

# 4 Anaphora and the Case for Emergentism

WILLIAM O'GRADY

## 1. Introduction

This essay focuses on two questions of fundamental importance to cognitive science.

1. Why does language have the particular properties that it does?
2. How is language acquired in response to the particular types of experience that children receive in the first years of life?

In a sense, the answer to both questions is obvious. Human language is the way it is, and children learn it so successfully, because it is a good fit for the brain. Everyone believes this, and the point is frequently made in one form or another by scholars whose views otherwise differ (Chomsky 2007; Christiansen and Chater 2008, to take just two examples). But what features of the human brain create and mediate the fit? The list of possible contributors, summarized by Chomsky (2005), is practically self-evident: (1) inborn principles of grammar, if there are any; (2) a capacity for extracting regularities from experience; and (3) the influence of perception, processing, economy, and cognition (the so-called “third factor”).

The first factor has been the central concern of work on classic Universal Grammar (UG), as developed by Chomsky (1981) and many others. Within much of cognitive science, though, increasing attention has been devoted to the second factor, as evidenced by the growth of research focused on statistical learning (Elman 2002; Chang, Dell, and Bock 2006; Saffran 2003; Kaschak and Saffran 2006; Sebastián-Gallés 2007; Xu and Garcia 2007; McMurray and Hollich 2009; Chater and Christiansen 2010; Romberg and Saffran 2010; Thiessen and Erickson, chapter 18, this volume; and McCauley, Monaghan, and Christiansen, chapter 19, this volume, among many others). Soderstrom, Conwell, Feldman, and Morgan (2009: 409) go so far as to call this approach “the new paradigm of language acquisition.”

However, as widely acknowledged by emergentists and non-emergentists alike, the input provides essentially *no* information about why language has the properties that it does; it simply exemplifies those properties, with varying degrees of frequency and

transparency (e.g., Saffran 2003: 110; O'Grady 2008: 457; Goodluck 2011: 49; Chomsky 2011: 272; MacDonald, chapter 3, this volume). This means that emergentism must look elsewhere to understand why languages permit certain patterns and not others. A third factor – something other than UG and statistical learning – must be in play.

In all likelihood, there is no single “third factor,” of course; a wide variety of forces are almost surely involved. But some appear more promising than others, and none more so than the exigencies associated with real-time processing – a common object of attention in explanatory work within a variety of theoretical frameworks (Fodor 1978; Saffran 2003: 110; Hawkins 2004; Newmeyer 2005; O'Grady 2005, 2008; Sebastián-Gallés 2007; Chater and Christiansen 2010; MacDonald, chapter 3, this volume, among countless others). My goal here is to explore the role of processing pressures in an explanatory account of anaphora, a phenomenon whose intricacy and complexity make it an instructive case study.

The interpretation of reflexive pronouns presents a twofold challenge. On the one hand, there is the challenge of understanding why English and so many other languages permit the patterns of co-reference in (1), but not those in (2)?<sup>1</sup> (I follow the traditional practice of using subscripted co-indexing to indicate referential dependencies.)

(1) Some acceptable patterns of anaphora:

- a. Jerry<sub>j</sub> hurt himself<sub>j</sub>.
- b. [Mary's brother]<sub>b</sub> hurt himself<sub>b</sub>.
- c. Mary thinks [Jerry<sub>j</sub> hurt himself<sub>j</sub>].

(2) Some unacceptable patterns of anaphora:

- a. \*Jerry<sub>k</sub> hurt themselves<sub>k</sub>. (referring to a previously mentioned group)
- b. \*[Mary's<sub>m</sub> brother] hurt herself<sub>m</sub>.
- c. \*Mary<sub>m</sub> thinks [Jerry hurt herself<sub>m</sub>].

On the other hand, there is the problem of explaining how children come to know which patterns of co-reference are acceptable. As we will see, the opportunity to hear reflexive pronouns used in adult speech is more limited than might be expected, especially in light of the intricacy of the constraints on their interpretation.

These are substantial challenges that take us well beyond most emergentist work on syntax, which tends to focus on topics such as word segmentation, category assignment, subject–verb agreement, and other fairly basic matters. Phillips (2013: 134) characterizes such phenomena as “too simple to be interesting” – a harsh assessment perhaps, but one that reflects a general feeling among linguists that the real challenge for emergentism lies in confronting the complex puzzles upon which the case for Universal Grammar has been built. Anaphora is one such puzzle. An understanding of its workings is crucial to the case for emergentism, both as a proof of concept and as an illustration of how the study of “higher-order” phenomena might fit into the larger emergentist enterprise surveyed in this book.

I begin by outlining a processor-driven system for mapping form onto meaning (section 2), from which it is possible to derive a compelling explanation for the syntax of co-reference (sections 3 and 4). Section 5 addresses the question of language acquisition, arguing that the processing account both obviates the need for UG and minimizes the role of statistical learning.

## 2. Sentence Processing

By definition, processing consists of a series of actions that bring about a result. In the case of cognition, these actions correspond to mental operations, as when a particular pattern of light on the retina is interpreted by the visual system as the image of a house, or a particular pattern of acoustic vibrations is interpreted by the auditory system as the sound of birdsong, or a sentence is interpreted by the linguistic system as a description of a particular event.

It is commonly assumed (and I concur) that at least two different types of processing are required to map strings of words onto proposition-type meanings in the course of comprehension. SENTENCE-LEVEL (OR STRUCTURAL) PROCESSING is concerned with the form and composition of the utterance, including the lexical properties of its component words, their linear relationship to each other, and their morphological form. Drawing on this information, the sentence-level processor should be able to return a result for *He ate it* that includes at least the information depicted in the rudimentary semantic representation in (3), which describes an eating event, in which an agent  $x$  acts on a theme  $y$ .

- (3)        EAT  
          < $x$   $y$ >

Such information is indispensable to the sentence's interpretation, of course, but it says nothing about the identity of the predicate's two arguments (hence the variables  $x$  and  $y$ ). In the case at hand, this information must be inferred from the linguistic and situational context rather than from the structure of the sentence itself – a procedure that calls for PRAGMATIC PROCESSING.

### 2.1 Direct mapping

The standard view of processing holds that the sentence-level processor, assisted by a grammar, maps a string of words onto a syntactic structure, which is then converted into a semantic representation with the help of additional grammatical principles (Frazier 1998; Levelt 1989; Regier, Kemp, and Kay, chapter 11, this volume). Let us call this "mediated mapping" (Figure 4.1), in recognition of the intermediary role played by syntactic structure in converting form to meaning and vice versa. I adopt a different view: processing maps a string of words directly onto a semantic representation without the mediation of grammatical principles or syntactic structure, an instance of "direct mapping" (Figure 4.2) in the sense of Bates and MacWhinney (1987: 163).

The sentence-level processor that I have in mind makes use of operations that comply with three relatively uncontroversial assumptions.

1. They operate in an incremental manner, attempting an interpretation of each word as it is encountered and immediately integrating the result into the semantic representation for the sentence.
2. The physical form of a word is dismissed from active working memory as soon as it is interpreted; all that remains is the interpretation, as recorded in the semantic

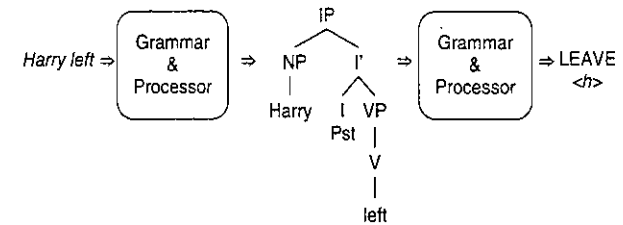


Figure 4.1. Mediated mapping: The processor, assisted by the grammar, maps a string of words onto a syntactic structure, which in turn is mapped onto a semantic representation

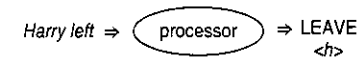


Figure 4.2. Direct mapping

representation. (This doesn't mean that we never remember exactly what we say or hear. It just means that such feats of memory are not required for ordinary language use.)

3. Over time, the processing routines responsible for form–meaning mapping are strengthened with use, until they become so deeply entrenched that they apply automatically (see O'Grady 2013b for one proposal about how this works).

### 2.2 An example

The example below offers a simple illustration of how a sentence-level processor that satisfies these three assumptions goes about mapping the sentence *Robin met Terry* onto a basic semantic representation in an incremental left-to-right manner. The processing routines illustrated here carry out various operations, including the association of proper names with referents, the activation of lexical information (e.g., argument structure), and the use of information about form and position to associate particular referents with particular argument positions.

- (4) How sentence-level processing might map the sentence *Robin met Terry* onto a semantic representation in real time:

- a. The nominal *Robin* is assigned a referent (represented here as the index  $r$ ), and identified as likely first argument of a still-to-be-determined predicate. The nominal itself is immediately discarded, as indicated by the strike-through.

~~Robin~~  
PRED  
< $r$  ...  
↑

The referent of *Robin* corresponds to the first argument of an anticipated predicate.

- b. The transitive verb *meet* is encountered and its two-place predicate–argument structure is accessed and integrated into the semantic representation, with Robin as its first argument.

*Robin met*  
MEET  
< r \_ >

- c. The nominal *Terry* is assigned a referent (represented by the index *t*), and is interpreted as the predicate's second argument.

*Robin met Terry*  
MEET  
< r t >  
↑

The referent of *Terry* corresponds to the verb's second argument.

The end result is a semantic representation consisting of the predicate MEET, and its arguments *Robin* and *Terry*. This is of course not a full representation of the meaning of the sentence *Robin met Terry* (for example, it contains no information about number, gender, tense, aspect, or modality), but it will allow us to proceed to the principal focus of this chapter – the syntax of anaphora.

### 3. A Processing-Based Approach to Pronoun Interpretation

I take the key property of pronouns, including anaphors, to be that they introduce a referential dependency: they pick up their interpretation from some other element (the “antecedent”), usually previously mentioned. Thus, upon encountering a reflexive pronoun, the processor projects a referential dependency, represented in (5) as *x*.

- (5) *Jerry hurt himself* ...

HURT  
< j x >  
↑

The verb's second argument is identified as an anaphor, leading to the projection of a referential dependency

In the theory that I propose, the processor responds to a referential dependency by seeking to resolve it at the first opportunity, consistent with a general commitment to minimizing processing cost.

- (6) The referential dependency introduced by an anaphor is resolved immediately, if possible.

This leaves just one option in patterns such as (5). At the point where the reflexive pronoun is encountered and identified as the verb's second argument, only the index

of the verb's first argument (*Jerry* in the case at hand) is immediately available to resolve the referential dependency. The processor reacts accordingly, returning this interpretation, thereby capturing Jespersen's (1933: 111) intuition that canonical reflexive pronouns have a co-argument antecedent – a generalization that is implemented in one way or another in all work on anaphora.

- (7) *Jerry hurt himself* ...

HURT  
< j x >  
↓  
j

Notice that the processor operates on the semantic representation itself, not on a conventional syntactic structure (which it does not attempt to construct) and not on the string of input words (each of which is dismissed from working memory as it is interpreted).

Now consider the unacceptable pattern in (8).

- (8) \**Jerry<sub>i</sub> hurt themselves<sub>x</sub>*.

HURT  
< j x >  
↓  
\*j

Here too the processor is compelled to take advantage of the index already present in the predicate's argument grid to resolve the referential dependency introduced by the reflexive pronoun. But this time the interpretation is incoherent because of a feature mismatch (*Jerry* is a single individual, but *themselves* requires a plural antecedent). The sentence is thus unacceptable – exactly the right result.

Consider next the pattern in (9), in which the verb's first argument is expressed by the complex expression, *Mary's brother*.

- (9) \*[*Mary's brother*] hurt herself.

In an initial step, the processor assigns a referent to *Mary's brother*, represented here by the index *b*, and tentatively identifies it as the first argument of a still-to-be-determined predicate.

- (10) \**Mary's brother* ...

PRED  
< b ... >

In the next step, it identifies *hurt* as the predicate, and adjusts the semantic representation accordingly. (Note that *Mary* is not an argument of the predicate and therefore does not appear in its argument structure.)

- (11) \**Mary's brother hurt* ...

HURT  
< b \_ >

Upon subsequently encountering the reflexive pronoun, the processor has no choice but to link it to the immediately available index of *Mary's brother*, creating a gender mismatch and an unacceptable interpretation.

- (12) \*Mary's brother hurt himself.\*  
 HURT  
 <b x>  
 ↳ \*b

Finally, consider the case of bi-clausal sentences such as (13), in which the reflexive pronoun must find its antecedent in the inner clause: *himself* can refer to Jerry, but not to Richard.

- (13) [Richard<sub>r</sub> thinks [Jerry<sub>j</sub> hurt himself<sub>j/r</sub>]].

On the processing account, this interpretation arises because only the index of *Jerry* is immediately available at the point at which the anaphor is interpreted as the second argument of *hurt*. There is therefore no option other than to select it as antecedent.

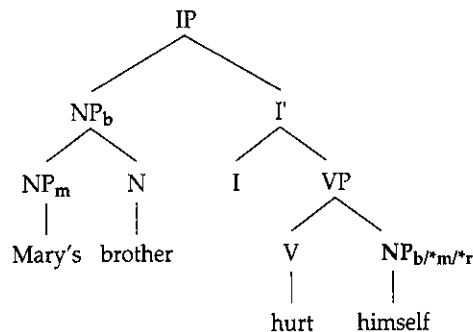
- (14) Richard<sub>r</sub> thinks Jerry<sub>j</sub> hurt himself.  
 ... HURT  
 <j x>  
 ↳ j

In all the cases considered thus far, the sentence-level processor implements a highly efficient routine for dealing with English reflexive pronouns: referential dependencies are resolved immediately (hence locally) with the help of information available in the portion of the semantic representation that is highly activated at the point where the anaphor is encountered. This can be summarized as follows.

- (15) Interpretive routine for reflexive pronouns:  
 Resolve the referential dependency immediately.  
 <α ... x ... >  
 ↳ α

The end result is a system of interpretation that gives the illusion of syntactic sophistication, in that the selected antecedent seems (in traditional terms) to always be an NP that is in a structurally higher position within the same clause – precisely the requirement imposed by Principle A of Chomsky (1981).<sup>2</sup>

- (16) Richard<sub>r</sub> thinks that ...



But, in fact, no syntactic representation is consulted (or even constructed). Rather, as we have seen, the facts follow entirely from the manner in which the processor does its work as it goes about mapping form onto meaning in a manner than minimizes operating cost.

A core tenet of emergentist theory is that the complexity that we find at the level at which linguistic phenomena are traditionally described arises from the effects and interaction of much simpler forces at other levels. As we will see in the next two sections, this line of analysis has implications both for our understanding of anaphora as a linguistic phenomenon and for our understanding of the developmental forces that shape its emergence in children.

## 4. A Deeper Look

The facts of anaphora merit a deeper and broader look, as the examples considered thus far provide no more than a quick overview of a phenomenon whose intricacy has long been an object of marvel. Readers who wish to focus on developmental matters are invited to proceed directly to section 5.

### 4.1 Understanding locality

A key component of the analysis I have proposed is that the interpretation of reflexive pronouns is engineered by the processing operations that create the mapping between form and meaning in the real-time course of language use. This is very different from a system in which co-reference is determined by scanning a string of words and selecting the linearly closest antecedent – an approach that fails even for the basic patterns illustrated in (17).

- (17) a. A friend [of Jerry<sub>j</sub>] overestimates himself<sub>j</sub>.  
 b. The girl [who Mary<sub>m</sub> likes] introduced herself<sub>m</sub>.

Here, as Orfitelli and Polinsky (2013) note (see also Cunnings and Felser 2013: 190), linear proximity selects the wrong antecedent – *Jerry* in (17a) and *Mary* in (b).

In the system I propose, there is no direct access to previously processed words, which are dispensed with as soon as they are interpreted. Instead, the processor seeks out opportunities to resolve referential dependencies in the semantic representation that it is constructing. Crucially, at the point where the reflexive pronoun is encountered in a sentence such as (17a), the semantic representation offers just one option for resolving the referential dependency – the predicate's first argument, *a friend of Jerry*, represented below by the index *f*. This is exactly the right result.<sup>3</sup>

- (18) A friend of Jerry overestimates himself.  
 OVERESTIMATE  
 <f x>  
 ↳ f

Example (17b) works in a parallel way: the only available option for the immediate interpretation of the reflexive pronoun is the first argument of *introduce*, namely *the girl who Mary likes*, represented below as the index *g*. (Notice that *Mary* is not an argument of *introduce* and therefore does not appear in its argument grid.)

- (19) ~~The girl who Mary likes~~ introduced herself ...

INTRODUCE  
 <g x>  
 ↓g

A somewhat different issue arises in patterns such as the following.

- (20) a. John described Bob to himself.  
 b. Mary showed Jane herself in the mirror.

Here, there is potential ambiguity in the interpretation of the anaphor, as can be seen by replacing one or the other of the names with a first person pronoun.

- (21) a. I described **Bob** to **himself** (so that he would know how others see him).  
 b. **Bob** described me to **himself** (so he wouldn't forget what I looked like).

If we equate immediate availability with proximity, the sentences in (20) should permit only the postverbal NP to serve as antecedent, which is clearly false. In contrast, the analysis that I propose predicts ambiguity: at the point where the reflexive pronoun is encountered in a pattern such as (20a), the processor has constructed the partial semantic representation depicted below.

- (22) ~~John~~<sub>1</sub> described ~~Bob~~<sub>2</sub> to himself.

DESCRIBE  
 <j b ... >

As can be seen here, *two* potential antecedents are available in the verb's argument grid – the referent of *John* and the referent of *Bob*. Either can be used to immediately resolve the referential dependency, thereby giving the observed ambiguity.

Yet another challenge is raised by Chomsky (2011: 273), who suggests that a processing-based approach fails in patterns such as (23) – once again because of the (irrelevant) fact that the antecedent is not the nearest NP in the linear string.

- (23) Who<sub>w</sub> do you<sub>y</sub> think [<sub>1</sub> overestimated himself<sub>w</sub>]?

In fact, such sentences manifest a straightforward interaction between filler–gap dependencies and referential dependencies. As illustrated in (24), the filler–gap dependency is resolved by identifying *who* as first argument of the predicate *OVERESTIMATE* (*w* = the index of *who*).

- (24) Resolution of the filler–gap dependency:

Who<sub>w</sub> do you<sub>y</sub> think overestimated ...  
 ... OVERESTIMATE  
 <w ... >  
 ↑

the *wh*-word is identified as the predicate's first argument

At the point where the reflexive pronoun is subsequently encountered, the argument grid for *overestimate* makes available just one opportunity to immediately resolve the referential dependency – via the index of the *wh*-word. This is just the right result.

- (25) Resolution of the referential dependency:

Who<sub>w</sub> do you<sub>y</sub> think overestimated himself<sub>x</sub>?  
 ... OVERESTIMATE  
 <w x>  
 ↓w

A second sort of interaction between filler–gap dependencies and referential dependencies arises in the following contrast.

- (26) a. Who<sub>w</sub> did you<sub>y</sub> describe \_ to himself<sub>w</sub>?  
 b. \*Who<sub>w</sub> did you<sub>y</sub> describe himself<sub>w</sub> to \_?

The second of these sentences exemplifies a “crossover effect”: the *wh*-word (the intended antecedent) appears to have moved across the anaphor, in contrast to the situation in the acceptable first pattern. Long thought to be a reflection of abstract syntax, the difference follows straightforwardly from processing considerations.

In the acceptable (26a), the filler–gap dependency is resolved at the verb, where the *wh*-word is identified as second argument of the predicate *DESCRIBE*. This in turn makes the index of *who* available to assist in resolution of the referential dependency when the anaphor (the verb's third argument) is subsequently encountered.

- (27) a. Resolution of the filler–gap dependency:

Who<sub>w</sub> did you<sub>y</sub> describe ... ?  
 DESCRIBE  
 <y w ... >  
 ↑

the *wh*-word is identified as the verb's second argument

- b. The reflexive pronoun is encountered and the referential dependency resolved:

Who<sub>w</sub> did you<sub>y</sub> describe to himself<sub>x</sub>?  
 DESCRIBE  
 <y w x>  
 ↓w

In the unacceptable (26b), in contrast, the reflexive pronoun, not the *wh*-word, is the verb's second argument and its referential dependency must therefore be dealt with before the filler-gap dependency is resolved, as illustrated below.

(28) Attempt to interpret the reflexive pronoun upon encountering it:

Who<sub>w</sub> did you<sub>y</sub> describe himself<sub>x</sub> ...?  
 DESCRIBE  
 <y x ...>  
 ↓\*y

As can be seen here, the only opportunity for immediate resolution of the referential dependency comes from the index of *you*, resulting in a person-feature mismatch and an unacceptable sentence.

## 4.2 Exempt anaphora

All of the examples considered so far involve interpretation of the anaphor via action by the sentence-level processor, whose primary concern is the immediate and local resolution of the referential dependency in the available semantic representation. Crucially, however, this cannot be the whole story, as shown by the next set of examples.

- (29) a. Richard's diary contained [a flattering description of himself].  
 b. Richard didn't think [that Mary should see those two pictures of himself].  
 c. Richard was furious. It was because [a rumor about himself was circulating on the Internet].

In (29a), the element to which the anaphor looks for its interpretation is not an argument of the verb around which the clause is built; in (b), it lies in a different clause; and in (c), it is located in a different sentence altogether. All three examples illustrate what Pollard and Sag (1992) dub "exempt anaphora": a referential dependency somehow escapes the usual interpretive strictures and is interpreted pragmatically, giving a reading that could also be expressed by a plain pronoun such as *him*. The processing approach offers an attractive account of how this can happen.

The key feature of the patterns in (29) is that the reflexive pronoun occurs in a position that does not permit immediate resolution of the referential dependency. This can be seen by considering (29b) in more detail: at the point where the processor comes upon the reflexive pronoun and identifies it as the (sole) argument of *pictures*, there is no other index in its argument grid to assist in the immediate resolution of the referential dependency.

(30) pictures of himself<sub>x</sub>

PICTURE  
 <x>  
 ↓?

I have proposed elsewhere (e.g., O'Grady 2005: 40ff.) that under these circumstances the sentence-level processor stands to the side, surrendering responsibility for the

referential dependency to the pragmatic processor. Drawing on the resources and information available to it, this system then seeks out a pragmatically prominent antecedent (*Richard*, in the example at hand) to resolve the referential dependency (*P* = pragmatic processor).

(31) Richard didn't think [that Mary should see those two pictures of himself]

... PICTURE  
 <x>  
 ↓  
 P  
 ↓ Richard

Of course, no such option is available in patterns such as (32), where the reflexive pronoun is assigned to the argument grid of the verb *overestimate*, which offers an immediate opportunity to resolve the referential dependency via the index of *Mary*. This gives a gender mismatch and an unacceptable sentence.

(32) \*Richard didn't think [that Mary should overestimate himself]

... OVERESTIMATE  
 <m x>  
 ↓ \*m

In sum, we end up with the system summarized in (33), in which the first chance to interpret the reflexive pronoun falls to the sentence-level processor, which attempts immediate local resolution of the referential dependency. In the absence of such an opportunity, responsibility for the interpretation of the reflexive pronoun is passed to the pragmatic system, which seeks out a prominent antecedent without regard for locality.

(33) Interpretive protocol for reflexive pronouns in English:

- Resolve the referential dependency immediately, if possible (e.g., (32)).  
 <α ... x ...>  
 ↓ α
- If immediate resolution is impossible, transfer the referential dependency to the pragmatic system (e.g., (31)).

<... x ...>  
 ↓  
 P

## 4.3 Cross-linguistic variation

Space does not permit a detailed discussion of cross-linguistic differences in the interpretation of reflexive pronouns, but principled variation is possible. For example, there appear to be languages that do not allow recourse to pragmatic processing in the interpretation of reflexive pronouns: if the referential dependency cannot be resolved

immediately and locally, it is simply rejected. Thus (34) is acceptable in French, with the reflexive pronoun (*se*) picking up its reference from its co-argument, *Paul*.

- (34) Paul *se* décrira à tout le monde.  
Paul self describe.FUT to all the world  
'Paul will describe himself to everyone.'

But a *se* reflexive is not permitted where there is no immediate opportunity for resolution of the referential dependency, as in clauses with an expletive subject.

- (35) Paul dit [qu'il lui/ \*s'est arrivé un problème].  
Paul say that there to.him/himself happened a problem.  
'Paul says that there happened to him/himself a problem.'

Korean illustrates yet another possibility: it relies solely on pragmatic processing for its interpretation of reflexive pronouns, thereby allowing a discourse-prominent extra-sentential antecedent even when a more local option is available (O'Grady 1987, 2013a). The following example is from Kang (1988: 425).

- (36) John-i kyengchalse-ey kassta. Secang-i caki-lul hochwulhaysski ttaymwun-iessta.  
John-Nom police station-to went. Chief-Nom self-Acc summon because-was  
↑  
'John went to the police station. It was because the chief had summoned him.'

On the other hand, consistent with the involvement of the pragmatic processor, a different choice of verb can lead to a local interpretation, as in the following example from Choi and Kim (2007); see also Han and Storoshenko (2012).

- (37) Hyosawen-i [annaywen-i caki-lul kwasihayss-tako] malhayssta.  
businessman-Nom helper-Nom self-Acc boasted-that said  
'The businessman<sub>s</sub> said that the helper<sub>n</sub> had boasted about self<sub>n</sub>.'

Table 4.1 summarizes the options that we have been considering.

In sum, processing pressures do not impose a single system of co-reference, any more than evolutionary pressures yield a single species. Rather, as we have just seen, the interplay between the sentence-level processor and the pragmatic processor (one of many factors relevant to processing) can result in a variety of options, each underpinning a system of co-reference attested in one or another language.

## 5. Language Acquisition

If we are on the right track, constraints on pronoun interpretation emerge from the manner in which referential dependencies are resolved in the course of processing. In the case of English, on which we focus here, the leading idea is that anaphor interpretation is primarily regulated by the sentence-level processor, whose commitment to the

Table 4.1. A partial taxonomy for reflexive pronouns

Type of processing commitment	Diagnostic properties
Action by the sentence-level processor alone (e.g., French <i>se</i> )	Interpretation is strictly local, with exclusive focus on immediately available arguments in the same grid
Action by the pragmatic processor alone (e.g., Korean <i>caki</i> )	The possibility of either a local or a non-local antecedent
Action by both processing systems; the first opportunity to resolve the referential dependency falls to the sentence-level processor, which acts only if there an opportunity for immediate resolution; otherwise, the dependency is passed to the pragmatic processor (e.g., English <i>Xself</i> )	A local antecedent is selected if available in the verb's argument grid; otherwise, a distant antecedent can be selected, provided that it is sufficiently prominent in the discourse.

Table 4.2. Instances of pronoun types in maternal speech to Adam, Eve, and Sarah

	Reflexive pronouns	Plain pronouns
3rd masc sg	15 ( <i>himself</i> )	292 ( <i>him</i> )
3rd fem sg	1 ( <i>herself</i> )	1079 ( <i>her</i> )
3rd pl	1 ( <i>themselves</i> )	465 ( <i>them</i> )
Total	17	1836

immediate resolution of referential dependencies yields the broad range of facts and contrasts considered in the two preceding sections.

Intriguingly, this system of co-reference appears to emerge with relatively little help from the input. A search that I conducted of speech to Adam, Eve, and Sarah in the CHILDES database revealed few instances of reflexive pronouns in maternal speech, in contrast to the situation for plain pronouns (see Table 4.2). A comparable asymmetry is reported for *myself* and *me* by Bloom, Barss, Nicol, and Conway (1994: 59).

This notwithstanding, a variety of comprehension studies (see Guasti 2002: 285 for a review) have demonstrated that children typically interpret reflexive pronouns correctly from the earliest point at which they can be tested; even three-year-olds can be right more than 95% of the time. Thus they correctly respond 'yes' when asked whether the penguin in Figure 4.3 is hitting himself. How can children do so well, based on so little experience?

An intriguing feature of the processing account of reflexive pronouns is that it leaves very little for children to learn, other than the form of the pronoun itself (e.g., *himself*, not *hissself*, in standard English) and the fact that it introduces a referential dependency. Beyond that, we need only assume that a child's brain seeks to process linguistic input in

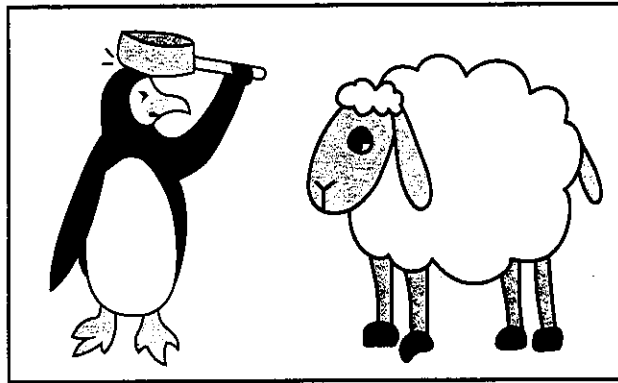


Figure 4.3. Sample picture from Van Rij et al. (2010: 749). © 2010 Cambridge University Press. Reprinted with the permission of Cambridge University Press

a way that minimizes operating cost, just as an adult brain does. This guarantees a preference for the immediate resolution of referential dependencies – just what is needed to get the right results for reflexive pronouns.

### 5.1 The developmental profile for reflexive pronouns

On the view I adopt, what we think of as language acquisition is actually just processing improvement – the gradual strengthening of one routine at the expense of competitors until the weaker routines are totally suppressed (O'Grady 2013b). This scenario receives support from recent experimental work on the development of anaphora.

In an eye-movement monitoring experiment conducted by Clackson, Felser, and Clahsen (2011), 40 children aged 6–9 and 40 adults (mean age 21;3), all native speakers of English, heard test sentences such as the following as they looked at an accompanying set of pictures (Figure 4.4).

*Peter was waiting outside the corner shop. He watched as Mr. Jones bought a huge box of popcorn for himself over the counter.*

The key variable involved the direction of eye gaze at the point where the reflexive pronoun was heard. Clackson et al.'s results point toward two different types of processing activity.

On the one hand, the children show signs of temporarily considering Peter as antecedent, suggesting activity by the pragmatic processor, which is sensitive to discourse prominence. (Peter is mentioned first, is encoded as subject of the lead-in sentence, and is referred to twice before the reflexive pronoun is encountered.)

On the other hand, the children end up picking Mr. Jones as the antecedent 90% of the time. This suggests that the sentence-level processor too is active, successfully selecting an antecedent that is immediately available in the argument grid containing the reflexive pronoun. (As depicted in (38), both *Mr. Jones* and *himself* are arguments of the predicate *buy*.)

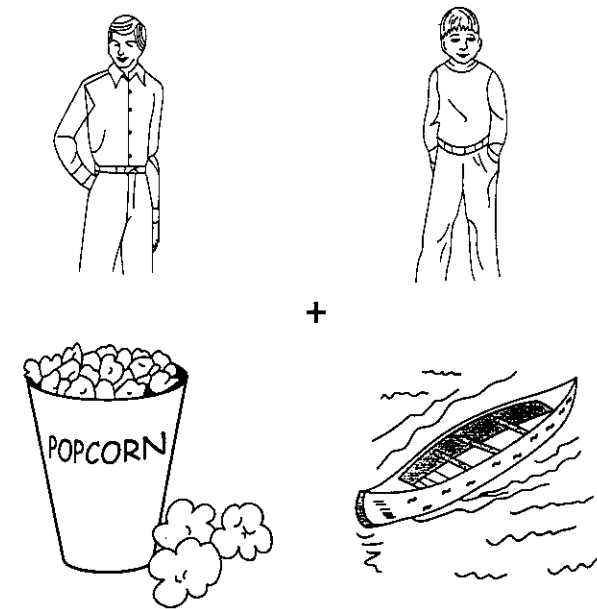


Figure 4.4. Sample picture from Clackson et al. (2011: 143). The man in the upper left is Mr. Jones; the boy in the upper right is Peter. The canoe is a distractor. © Elsevier

(38) He watched as Mr. Jones bought popcorn for himself.

... <jpx>  
bj

The competition between the two types of processing is most evident in childhood: the effect of pragmatic prominence (looks to Peter) was stronger in the six- and seven-year-olds than in eight- and nine-year-olds, and there were only slight signs of its presence in the adult participants.

This suggests that learners are initially subject to two competing forces. On the one hand, there is pressure from working memory that encourages use of a sentence-level interpretive procedure (call it "Routine S") that focuses on immediacy. On the other hand, there is an attention to prominence that is more compatible with discourse-sensitive pragmatic processing ("Routine P").

By age 3, the sentence-level routine establishes its dominance over its pragmatic counterpart, perhaps because of its overall lower operating cost (see section 5.2), and becomes the first recourse for the interpretation of reflexive pronouns. That is why interpretive judgments are correct the vast majority of the time in Clackson et al.'s six-year-olds and in the even younger children studied in other experiments (e.g., the three-year-olds in Chien and Wexler 1990). Over the next several years, the dominance of the sentence-level routine increases to the point where it pre-empts activation of the pragmatic processor when a reflexive pronoun is encountered in a pattern that permits a local interpretation.<sup>4</sup>



That is why Clackson et al.'s eye-gaze data shows competition between the two processing systems in children, but not adults.

The developmental profile for the processing routines used for the interpretation of reflexive pronouns can therefore be summarized as follows:

Time Frame	Relative strength of processing routines
Very early	ROUTINE S – ROUTINE P
By age 3	ROUTINE S – ROUTINE P
After age 12	ROUTINE S – ROUTINE P

Interestingly, children's interpretation of plain pronouns such as *him* and *her* also offers support for the general picture of development that I have proposed.

## 5.2 The developmental profile for plain pronouns

As first reported by Chien and Wexler (1990) and subsequently confirmed with great methodological care by Conroy, Takahashi, Lidz, and Phillips (2009), pre-school children do less well on plain pronouns than on reflexive pronouns. In situations such as the one in Figure 4.5, they often accept as true the sentence *The penguin is hitting him*, apparently interpreting the plain pronoun *him* as if it were the reflexive pronoun *himself*.

If we consider just the input, children's greater success on reflexives is puzzling, as plain pronouns are many times more frequent in experience than their reflexive counterparts, as reported in section 5.1. However, the facts make sense from a processing perspective. Unlike reflexive pronouns, whose referential dependency can be resolved immediately and locally at very minimal processing cost, the interpretation of plain pronouns calls for action by the pragmatic processor. This is because plain pronouns have

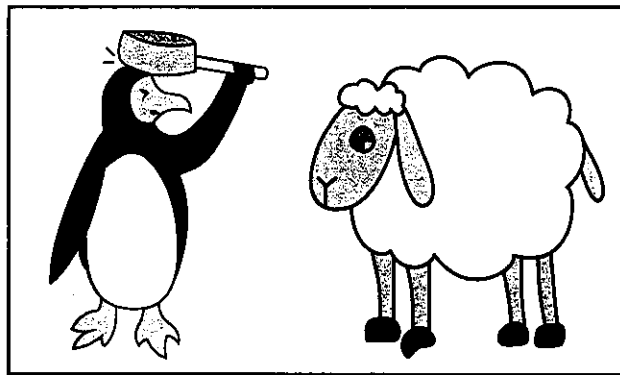


Figure 4.5. Sample picture from Van Rij et al. (2010: 749). © 2010 Cambridge University Press. Reprinted with the permission of Cambridge University Press

a crucial role in linking sentences to situations, selecting antecedents that are prominent in the discourse without regard for locality (Song and Fisher 2007; Foraker and McElree 2007, among others). As noted by Reinhart (2006: 181ff.) and Reuland (2011: 127), the search for an appropriate antecedent in such cases can be a demanding enterprise; it often extends beyond the sentence at hand, and may even require the use of non-linguistic cues (as when a speaker nods in the direction of a stranger and says "He looks lost").

It seems plausible to suppose that early errors with plain pronouns reflect an urge to avoid those additional demands, consistent with the frequent observation that children have more difficulty than adults weighing and integrating information from different sources (e.g., Clackson, Felser, and Clahsen 2011: 140 and the references cited there). Put simply, children interpret plain pronouns as if they were reflexive pronouns because that strategy incurs less processing cost.

Independent support for this idea comes from two sources. First, children appear not to make systematic errors of this type in their own speech: there is no tendency to use a reflexive in place of a plain pronoun in production (Bloom et al. 1994). This makes sense from the perspective I have adopted: because speakers already know the referent of the pronominal forms they are producing, the processing pressures that underlie the search for an antecedent in comprehension are neutralized.

Second, Love, Walenski, and Swinney (2009) report that children aged 5 to 13 improved dramatically in their interpretation of plain pronouns in a picture selection task (see Figure 4.6) when the test sentences were presented more slowly (at the rate of 3.19 syllables per second rather than 5 syllables per second).

(39) The turtle with the hard shell is rubbing *him/himself* with suntan oil on the sandy beach.

This is just what we would expect if errors in the interpretation of plain pronouns reflect an increased stress on processing resources: lessening the processing demands (as Love et al. did by giving children more time to carry out the necessary interpretive procedures) should lead to improved performance. Van Rij, van Rijn, and Hendriks (2010) report similar results for Dutch children aged 4 to 6; see Bergmann, Paulus, and Fikkert (2012) for further evidence that pronoun interpretation is fragile and susceptible to task effects.

## 5.3 Discussion

The processing approach to anaphoric interpretation offers a compelling account of language acquisition in two respects. First, it provides a plausible account for how children are able to converge on the correct interpretation of reflexive pronouns at such an early age, despite ongoing problems with plain pronouns that are far more frequently instantiated in the input. Second, it offers a seamless account of development, which is reduced to processing amelioration: processing routines emerge, are strengthened, and ultimately become entrenched, creating a sophisticated system of pronoun interpretation along with the illusion that grammatical principles are involved.

In both cases, the "heavy lifting" is done by the processor, whose commitment to minimizing operating cost defines the initial option (immediate resolution of referential

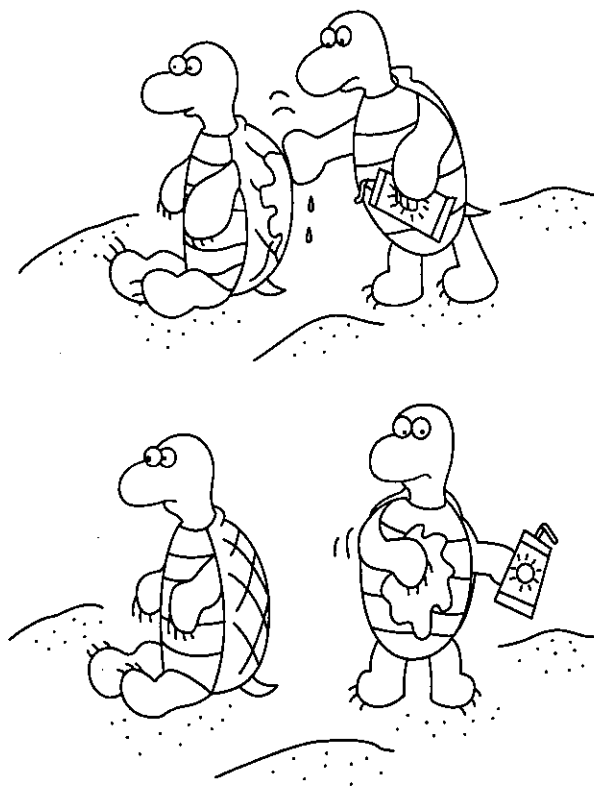


Figure 4.6. Sample picture from Love et al. (2009: 297)

dependencies). One way to think about this is to imagine that low processing cost creates an “attractor state” in the sense of van Geert and Verspoor (chapter 24, this volume), which favors certain types of processing routines over others, including the routine that implements immediate resolution of referential dependencies. This in turn shapes much of what we think of as development, including early success on reflexive pronouns and (some) early difficulty with plain pronouns. The role of input is minimal.

This is an attractive scenario, even for proponents of an input-based approach to language learning. To the extent that so much, including the general character of the routines themselves, is determined by processing pressure, the prospects for successful input-based statistical learning are enhanced in places where it is genuinely needed. One such place involves the morphological shape of reflexive pronouns.

There are idiosyncrasies in the way in which reflexive pronouns are constructed in English – sometimes from the possessive form of the plain pronoun (*myself*, *yourself*, *ourselves*), and sometimes from the objective form (*himself*, not *\*hissself*; *themselves*, not *\*theirselves*). Interestingly, there is some indication that errors run in just one direction during language acquisition. Even children learning standard English sometimes produce *hissself* for *himself*, but they apparently don't say *youself* for *yourself*.

The case of Adam is instructive in this regard. The CHILDES database (biweekly samples over a two-year period beginning when Adam was 2;3) reveals that he used *hissself* twice in thirteen attempts to produce a third-person masculine anaphor. In contrast, all twelve of his second-person reflexive pronouns were instances of *yourself*; he never said *youself*. This asymmetry almost certainly reflects a fact about Adam's opportunities to observe the standard form in the input: his mother produced *yourself* 59 times, compared to just 14 instances *hissself*.

These minutiae too are ultimately the product of processing: the routine that selects the appropriate *self*-form is strengthened by exposure to its use by others, an instance of the processor's sensitivity to frequency that has been well documented for a very broad range of linguistic phenomena (e.g., Jurafsky 2003; Jaeger and Tily 2011). Input is vital to language acquisition, of course, but its study should not obscure the crucial importance of factors that are *internal* to the system of language use, such as the pressure to minimize processing cost. If I'm right, it is effects of the latter sort that are largely responsible for why English has the system of anaphora that it does and for how children acquire it in the way that they do.

## 6. Concluding Remarks

Anaphora has long been treated as a prototypical example of a phenomenon whose analysis requires inborn grammatical principles and abstract syntactic representations – the hallmarks of contemporary syntax. However, as I have tried to demonstrate here, this is all an illusion. At the same time, though, it seems futile to suppose that the input can provide a satisfactory account for why systems of anaphora have the particular properties they do, or for how they emerge in the course of development.

On the account that I have proposed, the interpretive facts follow straightforwardly from the operation of the sentence-level processor (and, on occasion, from its interaction with the pragmatic processor). Put simply, the interpretation of reflexive pronouns reflects the manner in which sentences are processed – one word at a time, from left to right, with constant attention to the need to minimize operating cost. The result is a system for resolving referential dependencies that yields the core patterns of anaphora repeated in (40) – among many other facts and contrasts, as we have seen.

- (40)
- a. Jerry<sub>i</sub> hurt himself<sub>i</sub>.
  - b. [Mary's brother]<sub>b</sub> hurt himself<sub>b</sub>.
  - c. Sue thinks [<sub>S</sub> Jerry<sub>j</sub> hurt himself<sub>j</sub>].

There is also a straightforward explanation for the developmental facts, including children's early success on the interpretation of reflexive pronouns and their difficulty with plain pronouns, despite a rate of occurrence of the latter in the input that is several orders of magnitude greater. The key observation is that the interpretation of reflexive pronouns is an almost direct instantiation of processing efficiency: the referential dependency is resolved immediately and locally, at minimal cost. In contrast, the search for the antecedent of a plain pronoun often takes place in a much broader domain.

We thus return to the consensus view paraphrased at the outset. Language is the way it is, and children learn it so successfully, because it is a good fit for the brain. On the implementation of that view proposed here, the nature of the fit makes good functional sense: the brain needs to process information quickly and economically in real time; language is organized to make that possible.

Anaphora offers an opportunity to study how this happens, and to draw conclusions about both the syntax of co-reference and the nature of the forces that shape it. The proposal that I have outlined is fundamentally emergentist: the complexity observed in anaphora at the level of descriptive analysis dissolves once the effects of more fundamental processing pressures are understood. Herein lies the case for emergentism and, with it, a promising framework for approaching the challenge of understanding language and its acquisition.

## Acknowledgments

I am grateful for valuable comments from Kevin Gregg, Brian MacWhinney, and members of various audiences to whom I have presented parts of the material in this chapter.

## NOTES

- 1 This is close to a universal property of language; we find substantial variation only with respect to the acceptability of (2c); see O'Grady (2013a).
- 2 Principle A states that an anaphor must be bound in its governing category. An anaphor is bound if it is linked to a structurally higher antecedent; its governing category typically corresponds to the smallest clause containing it (i.e., the embedded clause in (16)). See Büring (2006) for a general review.
- 3 Cummings and Felser (2013: 211) report a recency effect in low-span readers, who showed a slowdown when the gender of the more proximate NP in patterns such as (17) mismatched that of the reflexive pronoun (e.g., *A friend of Mary overestimated himself*). Nothing in my proposal rules out the possibility of recency effects, which are ubiquitous in all types of processing. Moreover, it is worth noting that the recency effect observed by Cummings and Felser was quickly overwhelmed by a much stronger attraction to the correct antecedent, consistent with my proposal that the resolution of referential dependences involves the computation of locality and immediacy in the semantic representation, not in the fast-decaying string of words that serves as the processor's initial input.
- 4 In patterns such as *A picture of himself lay on the floor*, where there is no option for local interpretation, recourse to pragmatic processing is of course possible.

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## 5 Morphological Emergence

PÉTER RÁCZ, JANET B. PIERREHUMBERT, JENNIFER B. HAY,  
AND VIKTÓRIA PAPP

### 1. Introduction

The discipline of linguistic morphology is the study of word-structure, specifically of “systematic covariation in the form and meaning of words” (Haspelmath and Sims, 2010: 2). Classic structuralist and generative approaches to morphology made strong assumptions about the decomposability of words into minimal meaningful parts, or *morphemes*. They sought simple rules (such as affixation, compounding, or conversion rules) to explain how new words that express new composite meanings can be created.

Connecting the decomposition of known words to the possibilities for forming new words is an important insight of this approach. However, it does not capture the full complexity of morphology. Morphology is messy. It reflects a set of associations between meaning and form, but these associations can be partial or overlapping. Bybee (1985), for example, has an extensive cross-linguistic analysis of verbal inflection. She shows that it is usually not possible to delineate morphemes as one-to-one relationships of form to function. Typically, either one form is associated with several functions or one function is associated with several forms, and the possible sets of combinations can overlap in complex ways. It is also often impossible to tell where one morpheme ends and another starts. Furthermore, associations between form and function are gradient. The word *stick* is more evident in *dipstick* than in *slapstick*. The suffix *-ize* is more separable in *industrialize* than in *organize*. This gradience can be thought of in terms of association strengths amongst pairs or sets of words: *industrialize* is strongly linked to *industrial*, but weaker semantic relatedness has the result that *organize* is less associated with *organ*. Because different people know different words, this means that people's propensity to analyze existing forms as complex, and the probability that they will generalize patterns to create new forms, are functions of the content and structure of their individual lexical systems. Morphological systems, then, emerge in individuals as learned generalizations across lexical items. The content, frequency, and structure of lexical items, as well as the inter-relationships amongst them, thus play a central role in what is learned.

Many cognitive, linguistic, and social factors are at play in influencing the types of morphological generalizations available to individuals, and those that they choose to operationalize in their own speech. This speech forms the input for new generations