocutors, social relationships, emotions, past memories, communicative goals, and so on. Syntactic processing has been a major concern of work on sentence comprehension since the 1970s (e.g., Kimball 1973, Frazier & Fodor 1978), and has generally focused on those aspects of comprehension that can be derived from a speaker's use of words with a particular inflectional form arranged in a particular way to express a particular proposition.[1] This will be my focus as well.

The job of processing is subtended by working memory, which provides the resources needed to hold information and to create the appropriate mappings between form and meaning. It is clear that these resources are severely limited, and that much of the information relevant to processing decays almost instantly. Various ideas have been put forward concerning the nature of these limitations (e.g., Just & Carpenter 1992, Caplan & Waters 1999, McElree et al. 2003, Grodner & Gibson 2005, Lewis et al. 2006), but there is no need to take a position here on a specific model of working memory. It suffices simply to agree on the need for efficiency in the way in which the processor draws on the spare resources available to it.

There is general agreement that processing efficiency is enhanced by automatizing the operations that are most frequently called upon in the course of language use (Townsend & Bever 2001:175, Paradis 2004:28, Bybee & McClelland 2005:382, Pienemann 2005, Herschensohn 2009). One way to achieve this is through the formation and strengthening of routines—the operations and sequences of operations that the processor implements as it does its work. As Sagarra & Herschensohn (2010:2022) observe, 'the child must develop computational procedures . . . to facilitate split-second processing in adult

[1] I will have nothing to say here about the origin and availability of the particular contrasts (±voice, ±coronal, ±nasal, etc.) that make sounds useful for communication, or the particular notions that turn out to be semantically relevant in language (tense, gender, modality). For the sake of proceeding, I will simply assume that they are determined by the properties of inborn articulatory/perceptual and conceptual systems.

speech and comprehension.' Thus, all other things being equal, processing is faster for more commonly encountered form-meaning mappings, whether they involve words (Jurafsky 2003) or syntactic patterns (Menn 2000, Ferreira 2003); for a general review, see Jaeger & Tily (2011).

To these assumptions, which are all widely accepted, I add two more controversial theses, both of which are closely linked to the Amelioration Hypothesis.

(i) Routines do the work traditionally assigned to the grammar, thereby calling into question the need for grammatical rules and principles.

(ii) Routines predict and explain what appears to be development—the attainment of ever-higher degrees of proficiency after an early period of errors, confusion, and/or slowness.

In exploring these ideas, I'll begin by using basic word order to illustrate how a processor, striving only to improve its functioning, can produce a generalization that is usually attributed to grammatical mechanisms. I will then turn to the much more challenging phenomenon of scope and consider the role of processing in the acquisition of a particular scopal pattern by five different groups of learners: children learning English as a first language, children learning Korean as a first language, Korean-speaking adults learning English as a second language, English-speaking adults learning Korean as a second language, and children learning Korean and English in a bilingual setting.

3. Word order in first language acquisition

Any proposal about how even the simplest sentences of a language are processed must begin with two widely accepted assumptions.

- Sentences are built and understood incrementally, one word at a time from 'left to right'. In listening to a sentence such as *Sheep eat grass*, for example, we think of sheep as soon as we hear the first noun, we identify them as agents (as eaters rather than as things eaten) as soon as we hear the verb, and so on.
- Words can generally be dismissed from active working memory as soon as they are interpreted. This doesn't mean we don't ever remember exactly what we say or hear—sometimes we do, of course. It just means that such feats of memory are not required for ordinary language use.

For the sake of illustration, let's assume that the meaning of a sentence such as *Sheep eat grass* can be partially represented as a predicate-argument structure like the one in (2).

(2) $\begin{bmatrix} \text{EAT} \\ \langle s \;\; g \rangle \end{bmatrix}$

s = *sheep*, the verb's first (agentive) argument
g = *grass*, the verb's second (patient) argument

In actual fact, of course, there is much more to meaning than this (including, obviously, tense, aspect, number, and gender), but everyone agrees that there can't be *less*: the sort of information contained in a predicate-argument structure is a central part of a sentence's meaning.

We can now ask the crucial question: how does the processor go about mapping a form such as *Sheep eat grass* onto a semantic representation, and vice versa? In pursuing an answer to this question, I adopt the view that the processor creates a direct mapping between form and meaning, without building or making reference to conventional syntactic representations. This idea is put forward only occasionally within linguistics (e.g., Steedman 2000, Kempson et al. 2001), but it is quite widely held in various forms in other branches of cognitive science that deal with language (Bates & MacWhinney 1987, Chang et al 2006, Thompson & Newport 2007, Fitz et al. 2011). In the next section, I outline a proposal about how such a system might work for the example at hand.

3.1 Learning to process word order

Imagine the situation of a fourteen-month old child who knows no syntax but has a small vocabulary that includes the words *sheep*, *grass*, and *eat*. What might happen when such a child hears his mother utter the sentence *Sheep eat grass* for the first time, perhaps in a context where she is talking about what different types of animals eat?

My proposal is that an event of this type triggers a step-by-step series of operations that maps the novel sequence of words directly onto a semantic representation in the following manner.

(3) a. The nominal *sheep* is encountered and assigned an interpretation (represented here as the index *s*). The word itself is immediately discarded, as indicated by the strike-through.

~~*sheep*~~
s

b. The transitive verb *eat* is encountered, its two-place predicate-argument structure is accessed...

[EAT]
[<__>]

... and the referent of the preverbal nominal (represented by its index) is identified as first argument (agent).

~~*Sheep eat*~~
[EAT]
[<*s*_>]
↑
The referent of *sheep* corresponds to the verb's first argument.

c. The nominal to the verb's right, *grass*, is assigned a referent (represented by the index *g*) ...

~~*grass*~~
g

... which is immediately interpreted as the verb's second argument (the patient).

~~*Sheep eat grass*~~
[EAT]
[<*s g*>]
↑
The referent of *grass* corresponds to the verb's second argument.

A processor that goes through the series of operations exemplified in (3) every time it encounters a transitive sentence (*Cats chase birds*, *Mice like cheese*, *People drive cars*, etc.) will gradually develop a general routine like the one below for interpreting this type of pattern.

(4) Interpretive routine for pattern traditionally described as NP V NP:

a. NP_1 is assigned an interpretation, *a*.

a

b. The verb is encountered, its meaning and argument structure are accessed, …

$$\begin{bmatrix} \text{PRED} \\ <\_\ \_> \end{bmatrix}$$

… and the referent of NP_1 is identified as its first argument.

$$\begin{bmatrix} \text{PRED} \\ <a\ \_> \end{bmatrix}$$

c. NP_2 is assigned an interpretation, *b* …

b

… which is then identified as the verb's second argument.

$$\begin{bmatrix} \text{PRED} \\ <a\ b> \end{bmatrix}$$

A corresponding production routine will emerge as the processor repeatedly maps particular semantic representations onto sentences of the NP V NP type.

(5) Production routine for transitive sentences:

Semantic representation:

$$\begin{bmatrix} \text{PRED} \\ <a\ b> \end{bmatrix}$$

a. The predicate's first argument, *a*, is encoded as NP_1.
$a \Rightarrow NP_1$

b. The predicate is encoded as a verb.
$\text{PRED} \Rightarrow \text{V}$

c. The predicate's second argument, *b*, is encoded as NP_2.
$b \Rightarrow NP_2$

Over time, both routines are strengthened through repeated activation, facilitating the processor's functioning by speeding its operation and thereby reducing the burden on working memory.

The idea that children generalize from the observed distributional properties of particular words to more abstract mechanisms of some sort is a standard feature of work on language development (e.g., MacWhinney 1987, Seidenberg & MacDonald 1999, Tomasello 2003, Chang et al. 2006, Chater & Manning 2006. Goldberg 2006, Ambridge & Lieven 2011, among others). The precise manner in which language learners move from particular to general—what it is that allows them to see that *x* is an instance of *y*—is a matter of ongoing research in all approaches to language acquisition. The key point for now is simply that the basic scenario, including the processing-based implementation that I propose, fits well with the facts of development, which include two telling characteristics.

- Processing speed improves with ongoing exposure to and use of SVO patterns, consistent with the view that the corresponding routine is gradually becoming automatized (Song & Fisher 2007:1980, Lieven & Tomasello 2008:169, Clahsen 2008:13, Fernald et al. 2010:211, Kidd 2012).

- Children are able to successfully process transitive sentences at an earlier age in languages that consistently use a single word order pattern than in languages that permit significant word order variation (Chan et al. 2009), presumably because homogenous input facilitates the formation of processing routines.[2]

What we see here is essentially what one would expect if processing routines for the production and comprehension of word order are being formed, strengthened, and ultimately automatized: processing speeds up and errors disappear.

Of course, exactly the same result is expected if a grammatical parameter is set, strengthened, and accessed by the processor with increasing success—a familiar and plausible idea (Yang 2004, Truscott & Sharwood-Smith 2004). Crucially, though, this is *not* a point in favor of a parameter-based theory, for the reason put forward by Janet Dean Fodor (1978:470).

> … there *must* be psychological mechanisms for speaking and understanding, and simplicity considerations thus put the burden of proof on anyone who would claim that there is more than this. To defend the more traditional view, what is needed is some sign of life from the postulated mental grammar.

There are at least two ways in which a grammar might show signs of life in the case at hand. First, it might help account for how children come to distinguish between acceptable word order patterns such as *Horses like oats* and unacceptable ones such as **Like horses oats*. And second, it might contribute to an account of why, typologically, languages with verb-object order tend also to have prepositions and post-nominal relative clauses rather than postpositions and pre-nominal relative clauses (Greenberg 1963, Dryer 1992). Can a processor, dedicated just to improving its own functioning, offer insights into these matters?

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[2]Chan et al.'s study involved a total of 200 monolingual learners (aged 2;6-4;6) of English, German and Cantonese. SVO is the dominant order is all three languages. However, whereas English employs this order almost exclusively, German employs SOV order in embedded clauses and exhibits considerable word order variation related to focus and topicality. Cantonese also permits focus- and topic-related variation in word order, as well as frequent argument drop, both of which reduce the number of SVO sentences.

3.2 How the processor can subsume the duties of the grammar

Although it is often assumed that the ability to distinguish between unacceptable and acceptable word order patterns is prima facie evidence for a grammatical rule (e.g., Franck et al. 2011:133), another possibility comes to the fore when we consider the routines proposed above. In both comprehension and production, the processor begins with an NP, proceeds to the verb of which that NP is the first argument, and then moves on to the NP that is the verb's second argument. The relevant processing routines thus incorporate the key generalization about word order in English transitive clauses—the first argument (the subject) precedes the verb, and the second argument (the direct object) follows it.

But now another question arises: without a grammar to constrain it, won't a processor try to process just about anything? Initially, yes—that's what a processor is supposed to do. But a processor that seeks to improve its functioning by developing automatized routines will not be so ambitious for long. That is because routines are able to improve a processor's speed only by creating well-worn paths for it to follow. All other things being equal, a strong routine should always be the processor's first recourse when producing or comprehending a sentence. This seems to be the case even in the early stages of language development: based on a reanalysis of earlier research by Akhtar (1999) and Matthews et al. (2005) and on new experimental work, Franck et al. (2011) report that English-speaking children as young as 2;11 avoid repetition of unacceptable word orders (SOV and VSO) at a much higher rate than acceptable patterns.

The typological facts also fit well with a processing-based approach to word order. The key observation, developed in detail by Hawkins (2004:123ff), is that for reasons relating to working memory, languages seek to minimize the distance between the verb and the heads of its dependent phrases. As illustrated in (6), this creates an incentive for verb-complement languages to favor prepositions over postpositions.

(6)a. Preferred prepositional pattern—the head is maximally close to the verb:

walk [$_{PP}$ *to the door*]
V P NP
↑_____↑

b. Dispreferred postpositional pattern—the head is more distant:

walk [$_{PP}$ *the door to*]
V NP P
↑______________↑

By the same reasoning, NPs with post-nominal relative clauses should be preferred over NPs with a pre-nominal relative clause.

(7) a. Preferred post-nominal pattern—the head N is maximally close to the verb:

read [$_{NP}$ *books* [$_{S}$ *that are highly regarded*]]
V N RelClause
↑______↑

b. Dispreferred pre-nominal pattern—the head N is more distant:

read [$_{NP}$ [$_{S}$ *that are highly regarded*] *books*]
V RelClause N
↑______________________________↑

Hawkins discusses various additional features of the processing-based view of word order, including some that give it an advantage over the traditional parametric approach.

3.3 Summary

Although the sole purpose of routines is to improve the functioning of the processor, their emergence is accompanied by side effects that correspond to what is usually thought of as 'language acquisition.'

- The steady improvement in the production and comprehension of a language's basic word order reflects the emergence and strengthening of the corresponding processing routine(s).
- The emergence of an aversion to unattested word order patterns reflects the entrenchment of the routine(s) created by the repeated processing of actual word order patterns.
- The tendency for particular word order properties to cluster together across languages, in accordance with the familiar typological generalizations (V–NP ⊃ P-NP, etc.), reflects processing pressures.

None of these developmental events requires reference to conventional grammatical rules or representations, or to a specialized acquisition device. What we think of as acquisition in the case of basic word order comes down to simple processing amelioration—improvements to the speed and efficiency of the processor, via the creation and strengthening of processing routines in response to a particular type of input.

Its illustrative value notwithstanding, basic word order offers little opportunity to evaluate the viability of the Amelioration Hypothesis, let alone to explore its possible advantages over UG-based approaches. That is because basic word order is not a typical syntactic phenomenon. Not only does it involve an unusually simple contrast (it's either verb–object, or it's object–verb), it has an extravagantly high rate of instantiation in the input. Most of the phenomena whose study drives acquisition theory do not enjoy these two advantages. Scope, to which we turn next, is a case in point.

4. Scope in first language acquisition

The term 'scope' refers to the effect that logical operators of various sorts (quantifiers, negation, etc.) have on a sentence's interpretation. A well-known example involves the interaction between negation and the universal quantifier *all/every* in sentences such as the following in English and Korean.[3]

(8) a. Mike didn't eat all the cookies.

b. Mike-ka motun kwaca-lul an mekessta.
Mike-NOM all/every cookie-ACC not ate

Semantically, the Korean quantifier *motun* falls somewhere between English *every* and *all*, and is sometimes translated as one and sometimes as the other. Because of its compatibility with plurals in Korean, I prefer to translate it as 'all,' but I assume that data from either English quantifier is relevant for comparing development in the two languages. For the sake of expository convenience, I will use the symbol ∀ to stand for a universal quantifier, regardless of its actual form—*all*, *every*, or *motun*.

It is well known that the co-occurrence of negation and universal quantification in the same clause creates the potential for ambiguity. Thus, at least in principle, sentences such as those in (8) may have an interpretation in which the negative influences the interpretation of the quantifier (*not* > ∀—'Not all the cookies were eaten') or an interpretation in which there is no such influence (∀ > *not*—'All of the cookies remained uneaten').[4] As we will see in due course, native speakers of English strongly favor the *not* > ∀ interpretation, whereas speakers of Korean manifest an equally strong preference for the ∀ > *not* reading in their language. We are thus confronted with two questions:

[3] A more colloquial pattern in Korean makes use of the 'adverbial' quantifier *motwu* 'all' (e.g., *Mike-ka kwaca-lul motwu an mekessta* 'Mike ate the cookies all'). Following Han et al. (2007), I focus here on the 'adjectival' quantifiers exemplified in (8b), whose distribution more closely parallels that of their English counterparts.

[4] The ∀ > *not* reading entails the *not* > ∀ reading: if it is true that all the cookies are uneaten, it is also true that not all the cookies were eaten. When I say that the ∀ > *not* reading is favored, I mean that speakers use a particular structure, primarily or exclusively, for the subset of 'not all' situations in which all of the cookies are uneaten (O'Grady et al. 2011 call this the 'full set interpretation'). And when I say that the *not* > ∀ interpretation is preferred, I mean that speakers tend to reserve the pattern for the subset of 'not all' situations in which some of the cookies are eaten and some aren't (the 'partitioned set interpretation').

i. Why do the two languages differ in the way that they do with respect to scopal preferences?

ii. How do children come to have the appropriate preference in their native language?

The interest of these questions is heightened by a paradoxical fact: despite the obvious intricacy of scope, the input provides learners with relatively few instances of its use. In the case of English, for instance, my search of three corpora from the CHILDES database uncovered just 8 sentences in which a negated verb takes a universally quantified NP as direct object.

Table 1. Number of sentences containing a negated verb and a universally quantified direct object in input to Adam, Eve, and Timothy

Child	Input	*not V all/every ...* patterns
Adam	mother (2 years of 1-hour biweekly speech samples)	8 (7 *all*/1 *every*)
Eve	mother (9 months of 1-hour biweekly speech samples)	0
Timothy	various interlocutors in a bilingual Chinese-English setting (2 years of 1-hour biweekly speech samples, some for English only, some for Cantonese only, and some mixed)	0

The CHILDES database currently contains just a small sample for Korean (12 bi-weekly one-hour sessions, beginning when the child was two years old). That sample contains no instances of negated sentences containing *motun* 'all/every,' and O'Grady et al's (2009) search of the 10-million-word Sejong corpus of spoken and written Korean (http://www.sejong.or.kr) revealed just 23 examples of this pattern in adult-to-adult communication.

In sum, whereas learners of English and Korean encounter millions of examples of word order in the first few years of life, their exposure to scopal patterns in which a negated verb has a universally quantified direct object is extremely limited. Yet, paradoxically, scope is arguably a far more challenging phenomenon. How then can it be mastered?

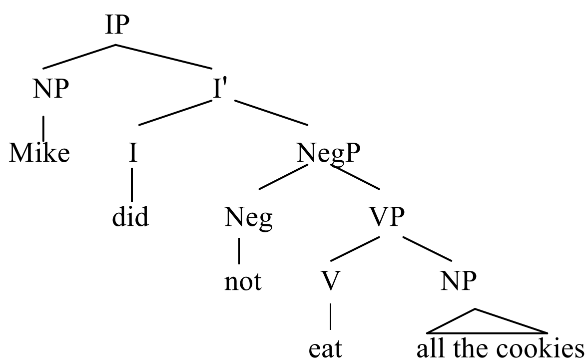
4.1 The UG account

One possibility, pursued in detail by Han, Musolino & Lidz (2007:18ff), is that the scopal facts in English and Korean are regulated in part at least by the classic principle of Universal Grammar paraphrased in (9).[5]

(9) The Scope Principle
C-command determines scope.

Matters in English are straightforward: as illustrated by the structure in (10), based on Han et al.'s (2007:21) example (45b), the negative c-commands *all*, giving the *not-all* reading.

(10)



The situation in Korean is somewhat less straighforward: on Han et al.'s account (p. 21), direct objects in that language obligatorily raise to a higher position (the specifier of an unnamed functional projection, FP), from which they c-command the negative—the reverse of what happens in English. This in turn accounts for the strong preference for the ∀ > *not* interpretation in Korean.[6]

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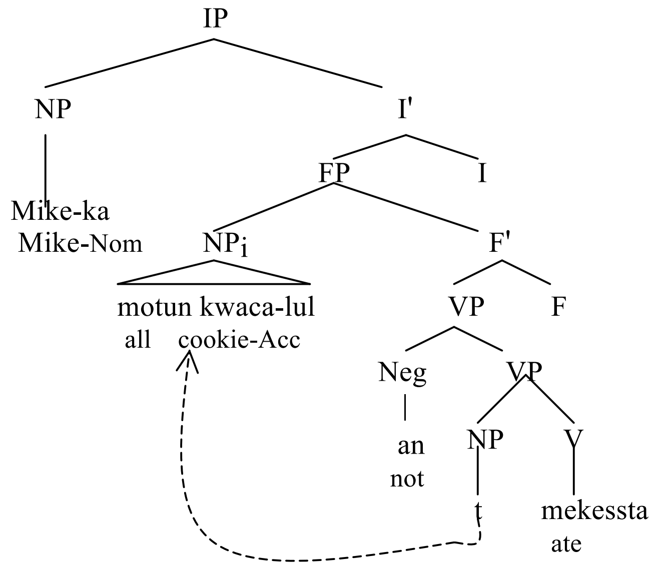
[5] Informally, X c-commands (and has scope over) Y, if X occupies a higher position in syntactic structure. On the centrality of c-command to UG-based accounts of scope, see Kiss (2002), among many others.
[6] Some speakers of Korean do in fact allow the *not* > ∀ interpretation. Han et al. account for this by assuming that the negative can cliticize to V, which then raises to I (p. 34).

(11)



4.2 The processing account

Phenomena like scope endow the study of language acquisition with much of its intellectual interest, and progress in this area is vital to our understanding of development. The challenge for a processing account is clear, if not easy: to show how the syntax of scope in English and Korean can emerge from attempts by the processor to improve its own functioning. As in the case of word order, this will involve the postulation of routines that meet the usual two conditions:

(i) They must be able to do the work normally assigned to the grammar.

(ii) They should predict and explain development—the attainment of ever-higher degrees of proficiency in a language, often after an early period of errors, confusion, and/or slowness.

A variety of factors can contribute to processing difficulty, of course, but just one is relevant for our current purposes. That factor involves what I will call 'unidirectionality'—whether the processor is able to assign the right interpretation to a quantifier immediately upon encountering it, without having to later retrace its steps and revise its earlier hypothesis.

(12) Unidirectionality
Ease of processing is enhanced if an item can be interpreted immediately upon being encountered, with no subsequent revision to its interpretation.

This is simply a strong version of incrementality: as noted at the beginning of section 3, it is a matter of consensus that the processor seeks to interpret each word and phrase as it is encountered. Backtracking to revise previously assigned interpretations increases the burden on working memory, since it requires access to items that are no longer active and the execution of new operations on those items. The resulting increase in processing cost has been well documented in children (Trueswell et al. 1999), in adults (Fodor & Ferreira 1998, Sturt et al. 2001, Sturt 2007, Cai et al. 2012), and in second language learners (Juffs & Harrington 1995, Roberts & Felser 2001).

With these considerations in mind, let us turn to the question of how a processor might go about interpreting scope in negated sentences that contain a universally quantified direct object. This is a very narrow question, of course, and it falls far short of a comprehensive account of scope—an essential goal for work on syntax regardless of theoretical orientation, but not a practical objective here. Nonetheless, it is perhaps not too much to hope that the study of a representative case can be revealing,

4.2.1 English

Let us begin by considering the manner in which an English sentence such as *Mike didn't eat all the cookies* might be processed in the course of comprehension, drawing on the word order routines discussed in section 2 in addition to interpretive routines that focus specifically on scope.

(13) *Mike didn't eat all the cookies*:

a. Interpretation of the nominal *Mike*

~~Mike~~
m

b. Interpretation of the negative (represented by the symbol ¬)

~~Mike didn't~~
m ¬

c. Interpretation of the verb *eat*: projection of its predicate-argument structure and association of 'Mike' with the first argument position.

~~Mike didn't eat~~

$$\begin{bmatrix} \neg\text{EAT} \\ \langle m\ \_\rangle \end{bmatrix}$$

d. Association of the NP *all the cookies* (represented here as $\forall c$) with the verb's second argument position.

~~Mike didn't eat all the cookies~~

$$\begin{bmatrix} \neg\text{EAT} \\ <m\ \forall c> \end{bmatrix}$$

Given the presence of a universally quantified argument in the grid of a negated verb, there are in principle two interpretive options—one in which the previously encountered negative influences the interpretation of the quantifier (*not* > ∀: 'Not all the cookies were eaten') and one in which it doesn't (∀ > *not*: 'All the cookies remained uneaten'). The two routines can be stated as follows for the purposes of exposition.

(14)a. Routine for the *not* > ∀ reading—the quantifier is interpreted under the influence of the negative: [7]

$$\begin{bmatrix} \neg\text{PRED} \\ <x\ \forall y> \end{bmatrix}$$
$$\Downarrow$$
'not all y'

b. Routine for the ∀ > *not* reading—the quantifier is interpreted without regard for the negative:

$$\begin{bmatrix} \neg\text{PRED} \\ <x\ \forall y> \end{bmatrix}$$
$$\Downarrow$$
'all y'

In terms of the unidirectionality criterion, the two options are comparable in cost. Since the negative occurs prior to the verb in English (*Mike* ***didn't*** *eat* ...), the information needed to compute either scopal interpretation is available when the processor comes upon the quantified direct object. To the extent that a processing preference exists, then, it has to emerge in response to experience: the routine that gives the *not* > ∀ interpretation is activated more frequently in the course of language use over a period of years and therefore comes to be stronger than the routine for the ∀ > *not* interpretation.[8]

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[7] Of course, these are not the only circumstances in which a negative can have scope over a quantifier—such a relationship is found with other types of negatives (e.g., *No one ate all the cookies*) and with other types of quantifiers (e.g., *He didn't eat many cookies*). I set to the side for now the question of whether and how the routine(s) proposed here can or should be generalized to a broader range of cases, or whether each scopal pattern requires a separate routine.

[8] This naturally raises the question of why the *not* > ∀ interpretation is more frequent in the input to begin with. Musolino & Lidz (2006:834) offer a promising pragmatic explanation: if a speaker

If this is right, then learners have no initial grounds for choosing between the two interpretations of English *not V all* patterns—each reading is easily accommodated by the processor, and the relevant input is too sparse to reveal the adult preference. We thus predict that children will initially not have a strong preference for either interpretation. The developmental facts appear to support this prediction: English-speaking children happily accept either interpretation if they are given a favorable context. In a truth-value judgment task involving 20 children aged 3;11 to 6;0 (mean 4;10), Musolino, Crain & Thornton (2000:13-14) report a 85% acceptance rate for the *not* > ∀ reading of sentences such as *Smurf didn't buy every orange*. In a similar study of 20 five year olds (mean age 5;4), Musolino & Lidz (2006) found a 75% acceptance rate for the ∀ > *not* interpretation, compared to just 20% for adults.

Table 2 Acceptance rates for children and adults (Musolino et al. 2000, Musolino & Lidz 2006)

	children	adults
not > ∀ interpretation	85%	100%
∀ > *not* interpretation	75%	20%

Two points are crucial here. First, young children's high acceptance rate for the ∀ > *not* interpretation is consistent with an early willingness to accept both readings, reflecting the initial parity in processing cost for the two interpretive routines. Second, the low acceptance rate for the ∀ > *not* interpretation among adults is consistent with the gradual strengthening of the *not* > ∀ routine at the expense of its ∀ > *not* counterpart in response to ongoing, albeit infrequent, encounters with relevant sentence types over a multi-year period (see also note 8). Further support for this scenario may eventually come from longitudinal data and from studies of individual variation correlating speed of development with variation in the relevant input.

In sum, this is a promising example of processing amelioration. After an initial period in which both interpretive routines enjoy equal status thanks to their comparable cost, the processor develops a preference for the routine that is more frequently activated and hence easier to call up and implement. A side-effect of this amelioration is a preference for the *not* > ∀ interpretation, which in turn creates the illusion that the acquisition device has produced a grammatical rule or set a grammatical parameter.

wishes to express the ∀ > *not* interpretation, it is more informative to do so via an unambiguous pattern such as *Mike didn't eat any cookies* or *Mike ate no cookies*. This leaves the *not V all* pattern with a single major function—expressing *not* > ∀ readings in which just some of the cookies are eaten.

4.2.2 Korean

Now (simplifying only slightly), let us consider how the processor goes about interpreting Korean sentences that consist of a negated verb and a universally quantified direct object.

(15) *Mike-ka motun kwaca-lul an mekessta*
Mike-Nom all cookies-Acc not ate

a. Interpretation of the nominative-marked *Mike*

~~Mike-ka~~
m

b. Interpretation of the accusative-marked *all cookies*:

~~Mike-ka motun kwaca-lul~~
Mike-Nom all cookies-Acc not ate
m $\forall c$
$\Downarrow$
'*all c*'

c. The negative + verb complex is encountered, its predicate-argument structure is projected, and its arguments are identified.

~~Mike motun kwaca-lul an mekessta~~
Mike all/every cookie not ate

$$\begin{bmatrix} \neg\text{EAT} \\ \langle m\ \forall c\rangle \end{bmatrix}$$

'*all c*'

As in the case of English, there are in principle two interpretive options at this point—one in which the negative influences the interpretation of the quantified NP (*not* > ∀) and one in which it doesn't (∀ > *not*).

Crucially, though, in this case there is a sharp difference in the cost of the two options with respect to unidirectionality. Because the quantified direct object precedes the negative + verb complex, it is encountered and assigned its usual 'full-set' interpretation (step b) before the processor comes upon the negative. The 'fewer-than-all' reading (*not* > ∀) can therefore be derived only by backtracking and revising the previously assigned interpretation with the help of a routine such as the one in (16), in violation of the unidirectionality criterion and at obvious additional cost to working memory.

(16) Routine for revising previously assigned ∀ > *not* interpretation:

[¬PRED]
[<*x* ∀*y*>]
‘~~*all y*~~’
⇓
‘*not all y*’

A simple prediction thus follows: a processor committed to facilitating its own operation should manifest an initial preference for the ∀ > *not* interpretation in Korean, even in the absence of relevant input. This seems to be right. In Han et al.’s (2007) between-group study of native Korean children living in Seoul, the 15 four year olds who were tested on sentences in contexts that favor the ∀ > *not* interpretation accepted them as true 81.7% of the time. In contrast, the 15 four year olds who were presented with a context that supported the *not* > ∀ reading accepted the test items as true just 36.7% of the time. (Nine of the 15 children judged all the test sentences to be false in this context; no child was reported to have uniformly rejected the ∀ > *not* interpretation in the contexts supporting it.)

O’Grady, Kwak, Lee, & Lee (2011) report an even sharper contrast for 20 native Korean children aged 5;0 to 6;9, all of whom were tested in both types of contexts with orally presented materials as part of a truth-value judgment task (see the appendix for an example). As summarized in Table 3, negated sentences with a universally quantified direct object were accepted as true 98% of the time in contexts favoring the ∀ > *not* interpretation compared to just 25% of the time in contexts supporting the *not* > ∀ interpretation. This difference was statistically significant (t (19)=8.53, p<.001).[9]

---

[9] Lidz & Musolino (2002) show that children learning Kannada as a first language prefer the non-specific (*not* > *two*) interpretation of patterns such as (i), even though the negative follows the numeral.

(i) Naanu eradu pustaka ood-al-illa.
I.Nom two book read-Inf-Neg
‘I didn’t read two books.’

My proposal does not rule out a preference for inverse scope in such cases; it simply posits an aversion to backtracking. In sentences such as (i), it is plausible to assume that the processor assigns a non-specific interpretation to the numeral-bearing direct object NP upon first encountering it, so that no recomputation is required upon subsequently encountering the negative; see Kwak (2010) for extensive discussion. This option is not open to universally quantified NPs, which count as definites under standard assumptions.

Table 3. Interpretive preferences for Korean children aged 5;0–6;9

∀ > *not* context		*not* > ∀ context	
True	False	True	False
98.3% (SD=7.37)	1.7%	25% (SD=38.83)	75%

Experimental work with adults by Han et al (2007:30) and by O'Grady et al. (2011) suggests that this preference is maintained throughout life.

4.3 Summary

In sum, what appears to be the application of a (presumably inborn) grammatical principle for scope interpretation in Korean and English is actually just processing amelioration—attempts by the processor to improve its own functioning by easing the burden on working memory. In the case of Korean, this involves an early and lasting preference for the ∀ > *not* interpretation, consistent with the lower cost of the associated interpretive routine. And in English, it involves an initial willingness to accept either the ∀ > *not* or the *not* > ∀ interpretation, consistent with their shared low cost, followed by input-motivated adjustments in favor of the more frequently activated routine.

Table 4. Summary of the development profiles for Korean and English

	Korean	English
Children	Minimal relevant input; lower processing cost and higher acceptance rate for the ∀ > *not* interpretation	Minimal relevant input; comparable processing cost and acceptance rates for both interpretations
Adults	Accumulated input reinforces the ∀ > *not* preference	Accumulated input favors the *not* > ∀ interpretation

There is no reason to think that a specialized acquisition device has produced a grammatical rule in either language. Both the contrast in scopal preferences between the two languages and the manner in which they emerge can be traced to the processor's attempts to improve its functioning. Consistent with the amelioration thesis, the emergence and timing of the resulting routines have side effects that correspond to what is usually called 'language acquisition.'

5. Scope in second language acquisition

It is widely recognized that processing factors have a major role to play in understanding the acquisition and use of a second language (see, e.g., Hopp 2010 for an important demonstration of this point). This raises the obvious question: could second language acquisition too be an instance of processing amelioration? That is, could the developmental profile associated with L2 learning, including the properties of the interlanguage, reflect the processor's attempt to improve its functioning in response to new types of input?

The study of basic word order is unlikely to be helpful, as both the processing approach and the UG-based approach can easily accommodate word order transfer in the early stages of L2 learning, such as the appearance of SOV order in the English of Korean-speaking child and adult L2 learners (Park 1997, Hahn 2000). On the one hand, such errors are consistent with the gradual suppression of the object–verb routine of Korean in favor of the verb–object routine of English—an instance of processing amelioration since it improves the processor's performance on the newly encountered input. On the other hand, the facts can also be accommodated by UG theories that allow parameter settings to vary in strength. Truscott & Sharwood Smith (2004) offer just such a theory, suggesting (in effect) that the head-final setting of the word order parameter in Korean-speaking second language learners might gradually weaken as the head-initial setting of English is strengthened, until at some point a complete change in its value takes place.

In order to tease apart the predictions of the processing-based and parameter-based approaches, we need a phenomenon for which they make different predictions. Scope is a possible case in point.

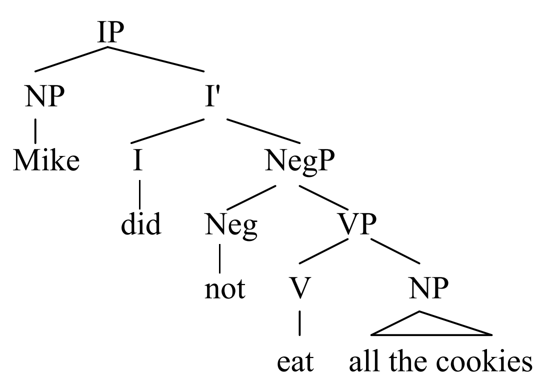
5.1 The UG account

Let us begin with the Scope Principle that is central to much work on scopal interpretation in the UG framework.

(17) The Scope Principle:
C-command determines scope.

As we have seen, this principle straightforwardly explains the preference for the *not* > ∀ interpretation in English, since the negative c-commands the quantifier.

(18)



What, if anything, does this account predict about the acquisition of English as a second language? On the assumption that second language learners have access to Universal Grammar (e.g., White 2003 and the many references cited there) and that the Scope Principle is universal, a prediction seems to follow: L2 learners should accept the *not* > ∀ reading of sentences such as *Mike didn't eat all the cookies* without hesitation, just as native speakers of English do.[10] Interestingly, this is not what the processing account predicts.

5.2 The processing account

The foundation for the processing account of second language acquisition consists of a proposal about transfer and how it shapes early development.

(19) The Transfer Calculus
L2 learners transfer dominant processing routines, unless the cost of implementing those routines is less favorable in the second language than in the first language.

The key idea here is that transfer reflects an entirely processor-centered strategy—it is motivated by the pressure to facilitate processing in the L2. If for some reason the cost calculus for a particular routine is less favorable in the second language than in the first, transfer is pre-empted.

In the case at hand, the calculation of cost focuses on compliance with the unidirectionality criterion. Let us examine how this works for both the acquisition of English by Korean speakers and the acquisition of Korean by English speakers.

5.2.1 English as a second language

As we have seen, Korean favors the ∀ > *not* interpretation for the reasons outlined in section 4.2.2.

(20) Dominant routine in Korean for a universally quantified direct object:

$$\begin{bmatrix} \neg\text{PRED} \\ <x\ \forall y> \end{bmatrix}$$
$$\Downarrow$$
$$\text{‘}\textit{all } y\text{’}$$

This routine is easily transferable to English, in which it can be executed at a cost comparable to that of the routine underlying the *not* > ∀ interpretation

[10] This prediction would not follow if Korean-speaking L2 learners raise the direct object in English to a position higher than the negative, as they supposedly do in Korean (see (11) in section 4.1). Note, though, that raising has visible effects in Korean, where it moves the direct object to the left of the negative. There is clearly no such movement in English, although the possibility of 'covert' raising cannot be ruled out in UG-based theories.

(21) Dominant routine in English for a universally quantified direct object:

$$\begin{bmatrix} \neg\text{PRED} \\ \langle x\ \forall y \rangle \end{bmatrix}$$
$$\Downarrow$$
'not all y'

As observed in section 4.2.1, both routines comply with unidirectionality and are therefore comparable in cost. By the Transfer Calculus, then, we expect transfer of the dominant routine from Korean. This leads to the prediction that Korean-speaking L2 learners will initially favor the ∀ > *not* reading in English, just as they do in Korean—the precise reverse of the prediction made by the parameter-setting approach.

Table 5. Predictions for the acquisition of English by Korean speakers

Theory	Prediction
The UG theory	general acceptance of the *not* > ∀ interpretation (due to the Scope Principle)
The processing theory	initial reluctance to accept the *not* > ∀ interpretation (due to transfer of the dominant routine from Korean)

In order to evaluate these predictions, O'Grady et al. (2009) tested 42 native speakers of Korean on their interpretive preferences, both in their native language and in English. The participants, all undergraduate students at Hanyang University in Seoul, had attained an intermediate to high-intermediate level of proficiency in English, based on their previous coursework in their university's English-language program.

As shown in Table 6, the participants manifested the expected strong preference for the ∀ > *not* interpretation in their native Korean, which they accepted in supporting contexts 97% of the time. In contrast, the *not* > ∀ interpretation was accepted in contexts that favored it just 21% of the time. This difference is statistically significant (t (41) = 12.49, $p < .05$).

Table 6 Participants' interpretive preferences in their native Korean

∀ > *not* context		*not* > ∀ context	
True	False	True	False
97%	3%	21%	79%
(SD=15.81)		(SD=37.68)	

Now consider the crucial data, which comes from Korean speakers' interpretation of ENGLISH scopal patterns.

Table 7 Participants' interpretive preferences in English

∀ > *not* context		*not* > ∀ context	
True	False	True	False
93%	7%	28%	72%
(SD=22.13)		(SD=34.57)	

As documented in Table 7, the Korean speakers exhibit the same scopal preference (∀ > *not*) for English (t (41) = 9.06, $p < .05$) that they do for their native language, manifesting the same reluctance to accept the *not* > ∀ interpretation. This is exactly what the processing account predicts, in contrast to the UG account: the dominant routine is transferred from the first language, in the absence of any additional processing cost when it is used in the L2.

Work by Lee (2009:68) on the interpretation of *every* suggests that Korean-speaking L2 learners eventually encounter enough relevant input to upgrade the routine that favors the *not* > ∀ reading in English. As summarized below, the high-proficiency learners in her experiment chose a *not* > ∀ paraphrase for test sentences (presented in writing, without a context) 70% of the time, reversing the preference manifested in lower proficiency groups. (Proficiency was estimated with the help of a cloze test.)

Table 8 Interpretive preferences in Lee's (2009:68) study of ESL learners

Proficiency	∀ > *not* interpretation	*not* > ∀ interpretation
Low (N=28)	75%	25%
Intermediate (N=28)	65%	35%
High (N=28)	30%	70%
English NS (N=30)	6%	94%

Lee's data gives us reason to think that over time L2 learners receive enough input to strengthen the *not* > ∀ routine at the expense of the routine transferred from Korean, thereby allowing faster and more efficient interpretation of the scopal interpretation preferred by English speakers—an instance of processing amelioration. Additional support for this scenario may eventually come from the longitudinal study of individual language learners, permitting the establishment of a direct correlation between the strengthening of particular interpretive routines and exposure to particular types of input.

5.2.2 Korean as a second language

A further test of the Amelioration Hypothesis comes from the acquisition of Korean by native speakers of English. It is difficult to know what a UG-based theory would predict in this case because of uncertainty concerning the position of the direct object and the negative in L2 learners' representation of Korean sentence structure. (As noted in the discussion of (11) in section 4, each could in principle occur in a higher position than the other, because of the availability of various movement operations.) I will therefore set this matter to the side here.

The prediction of the processing-based theory is clear. If transfer is driven by processing amelioration, it should NOT take place when speakers of English learn Korean. This is because deriving the *not* > ∀ interpretation is more costly in Korean than in English. As explained in detail in section 4.2.2, this reading can only be derived via backtracking in Korean, since the negative is not available when the quantifier is initially encountered, given the language's S-O-Neg-V order.

(22) Routine for deriving the *not* > ∀ interpretation in Korean (backtracking):

$$\begin{bmatrix} \neg\text{PRED} \\ <x\ \forall y> \end{bmatrix}$$

'~~*all y*~~'

⇓

'*not all y*'

Because the implementation of the routine giving the *not* > ∀ reading in Korean is more costly than its implementation in English, transfer from English to Korean should be blocked regardless of the routine's dominance in the former language.

As a preliminary test of this prediction, I devised a simplified scope interpretation task suitable for low- and mid-intermediate learners of Korean, whose vocabulary and comprehension abilities are in general quite limited. The task was administered to ten participants in their late teens and early twenties, all native speakers of English who were enrolled in a fourth-semester Korean language course at a U.S. university. Each participant received a small monetary reward as compensation for their time.

Participants were presented with a booklet that contained a series of Korean sentences, each accompanied by two alternative contextual situations. Their task was to decide which situation the sentence better describes. In the sample test item below, for example, selection of the context on the left indicates a preference for the ∀ > *not* reading, while choice of the context on the right points to a preference for the *not* > ∀ interpretation.

(23) Tom-i motun chayk-ul an ilkesseyo.
(Tom all the books not read)

I gave Tom all the books that he was supposed to read, but he didn't read any of them.	I gave Tom all the books that he was supposed to read, but he read only some of them.

In the actual task, the Korean sentence was presented in the Korean script, without glosses or translation. However, in order to circumvent vocabulary limitations and in order to facilitate a response while the Korean sentence was still fresh in the participants' minds, contexts were presented in English—at the possible risk of oversimplifying the task. There were five test items, randomly interspersed among nine distractors; the entire task took less than ten minutes to complete. Table 9 reports the results.

Table 9 Interpretive preferences for KSL learners

∀ > *not* interpretation	*not* > ∀ interpretation
100%	0

As can be seen here, the L2 learners exhibited an overwhelming preference for the ∀ > *not* interpretation of the Korean test items. In contrast, when a group of ten undergraduate native speakers of English who had never studied Korean were given the same test with English test items, the preference was reversed: the *not* > ∀ interpretation was favored 96% of the time.

Of course, these results do not tell us whether the ∀ > *not* interpretation is the *only* one permitted by L2 learners of Korean. But that is not the relevant issue: as observed earlier, some native speakers of Korean permit both scopal interpretations. The crucial issue for now has to do with which reading is *preferred* and what factors shape that preference. Our results suggest that, like adult native speakers of Korean, intermediate-level second language learners strongly favor the ∀ > *not* interpretation, consistent with the aversion to transfer predicted by the processing theory: the preferred interpretation in L1 English is not carried over to L2 Korean because it has a higher processing cost in the new language. Cost blocks transfer.

Also suggestive here is an interesting asymmetry with respect to the effects of pedagogy in the two languages. I have been assured by several ESL teachers in Korea that the curriculum and textbooks there explicitly draw the attention of students to the favored status of the *not* > ∀ interpretation in English—evidently with little initial effect, as the data in Table 7 shows. In contrast, teachers of Korean as a second language assure me that their students receive no instruction at all relating to the interpretation of scope in Korean; yet, as the findings summarized in Table 8 illustrate, the preferences fall into place immediately. This is the expected outcome, if processing considerations shape the response to input from a second language.

5.3 Summary

As the signature phenomenon in second language acquisition, transfer has the potential to shed light on the fundamental question that we have been considering: is there a specialized grammar-oriented acquisition device, or is language acquisition (including second language acquisition) just processing amelioration? The developmental facts align well with the processing account.

Table 10. The L2 acquisition of scope

L1 and L2	Developmental profile
Korean-speaking learners of English	The dominant ∀ > *not* routine of Korean is transferred to English because it is no more costly in the L2 than in the L1. Exposure to new (but sparse) input in English then provides an eventual opportunity to develop and strengthen the *not* > ∀ routine.
English-speaking learners of Korean	The dominant *not* > ∀ routine in English is not transferred to Korean because it has a higher processing cost in the L2 than in the L1. Instead, the ∀ > *not* reading is favored from the outset.

Of special interest here is the fact that L1 scope preferences are transferred to English from Korean, but not vice versa—just what is expected if the dominant processing routine in the L1 is transferred to the L2 only when the cost of its use doesn't increase in the second language.

In sum, what we think of as development in second language acquisition is just a reflection of processing amelioration, which seeks to ease the burden on working memory by adopting two strategies. On the one hand, it transfers to the L2 only those L1 routines that do not add to processing cost (exemplified here by violation of the unidirectionality criterion)—hence the transfer of the scopal preference for Korean to English, but not vice versa. On the other hand, in response to L2 input, it creates and strengthens new routines, sometimes at the expense of transferred routines—as when the strength of the ∀ > *not* routine that is transferred from Korean to English is surpassed by that of the more frequently activated *not* > ∀ routine (see Table 8). In neither case is there any reason to think that a grammatical rule or parameter setting is in play, or that a specialized acquisition device has brought about an improvement in L2 proficiency. What we see here is simply the work of the processor.

6. Scope in bilingual acquisition

The abstract character of scope, the infrequency of scopal patterns in the input, and cross-linguistic differences in scopal preferences raise an intriguing question: what happens when language learners are exposed to both Korean and English in childhood? Might we find in such circumstances still further evidence for a processing-based approach to linguistic development?

Lee, Kwak, Lee & O'Grady (2011) used the truth-value judgment task exemplified in the appendix to examine the scopal preferences of nine children (aged 6;0 to 11;9—mean age, 8;5) of Korean parents living in Hawaii. The children had all learned Korean first at home, but subsequently been exposed to English for at least four years; they were attending English-language schools and were almost certainly more proficient in English than in Korean, consistent with the classic profile of 'heritage language' learners (Montrul 2008). Indeed, work by O'Grady et al. (2011) on children from similar backgrounds reports problems with even the most fundamental properties of Korean sentence structure, including the role of case markers in identifying subjects and direct objects in the course of comprehension.

This notwithstanding, Lee et al. found the same strong preference for the ∀ > *not* reading in the children's interpretation of Korean scopal patterns that occurs among monolingual speakers of the language. Interestingly, however, the children manifested an unusual pattern of responses to *English* scopal patterns, as summarized in Table 11.[11] (Similar results are reported by Kim 2007 for 15 Korean-English bilinguals aged 5:0 to 7;6 in New York.)

Table 11. Bilingual children's interpretive preferences for English sentences

∀ > *not* context		*not* > ∀ context	
True	False	True	False
100%	0%	59%	41%

The uniform acceptance by bilinguals of the ∀ > *not* interpretation in English (their stronger language) far exceeds their acceptance rate for the *not* > ∀ interpretation, as well as the acceptance rate for the ∀ > *not* interpretation in Musolino & Lidz's study of monolingual English-speaking children (see Table 2). This is a striking finding, suggestive of transfer from Korean, and clearly calls for further investigation, including comparison with results for child second language learners. Even more striking is the fact that the performance of the children was

[11] The children were tested first in Korean (their weaker language), and one or two weeks later in English.

more adult-like in their *weaker* language—they did 'better' in Korean than in English.

Processing considerations offer a straightforward explanation for the dissociation between language dominance and interpretive skill in this case. The scopal preferences of the children were adult-like in Korean because the favored interpretation in that language (∀ > *not*) is determined solely by processing considerations relating to the unidirectionality criterion and is therefore in place from the outset, independent of experience. In contrast, the preferred interpretation in English (*not* > ∀) carries no particular processing advantage and evolves over time in response to input that is sparse even in a monolingual setting.

7. Conclusion

My goal here has been to outline an approach to understanding linguistic development. The key idea, embodied in the Amelioration Hypothesis, is that what we think of as language acquisition is in fact a side effect of the processor's attempts to improve its functioning by favoring and developing particular types of routines. Put another way, the reason that the phenomenon of language acquisition has proven so hard to understand is that it doesn't exist in the form generally assumed. In a very fundamental sense, it is an illusion.

This idea obviously goes far beyond the data currently available to support it, but in the interests of exposition I have offered two illustrations—one involving basic word order, which is instantiated with a high degree of frequency in the input, and the other involving scope, which has a far fainter footprint. Neither phenomenon was treated exhaustively, and many issues obviously remain to be addressed. Nonetheless, it has at least been possible to put forward a thesis for consideration and, hopefully, eventual refinement.

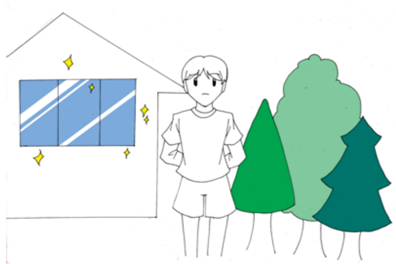
The emergence of language is a milestone event in cognitive development, and a genuine hallmark of humanity. But that tells us nothing about how it happens or what type of cognitive system unfolds. It is obvious that humans are in some sense innately equipped for language. They are born with an exquisite articulatory apparatus, a highly sensitive perceptual mechanism, and an extraordinarily rich conceptual system, as well as the capacity to create mapping relationships among the three. It is likewise beyond dispute that qualitative changes in proficiency take place in response to ongoing exposure to language. But there is no acquisition device, and there are no inborn grammatical constraints or options either. Rather, if the view outlined here is on the right track, the language instinct is just a processing instinct, a propensity to create mappings that make ever-improving use of the brain's limited computational resources. The result is a system of communication whose intricacy is matched only by the marvel of its emergence.

Appendix

The truth-value judgment task employed for Korean

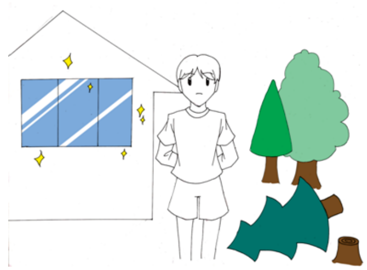
The children's interpretive preferences were assessed with the help of short stories such as the ones illustrated below. Each story, which was presented orally and illustrated with pictures on a laptop computer, consisted of a context-setting situation and a test sentence, produced by a puppet. The child's task was to judge whether the sentence offered an accurate summary of the story.

Sample story supporting a full set interpretation:
Robert is working hard at home. His father wants him to clean three windows and to cut down three trees. Robert says, "Okay, I'll do that." Robert cleans the three windows right away. Then, Robert looks at the first tree. It is very big. So he doesn't cut it down. The second tree looks even bigger. So Robert doesn't cut it down either. Then, Robert looks at the third tree. It is smaller than the other trees. So he thinks that he can cut it down. However, when he is about to start, he realizes that it is his sister's favorite tree. So he doesn't cut it down either.



Test sentence: *Robert didn't cut down all the trees*.

Sample story supporting the partitioned set interpretation:
Robert is working hard at home. His father wants him to clean three windows and to cut down three trees. Robert says, "Okay, I'll do that." Robert cleans the three windows right away. Then, Robert looks at the first tree. It is very big. So he doesn't cut it down. The second tree looks even bigger. So Robert doesn't cut it down either. Then, Robert looks at the third tree. It seems very big too. But he decides to try, and he manages to cut it down.



Test sentence: *Robert didn't cut down all the trees*.

There were three test items per condition, arranged in a Latin square design so that none of the subjects heard the same test item in more than one context. The experimental protocol also included two practice items and four filler items.

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