There is more than one language

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All linguistic theories agree that the phonologically interpreted expressions of a language present a fairly rich phrase structure (though just how rich varies among theories). Linguistically important relations between expressions are often characterizable directly in terms of that phrase structure; e.g. in terms of notions such as dominates, c-commands, specifier-head, etc. In instances where such direct characterization does not seem possible, this is often regarded as evidence for modified structures in which the relations do correlate with phrase structure configurations. The new structures are sometimes obtained by enriching the surface phrase structural analysis, or by invoking new levels of inaudible structure such as D-structure or LF. For example, the binding of reflexive pronouns is sometimes assumed to be instantiated only in c-command configurations at a level of derived structure, LF. And despite the wide range of positions in which case marked NPs may occur in audible structure, case marking itself (overt or not) is often assumed to apply in only a narrow range of phrase structural configurations at some underlying level of representation.

Here we explore a conceptually distinct alternative. Rather than assuming all significant relations are phrase structure relations (at some level of structure), we provide a more general notion of *structure* according to which even the identity of a particular morpheme may be a structural property. This allows for the possibility that human languages may differ in significant structural properties. Nevertheless, there are, as we support here, non-trivial structural universals of language.

In Part 1 we illustrate our approach by exhibiting three language types in which the Anaphor-Antecedent (AA) relation is directly characterizable in terms of bound morphology rather than phrase structure relations like c-command or government. Part 2 provides a theory-neutral definition of structure, and of what it is to be structurally definable (or simply structural for short). Phrase structure turns out always to be structural, in any language, human or not. So on our definition, relations like dominates, is a sister of, and c-commands are structural ones, as expected. But in addition, the identity of certain morphemes may be structural in the same sense, depending on the language. Part 3 provides explicit models for the three language types in Part 1. We show in each case that certain morphemes are structural and that a characterization of the Anaphor-Antecedent relation in each language is structurally definable in a direct way. In fact we propose as a universal of human language that the Anaphor-Antecedent relation is always structurally definable, in our sense.

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1 Morphology and the Anaphor-Antecedent (AA) Relation

We consider here three sorts of languages in which a direct characterization of the AA relation crucially involves bound morphology rather than hierarchical structure. In all three the reflexive anaphors behave like NPs rather than as clitics or bound morphology on the verb or auxiliary. The first type concerns Nominal Case Marking (NCM) languages like Korean, Bengali and Hindi in which NPs often carry overt case markers. The second type concerns VCM or Verbal Case Marking languages like Toba Batak or Malagasy in which the verbal morphology plays a crucial role in identifying which NPs may locally antecede anaphors. And in the third type, instantiated here by Inuit, both verbal and nominal morphology are used to identity the loci of anaphors.

1.1 Nominal Case Marking Languages

In certain NCM languages, such as Korean, Bengali and Hindi, we find a variety of expressions in which an accusative anaphor c-commands its nominative antecedent. Consider the following data from Korean.[1] In (1) we see that reflexives may follow (1a) or precede (1b) their antecedent with about equal ease.

(1) a. John-i   caki-casin-ul pinanhayssta
              -NOM self-EMP-ACC criticized
       'John criticized himself'
    b. Caki-casin-ul John-i   pinanhayssta
       self-EMP-ACC   -NOM criticized
       'John criticized himself'

The same pattern obtains when the antecedent is quantified (2) or interrogative (3):

(2) a. Nwukwunka(-ka) caki-casin-ul pinanhayssta
       someone-NOM   self-EMP-ACC criticized
       'Someone criticized himself'
    b. Caki-casin-ul nwukwunka(-ka) pinanhayssta
       self-EMP-ACC someone-NOM   criticized
       'Someone criticized himself'

(3) a. Nwuka caki-casin-ul pinanhayssta-ni
       who   self-EMP-ACC criticized-Q
       'Who criticized himself?'
    b. Caki-casin-ul nwuka pinanhayssta-ni
       self-EMP-ACC who   criticized-Q
       'Who criticized himself?'

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[1]Hyunoo Lee, personal communication. See also Park (1985), O'Ggrady (1987).

We note that fronting the accusative NP is not a normal way to mark contrast or emphasis. Rather the topic marker *(n)un* is used, replacing the case marker (for subjects and objects), as illustrated in (4):

(4) a. John-i   Mary-nun pinanhayssta
             -NOM   -TOP criticized
         'John criticized MARY (not someone else)'

Further (5b) shows that the reflexive first order occurs naturally in non-root contexts, in distinction to the reflexive-first order in English expressions like *Himself, John likes.*

(5) a. John-i   caki-casin-ul hoyhap-eyse pinanhayssta
             -NOM self-EMP-ACC meeting-at   criticized
         'John criticized himself at the meeting'
     b. Caki-casin-ul John-i   pinanhayssta hoyhap-eyse
         self-EMP-ACC   -NOM criticized   meeting-at
         'the meeting at which John criticized himself'

Finally, the crucial example is the ungrammatical (6) in which the reflexive follows its antecedent and arguably is c-commanded by it. The problem lies in the case marking. A nominatively marked reflexive cannot be anteceded by an accusatively marked co-argument.

(6) a. * John-ul   caki-casin-i   pinanhayssta
                 -ACC self-EMP-NOM criticized
         'he-self criticized John'
     b. * Caki-casin-i   John-ul   pinanhayssta
         self-EMP-NOM   -ACC criticized
         'he-self criticized John'

Now, while a thorough analysis of the distribution of reflexives in Korean will have to discuss their occurrence as genitives, and as nominatives anteceded by NPs outside their clause, a decent first approximation to the core local binding cases illustrated here can be given by:

(7) **The Korean Anaphora Constraint:** In a transitive sentence in Korean, α is a possible antecedent of β iff α and β are co-arguments and β is suffixed with *(l)-ul*

(7) characterizes the AA relation in the simplest cases in Korean in terms of the *co-argument* relation and the property of being *suffixed with* (l)-ul. In Part 3 we model these Korean data with an explicitly given grammar for a simple language called Little Korean, and we show that the co-argument relation and the property of being *(l)-ul* are both structural. Hence (7) counts as a structural characterization of (the simplest cases of) the AA relation in Korean. We are not of course claiming that it is empirically adequate; a much greater range of data would have to be considered. Our point here is just that the type of statement we see in (7) is acceptable as a structural one.

And it provides an alternative to ones which for example posit underlying structures and scrambling rules in the generation of (1b)–(3b).

1.2 Verbal Case Marking Languages

Reflexives in Toba Batak are discussed in much detail in Schacter (1984). They have been discussed from this perspective in Keenan (1994) and so we will just summarize the relevant facts here:

(8) a. [[Mang-ida si   Ria] si   Torus]
           -see ART   ART
       'Torus sees Ria'
     b. [[Mang-ida dirina] si   Torus]
           -see self   ART
       'Torus sees himself'
     c. * Mang-ida si   Torus dirina
           -see ART   self
         'self sees Torus'

(9) a. [[Di-ida si   Torus] si   Ria]
           -see ART   ART
       'Torus saw Ria'
     b. [[Di-ida si   Torus] dirina]
           -see ART   self
       'Torus saw himself'
     c. * Di-ida dirina si   Torus
           -see self   ART
         'self saw Torus'

In this language the verbal prefixes *mang-* and *di-* together with the verb root allow us to recover the semantic role of the external NP. Schacter provides abundant evidence that the NP immediately following the verb in these examples forms a constituent with the verb to the exclusion of the second NP, regardless of the choice of verbal affix. We note for example that only the second NP can be relativized or questioned by movement from these Ss. And the grammaticality (and complete naturalness) of (9b) and the ungrammaticality of (9c) are counterexamples to the expected c-command relations. A descriptively adequate statement of local binding in Batak is given by:

(10) **The Toba Batak Anaphora Constraint:**   In transitive Ss [[AF-V NP_{int}] NP_{ext}], NP_{ext} may antecede NP_{int} iff the affix AF- is *mang-*; NP_{int} may antecede NP_{ext} iff the affix AF- is *di-*.

Again in Part 3 we show that the affixes *di-* and *mang-* are structural in Little Batak, so constraints like (10) are properly structural even though they refer to particular morphemes.

1.3 Languages with simultaneous verb and noun marking

In certain ergative languages such as West Greenlandic Inuit, Nez Perce (Oregon Penutian) and Kham (West Tibetan), reflexive arguments only appear with oblique case, never in the absolutive or ergative case. For example, in Inuit we find structures like the following.[2] (11) and (12) show that we may not simply replace either the absolutive or the ergative NP with a reflexive, even though replacement of the absolutive in (11b) is consistent with usual c-command assumptions (the antecedent c-commands the anaphor).

(11)   a. Suulu-p   Kaali aallaa-v-a-a
                  -ERG   shoot-IND-TRANS-3s.3s

          'Suulut shot Kaali.'

        b. * Suulu-p   immi aallaa-v-a-a
                    -ERG self shoot-IND-TRANS-3s.3s

           'Suulut shot himself.'

(12)   a. Kaali-p   Aani qimmi-mik pitsip-p-a-a
                  -ERG   dog-INS   buy.for-IND-TRANS-3s.3s

          'Kaali bought Aani a dog.'

        b. * Kaali-p   immi qimmi-mik pitsip-p-a-a
                    -ERG self   dog-INS   buy.for-IND-TRANS-3s.3s

           'Kaali bought himself a dog.'

The acceptable patterns are as in (13) and (14) in which the transitive suffix *-a* has been replaced by the intransitive marker *-u*. These verbs take optionally an oblique complement, which may be reflexive.

(13)   Suulut (immi-nut) aallaa-v-u-q
            (self-DAT) shoot-IND-INTRANS-3s

        'Suulut shot (himself).'

(14)   Kaali (immi-nut) qimmi-mik pitsip-p-u-q
            (self-DAT) dog-INS   buy-IND-INTRANS-3s

        'Kaali bought (himself) a dog'

In the latter sentences we see the use of a detransitivizing affix, together with the datively marked reflexive. When the reflexive argument is not in ergative or absolutive case anyway, then it can appear as usual:

(15)   Juuna-p   Kaali immi-nik uqaluttuup-p-a-a
           -ERG   self-DAT buy-IND-TRANS-3s.3s

       'Juuna$_i$ told Kaali about self$_i$.'

These examples illustrate that the reflexive *immi* is "subject-oriented," regardless of the case of the subject, just as the reflexive in Batak is subject oriented regardless of whether the subject is in the internal or external position.

    To a first approximation, the Inuit Anaphora Constraint can be given by:

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[2]Bittner (1994). See also Fortescue (1984), Bittner and Hale (1994).

(16)   **The Inuit Anaphor Constraint:** In transitive Ss in Inuit, α is a possible antecedent of β iff β is *-nik* marked (dative) and either α is *-p* marked (ergative) or else the verb is *-u* marked and α is *-$\varnothing$* marked (absolutive).

We turn now to our definition of structure and then to our models of Korean, Batak and Inuit which illustrate that the relations and morphemes we have discussed above are indeed structural.

2   Structure

A **grammar** G has four parts: a **vocabulary** V, a set of **categories** Cat, a **lexicon** of categorized vocabulary items, that is a set of pairs $\langle string, Category \rangle$, and a set $\mathcal{F}$ of (partial) **structure building (generating)** functions which take sequences of categorized expressions to form complex expressions. A grammar G can thus be schematically represented by the formula, $G = \langle V, Cat, Lex, \mathcal{F} \rangle$.

The language $L(G)$ defined by G is just the closure of *Lex* under the functions in $\mathcal{F}$. So $L(G)$ is the set of all expressions, ⟨string, category⟩ pairs, which can be formed by any (finite) number of applications of any of the generating functions to elements from the lexicon. For any expression σ in the language $L(G)$, we sometimes use $str(\sigma)$ to refer to the first coordinate of σ, the string, and $cat(\sigma)$ to refer to its second coordinate, the category.

This approach to grammar subsumes almost any conceivable generative approach to language. One proves easily that any set of expressions A, there are many grammars G such that $A = L(G)$.

2.1   Little Korean grammar

We can easily provide a simple grammar for a language which is similar to Korean with regard to the binding generalizations noted above. We provide each of the four components of **Little Korean**$= \langle V, Cat, Lex, \mathcal{F} \rangle$. First, let the vocabulary and categories be as follows:

V :   *john, bill, pron, himself, laughed, cried, praised, criticized,*
        -nom, -acc, both, and, either, or, neither, nor
Cat :   *NP, K, KPa, KPn, P2, P1a, P1n, S, CONJ*

The lexicon *Lex* is a set of vocabulary items paired with their categories, $\langle string, Category \rangle$, which we can just list as follows:

NP :   *john, bill, pron, himself*
K :   *-nom, -acc*
$CONJ$:   *and, or, nor*

$P1n$:   *laughed, cried,*
$P2$:   *praised, criticized*

So for example, *Lex* contains the expression $\langle john, NP \rangle$. Finally, we will have just three functions that build phrases from these lexical elements:

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noun marking *NM*, predicate argument application *PA*, and a coordination rule *BOOL*: $\mathcal{F} = \{NM, PA, BOOL\}$. We define the noun marking function *NM* so that its domain is pairs of NPs and case markers (except that *himself* cannot combine with *-nom*), and it applies to append the case marker to the NP:

$$DomNM = \{\langle\langle s, K\rangle, \langle t, NP\rangle\rangle \mid s \in \{\text{-}nom, \text{-}acc\},\ t \in V^*,$$
$$\neg(s = \text{-}nom\ \&\ t = himself)\}$$

$$NM(\langle s, K\rangle, \langle t, NP\rangle) = \begin{cases} \langle t\char`^s, KPn\rangle & \text{if } s = \text{-}nom \\ \langle t\char`^s, KPa\rangle & \text{if } s = \text{-}acc \end{cases}$$

The predicate-argument application rule *PA* will be allowed to put a *KPn* together with a *P1n* to form an *S*, a *KPa* together with a *P1a* to form an *S*, a *KPn* together with a *P2* to form a *P1a*, or a *KPa* together with a *P2* to form a *P1n*. Formally:

$$DomPA = \{\langle\langle s, C_1\rangle, \langle t, C_2\rangle\rangle \mid s, t \in V^*,\ C_1 \in \{KPa, KPn\},\ C_2 \in \{P1n, P1a, P2\},$$
$$\neg(C_1 = KPa\ \&\ C_2 = P1n),$$
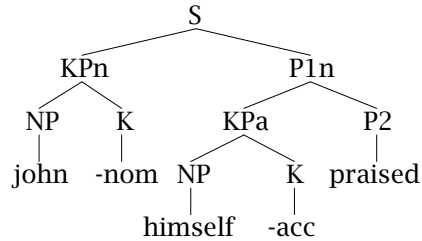$$\neg(C_1 = KPn\ \&\ C_2 = P1a)\ \}$$

$$PA(\langle s, C_1\rangle, \langle t, C_2\rangle) = \begin{cases} \langle s\char`^t, S\rangle & \text{if either } C_1 = KPn\ \&\ C_2 = P1n, \\ & \qquad \text{or } C_1 = KPa\ \&\ C_2 = P1a \\ \langle s\char`^t, P1a\rangle & \text{if } C_1 = KPn\ \&\ C_2 = P2 \\ \langle s\char`^t, P1n\rangle & \text{if } C_1 = KPa\ \&\ C_2 = P2 \end{cases}$$

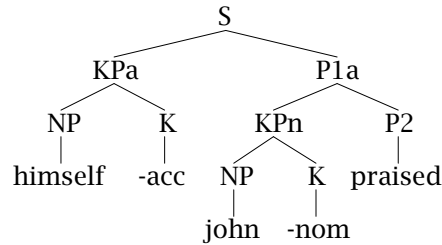And finally, we build coordinate expressions in the usual way:

$$DomBOOL = \{\langle\sigma, \tau, \eta\rangle \mid str(\sigma), str(\tau), str(\eta) \in V^*,\ cat(\sigma) = CONJ,$$
$$cat(\tau) = cat(\eta) \in \{S, KPa, KPn, P1a, P1n, P2\}\ \}$$

$$BOOL(\sigma, \tau, \eta) = \begin{cases} \langle both\char`^str(\tau)\char`^and\char`^str(\eta), cat(\tau)\rangle & \text{if } str(\sigma) = and \\ \langle either\char`^str(\tau)\char`^or\char`^str(\eta), cat(\tau)\rangle & \text{if } str(\sigma) = or \\ \langle neither\char`^str(\tau)\char`^nor\char`^str(\eta), cat(\tau)\rangle & \text{if } str(\sigma) = nor \end{cases}$$

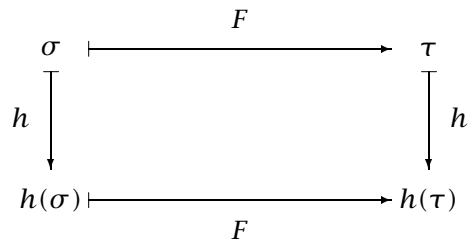The following tree depicts a derivation of the sentence *john -nom himself -acc praised*:

It is equally easy to derive the sentence *himself -acc john -nom praised*:

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                        S
              ┌─────────┴─────────┐
            KPa                  P1a
          ┌──┴──┐            ┌────┴────┐
        NP      K          KPn         P2
        │       │        ┌──┴──┐       │
     himself  -acc      NP     K     praised
                        │      │
                      john   -nom
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It is common to assume that the structure of an expression should be determined by the ways that it can be derived from the lexicon with the generating functions. Rather than simply identifying the structure of an expression with its derivation trees, though, there is another slightly more abstract approach, which takes the notion of "having the same structure as" as fundamental. This approach will make sense of the intuition that the ability to replace one expression by another, preserving grammaticality, is some evidence that the two expressions have the same structure. Roughly, if two expressions are everywhere interchangeable, we will say that they have the same structure. We formalize this idea in terms those functions, the **structure maps**, which replace one expression by another, preserving all the ways those expressions can be used by the generating functions.

This situation is naturally depicted by a diagram like the following. A function h is a structure map if for every generating function F, if F maps σ to τ then it maps $h(\sigma)$ to $h(\tau)$:[3]

$$
\begin{array}{ccc}
 & F & \\
\sigma & \longmapsto & \tau \\
h \downarrow & & \downarrow h \\
h(\sigma) & \longmapsto & h(\tau) \\
 & F &
\end{array}
$$

In these terms, we say that expressions σ and τ **have the same structure** just in case one is mapped to the other by some such structure map h. And we say that a set of A of expressions is **structurally identified** (i.e., structurally definable) just in case every structure map maps A to itself, $\{h(\sigma)|\ \sigma \in A\} = A$. Similarly, for any relation R which holds between pairs (or any n-tuple, for any n) of expressions, we say that R is **structurally identified** if and only if the set of pairs related by R is mapped to itself by

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[3]More precisely, we require $h : L(G) \to L(G)$ to be a bijection such that for all $F \in \mathcal{F}$, $h(F) = F$, where $h(F)$ is the function which, for any σ in the domain of F, maps $h(\sigma)$ to $h(F(\sigma))$.

every structure map h, $\{\langle h(\sigma), h(\tau)\rangle \mid \sigma R\tau\} = \{\langle \sigma, \tau\rangle \mid \sigma R\tau\}$.

Sometimes, a language will have an expression σ such that no other expression has the same structure; that is, an expression σ such that every structure preserving map h is such that $h(\sigma) = \sigma$. In this case, we say that σ is a **grammatical constant.**

2.2 Universally structural sets

It follows trivially from our definition of grammars and identification that some sets are structurally identified:

Theorem 1 *For every grammar G, the empty set $\varnothing$ and the whole language $L(G)$ are structural.*

Standard constituency-based relations are also identified by every grammar, no matter how weird and inhuman the language is. Let's define a few examples.[4] We can formally define an "occurs in" relation OCC as follows. First, let $\alpha OCC_0\beta$ iff $\alpha = \beta$. Then, for all $n \geq 0$ let $\alpha OCC_{n+1}\beta$ iff for some generating function $F \in \mathcal{F}$, $\beta = F(\delta)$ for some tuple $\delta \in DomF$, and $\alpha OCC_n\delta_i$ where δ_i is an element of δ. Finally, we say α **occurs in** β, $\alpha OCC\beta$, iff for some n, $\alpha OCC_n\beta$.

Let's say α and β are **sisters** in σ iff for some $F \in \mathcal{F}$ and some tuple $\delta \in DomF$, $F(\delta)$ occurs in σ and both α and β are elements of δ.

Let's say that α **precedes** β in σ iff for some $F \in \mathcal{F}$ and some tuple $\delta \in DomF$, $F(\delta)$ occurs in σ, where $\delta = \langle \ldots, \alpha', \ldots, \beta' \ldots \rangle$, α occurs in α' and β occurs in β'.

Finally, let's say that α **c-commands** β in σ iff for some τ, α and τ are sisters in σ, and β occurs in τ.

Theorem 2 *For every grammar G, the following relations are structural:* occurs in, sisters, precedes, c-commands.

Things that are structurally identified by every grammar are of no special interest to the linguist. What happens, though, is that we can make a significant relation like binding into a structural relation by forcing it to correspond to one of these universally structural relations. It is no surprise that providing the requisite structures can complicate the grammar considerably. In the simple grammar of Little Korean, binding relations are not defined this way. Rather, they depend on the particular case markers themselves. Nevertheless, the possible antecedent relation of Little Korean is structural, as we see in the next section. It is structural because of the particular properties of the language.

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[4]The careful reader will notice that we define these structural relations on expressions, rather than on particular occurrences of expressions. This is done just to simplify the presentation. On any reasonable approach to occurrences, the corresponding relations will remain structural.

3 Binding, morphology and structure

3.1 Little Korean

We gave a grammar for Little Korean in section 2.1. in which a transitive verb can combine with either a nominative or an accusative argument, yielding a constituent that will combine with a second argument of the appropriate type. It is perfectly possible to interpret these structures directly, without first mapping them into an (inaudible) alternative form. We here define simple models for Little Korean in such a way that *john -nom himself -acc praised* and *himself -acc john -nom praised* are logically equivalent.

A **model** $\mathcal{M}$ is standardly given by a pair $\mathcal{M} = \langle E, \mu \rangle$, where E is a nonempty set of objects and μ maps lexical items to their denotations. The function μ is then extended to an interpretation function for the whole language, subject to certain restrictive conditions. First, we set out the basic semantic domains in which expressions in each category will find their denotations. In any model with universe E, an expression of any category C will denote an element of the set $Den_E C$, defined as follows:

$Den_E S = \{0, 1\} = \mathcal{R}_0$ (the truth values)
$Den_E P1n = \mathcal{R}_1 = \mathcal{P}E$ (the power set of E, properties)
$Den_E P2 = \mathcal{R}_2 = \mathcal{P}(E \times E)$ (the binary relations)
$Den_E CONJ = \{f \in [Den_E C^2 \to Den_E \, C] |$
$$C \in \{S, KPa, KPn, P1a, P1n, P2\}\}$$

We treat the noun phrases as "arity reducers": each noun phrase denotes a function that binds an argument of the relation it applies to, reducing its arity by one. Let's call the set of functions of this type GQ (for "generalized quantifier"):

$$Den_E NP = GQ = [(\mathcal{R}_3 \cup \mathcal{R}_2 \cup \mathcal{R}_1) \to (\mathcal{R}_2 \cup \mathcal{R}_1 \cup \mathcal{R}_0)]$$

Then we define:

$Den_E KPa = GQ$
$Den_E KPn = \{nom(f) | \ f \in GQ\}$ (nom is defined below)
$Den_E P1a = [GQ \to \{0, 1\}]$

Finally, we let $Den_E K = \{acc, nom\}$ where these are functions defined as follows. Treating acc as the simpler case, we let acc be the identity function. Then $nom(f)$ is defined to be just like f when applied to properties, but to behave differently when applied directly to binary relations, as follows. For any $P \in \mathcal{R}_1$, $nom(f)(P) = f(P)$, and for $R \in \mathcal{R}_2$, $nom(f)(R)$ is the function that maps $g \in GQ$ to truth values as follows: $nom(f)(R)(g) = f(g(R))$. Notice that this approach uses the case markers directly as indicators of the argument structure. In particular, it is the interpretation of *-nom* which enables us to get the binding relation between *himself -acc* and the nominative antecedent.

A model $\mathcal{M} = \langle E, \mu \rangle$ for Little Korean can then be given by a nonempty set E and a mapping μ from expressions to denotations satisfying the following conditions:

Lexical Conditions:

(a) for all $\langle s, C \rangle \in Lex$, $\mu(s, C) \in Den_E C$

(b) $\mu(\text{-}acc, K) = acc$

(c) $\mu(\text{-}nom, K) = nom$

(d) $\mu(himself, NP) = SELF$, that function mapping binary relations R to properties $\{a \mid R(a, a)\}$, and 3-place relations R to binary relations $\{\langle a, b \rangle \mid R(a, b, a)\}$ (and we do not care what it does to properties, since this case does not arise in our examples)

(e) $\mu(and, CONJ)$ is the function which maps σ, τ from $Den_E C$ for any C to $\mu(\sigma) \wedge_C \mu(\tau)$

(f) $\mu(or, CONJ)$ is the function which maps σ, τ from $Den_E C$ for any C to $\mu(\sigma) \vee_C \mu(\tau)$

(g) $\mu(nor, CONJ)$ is the function which maps σ, τ from $Den_E C$ for any C to $\neg_C(\mu(\sigma) \vee_C \mu(\tau))$

Conditions on Derived Expressions:

(h) for $\langle \sigma, \tau \rangle \in DomNM$, $\mu(NM(\sigma, \tau)) = \mu(\sigma)(\mu(\tau))$

(i) for $\langle \sigma, \tau \rangle \in DomPA$,
$$\mu(PA(\sigma, \tau)) = \begin{cases} \mu(\tau)(\mu(\sigma)) & \text{if } cat(\sigma) = KPa \ \& \ cat(\tau) = P1a \\ \mu(\sigma)(\mu(\tau)) & \text{otherwise} \end{cases}$$

(j) for $\langle \sigma, \tau, \eta \rangle \in DomBOOL$, $\mu(BOOL(\sigma, \tau, \eta)) = \mu(\sigma)(\mu(\tau), \mu(\eta))$

By this definition of models for Little Korean, it is easy to calculate that in any model $\mathcal{M} = \langle E, \mu \rangle$, the sentence *himself -acc john -nom praised* has the interpretation

$\mu(himself\text{ -}acc\ john\text{ -}nom\ praised, S)$
$\quad = \mu(PA(\langle himself\text{-}acc, KPa \rangle, \langle john\text{-}nom\ praised, P1a \rangle))$
$\quad = \mu(john\text{-}nom\ praised, P1a)(\mu(himself\text{-}acc, KPa))$
$\quad = \mu(john\text{-}nom\ praised, P1a)(\mu(NP(\langle \text{-}acc, K \rangle, \langle himself, NP \rangle)))$
$\quad = \mu(john\text{-}nom\ praised, P1a)(\mu(\text{-}acc, K)(\mu(himself, NP)))$
$\quad = \mu(john\text{-}nom\ praised, P1a)(acc(SELF))$
$\quad = \mu(john\text{-}nom\ praised, P1a)(SELF)$
$\quad = \mu(PA(\langle john\text{-}nom, KPn \rangle, \langle praised, P2 \rangle))(SELF)$
$\quad = \mu(john\text{-}nom, KPn)(\mu(praised, P2))(SELF)$
$\quad = \mu(NM(\langle \text{-}nom, K \rangle, \langle john, NP \rangle))(\mu(praised, P2))(SELF)$
$\quad = \mu(\text{-}nom, K)(\mu(john, NP))(\mu(praised, P2))(SELF)$
$\quad = nom(\mu(john, NP))(\mu(praised, P2))(SELF)$
$\quad = \mu(john, NP)(SELF(\mu(praised, P2)))$

The same interpretation is determined for *john -nom himself -acc praised*. The reflexive pronoun takes the nominative co-argument as its antecedent in both sentences, regardless of its structural position. Now let's see that the possible antecedent relation in this language is structural.

In Little Korean, the expressions $\langle bill, NP \rangle$ and $\langle john, NP \rangle$ have the same structure in the sense we defined: there are structure preserving maps

which interchange these expressions. However, the expression $\langle \text{-}nom, K \rangle$ cannot be interchanged with any other, preserving structure, so it is a grammatical constant. One proves:

Theorem 3 *In Little Korean, expressions $\langle \text{-}nom, K \rangle$, $\langle \text{-}acc, K \rangle$, $\langle himself, NP \rangle$, and $\langle himself\text{ -}acc, KPa \rangle$ are grammatical constants.*

In Little Korean, let's say α is an **argument** iff it has category KPn or KPa. Call α a **predicate** iff it has category $P2, P1a$ or $P1n$. And let α and β be **co-arguments** (of γ) in σ just in case all of the following conditions hold: α and β are arguments, γ is a predicate, for some τ that occurs in σ, $\tau = PA(\eta_1, PA(\eta_2, \gamma))$, and $\alpha, \beta \in \{\eta_1, \eta_2\}$. In these terms, we prove:

Theorem 4 *The* co-arguments *relation in Little Korean is structural.*

Now we can define the possible antecedent relation in Little Korean, AA_{KOR}, as follows: $\alpha AA_{\text{KOR}} \beta$ iff α and β are co-arguments, and β is suffixed with *-acc*. Notice how this corresponds to the informal generalization stated in (7). Then one proves:

Theorem 5 AA_{KOR} *is structural in Little Korean.*

What this means is that, even though antecedence depends on the identity of particular morphemes, the case markers, a structure preserving map cannot change the possible antecedent relations in any structure of Little Korean.

3.2 Little Batak

The strategy of the previous section can be used to show that possible antecedent relations of the sort found in Toba Batak are similarly structural. Here we just quickly sketch an approach and the key results. We define a simple language and compositional semantics, with binding relations that correspond to the generalization (10).

Let **Little Batak**$= \langle V, Cat, Lex, \mathcal{F} \rangle$ where the vocabulary V and categories Cat are:

$$
\begin{aligned}
V: \quad & john, bill, pron, dirina, laughed, cried, praised, criticized, \\
& mang\text{-}, di\text{-}, both, and, either, or, neither, nor \\
Cat: \quad & NPn, NPa, Vaf, KPn, P2, P2a, P2n, P1a, P1n, S, CONJ
\end{aligned}
$$

The lexicon *Lex* is a set of vocabulary items paired with their categories, $\langle string, Category \rangle$, which we can just list as follows:

NPn :	$john, bill, pron$	Vaf :	$mang\text{-}, di\text{-}$
NPa :	$john, bill, pron, dirina$	$P1n$:	$laughed, cried,$
$CONJ$:	and, or, nor	$P2$:	$praised, criticized$

Finally, we will have just three functions that build phrases from these lexical elements: verb marking, predicate-argument application, and coordination: $\mathcal{F} = \{VM, PA, BOOL\}$, where these have straightforward definitions as

follows:

$$DomVM = \{\langle \sigma, \tau \rangle \mid cat(\sigma) = Vaf, \, cat(\tau) = P2\}$$

$$VM(\langle s, Vaf \rangle, \langle t, P2 \rangle) = \begin{cases} \langle s\,\hat{}\,t, P2a \rangle & \text{if } s = mang\text{-} \\ \langle s\,\hat{}\,t, P2n \rangle & \text{if } s = di\text{-} \end{cases}$$
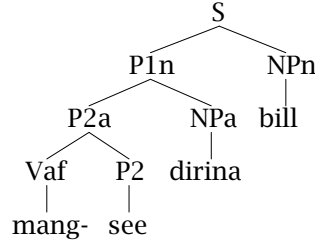
$$DomPA = \{\langle \sigma, \tau \rangle \mid cat(\sigma) = P\beta\alpha \,\&\, cat(\tau) = NP\alpha, \text{ for } \alpha \in \{a, n\}, \beta \in \{1, 2\}\}$$

$$PA(\sigma, \tau) = \begin{cases} \langle str(\sigma)\,\hat{}\,str(\tau), S \rangle & \text{if } cat(\sigma) \in \{P1n, P1a\} \\ \langle str(\sigma)\,\hat{}\,str(\tau), P1n \rangle & \text{if } cat(\sigma) = P2a \\ \langle str(\sigma)\,\hat{}\,str(\tau), P1a \rangle & \text{if } cat(\sigma) = P2n \end{cases}$$
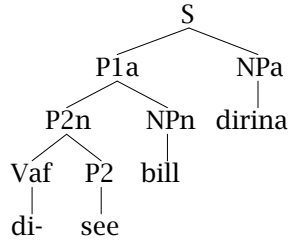
$$DomBOOL = \{\langle \sigma, \tau, \eta \rangle \mid cat(\sigma) = CONJ,$$
$$cat(\tau) = cat(\eta) \in \{S, NPa, NPn, P1a, P1n, P2a, P2n\} \}$$

$$BOOL(\sigma, \tau, \eta) = \begin{cases} \langle both\,\hat{}\,str(\tau)\,\hat{}\,and\,\hat{}\,str(\eta), cat(\tau) \rangle & \text{if } str(\sigma) = and \\ \langle either\,\hat{}\,str(\tau)\,\hat{}\,or\,\hat{}\,str(\eta), cat(\tau) \rangle & \text{if } str(\sigma) = or \\ \langle neither\,\hat{}\,str(\tau)\,\hat{}\,nor\,\hat{}\,str(\eta), cat(\tau) \rangle & \text{if } str(\sigma) = nor \end{cases}$$

With this grammar, we can show that $\langle mang\text{-} see \, dirina \, bill, S \rangle$ is in L(Little Batak) with a derivation like the following:

Similarly, we can show that $\langle di\text{-} see \, bill \, dirina, S \rangle$ is in L(Little Batak) with a derivation like the following:

We can now provide a model theory for Little Batak which makes $\langle mang\text{-} see \, dirina \, bill, S \rangle$ and $\langle di\text{-} see \, bill \, dirina, S \rangle$ equivalent. As before, we begin by delimiting the sets $Den_E C$ for $C \in Cat$, where E is the universe of

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any model. For $C \in \{S, P2, P1n, CONJ\}$, we keep the same definitions we had for Little Korean. For the other categories we have:

$$Den_E NPn = Den_E NPa = GQ$$
$$Den_E P2a = [GQ \rightarrow \mathcal{R}_1]$$
$$Den_E P2n = [GQ \rightarrow [GQ \rightarrow \mathcal{R}_0]]$$
$$Den_E Vaf = \{mang, di\}$$

The function $mang$ maps binary relations to functions from GQs to properties in the simplest way: $mang(R)(f) = f(R)$. The function di is more elaborate. For any binary relation R and GQ denotation f, $di(R)(f)$ is the function which applies to any GQ g to yield the truth value $f(g(R))$.

With these sets $Den_E C$, we define a model $\mathcal{M} = \langle E, \mu \rangle$ for Little Batak, where E is a nonempty set of objects and μ maps expressions to their denotations, as follows.

Lexical Conditions:
  (a)   for all $\langle s, C \rangle \in Lex$, $\mu(s, C) \in Den_E C$
  (b) $\mu(mang\text{-}, K) = mang$
  (c) $\mu(di\text{-}, K) = di$
  (d) $\mu(dirina, NP) = SELF$
  (e) $\mu(and, CONJ)$ maps σ, τ from $Den_E C$ to $\mu(\sigma) \wedge_C \mu(\tau)$
  (f) $\mu(or, CONJ)$ maps σ, τ from $Den_E C$ to $\mu(\sigma) \vee_C \mu(\tau)$
  (g) $\mu(nor, CONJ)$ maps σ, τ from $Den_E C$ to $\neg_C(\mu(\sigma) \vee_C \mu(\tau))$

Conditions on Derived Expressions:
  (h)   for $\langle \sigma, \tau \rangle \in DomVM$, $\mu(VM(\sigma, \tau)) = \mu(\sigma)(\mu(\tau))$
  (i)   for $\langle \sigma, \tau \rangle \in DomPA$,
$$\mu(PA(\sigma, \tau)) = \begin{cases} \mu(\tau)(\mu(\sigma)) & \text{if } cat(\sigma) = P1n \\ \mu(\sigma)(\mu(\tau)) & \text{otherwise} \end{cases}$$

  (j)   for $\langle \sigma, \tau, \eta \rangle \in DomBOOL$, $\mu(BOOL(\sigma, \tau, \eta)) = \mu(\sigma)(\mu(\tau), \mu(\eta))$

These conditions are very similar to the ones proposed for Little Korean.

With these definitions, we can calculate that in any model $\mathcal{M} = \langle E, \mu \rangle$, the expression $\langle di\text{-} see\ bill\ dirina, S \rangle$ has the interpretation

$$\mu(di\text{-} see\ dirina\ bill, S)$$
$$= \mu(PA(\langle dirina, NPa \rangle, \langle di\text{-} see\ bill, P1a \rangle))$$
$$= \mu(di\text{-} see\ bill, P1a)(\mu(dirina, NPa))$$
$$= \mu(di\text{-} see\ bill, P1a)(SELF)$$
$$= \mu(PA(\langle di\text{-} see, P2n \rangle, \langle bill, NPn \rangle))(SELF)$$
$$= \mu(di\text{-} see, P2n)(\mu(bill, NPn))(SELF)$$
$$= \mu(VM(\langle di\text{-}, Vaf \rangle, \langle see, P2 \rangle))(\mu(bill, NPn))(SELF)$$
$$= \mu(di\text{-}, Vaf)(\mu(see, P2))(\mu(bill, NPn))(SELF)$$
$$= di(\mu(see, P2))(\mu(bill, NPn))(SELF)$$
$$= \mu(bill, NPn)(SELF(\mu(see, P2)))$$

The very same interpretation is determined for the simpler $\langle mang\text{-}\ see\ dirina\ bill, S \rangle$. The reflexive takes the semantically appropriate co-argument as its antecedent in both structures.

It is also easy to establish that the possible configurations for reflexive binding in this language are structurally defined. First, we can observe:

Theorem 6 *In Little Batak, expressions $\langle di\text{-}, Vaf \rangle$, $\langle mang\text{-}, Vaf \rangle$, and $\langle dirina, NPa \rangle$ are grammatical constants.*

In Little Batak, α is an **argument** iff it has category NPn or NPa. And let's call α a **predicate** iff it has category $P2a, P2n, P1a$ or $P1n$. Then we can define the possible antecedent relation AA_{BAT} as follows: $\alpha AA_{\text{BAT}}\ \beta$ in σ iff α and β are co-arguments, and for some τ occurring in σ, either $\tau = PA(\alpha, PA(\beta, \eta))$ for some η of category $P2a$ or $\tau = PA(\beta, PA(\alpha, \eta))$ for some η of category $P2n$. Notice how this corresponds to the informal generalization stated in (10). With the Little Batak possible antecedent relation formalized in this way, we prove:

Theorem 7 *The* co-argument *and AA_{BAT} relations are structural in Little Batak.*

3.3 Little Inuit

Finally, we can treat the slightly more complex situation found in Inuit, where argument relations are determined by marking both the verb and the arguments.

$$V: \quad john, bill, immi, laughed, cried, praised, criticized, sent, showed,$$
$$-u, -erg, -dat, both, and, either, or, neither, nor$$
$$Cat: \quad NPn, NPa, Vaf, KPn, P2, P2a, P2n, P1a, P1n, S, CONJ$$

The lexicon *Lex* is a set of vocabulary items paired with their categories, $\langle string, Category \rangle$, which we can just list as follows:

$K:$	$-erg, -dat$	$Vaf:$	$-u$
$NP:$	$john, bill, immi$	$P1a:$	$laughed, cried,$
$CONJ:$	and, or, nor	$P2:$	$praised, criticized$
		$P3:$	$sent, showed$

We define four phrase-building functions: verb marking, noun marking, predicate-argument application, and coordination: $\mathcal{F} = \{VM, NM, PA, BOOL\}$:

$$DomVM = \{\langle \sigma, \tau \rangle | \; cat(\sigma) = Vaf, \; \tau \in Lex, \; cat(\tau) = P2\}$$

$$VM(\langle s, Vaf \rangle, \langle t, P2 \rangle) = \langle t\hat{\;}s, P1d \rangle$$

$$DomNM = \{\langle \sigma, \tau \rangle | \; cat(\sigma) = K, cat(\tau) = NP, \; \& \\ \neg(str(\sigma) = \text{-}erg \; \& \; str(\tau) = immi)\} \\ \cup \{\langle \sigma \rangle | \; cat(\sigma) = NP \; \& \; str(\sigma) \neq immi\}$$

$$NM(\delta) = \begin{cases} \langle s, KPa \rangle & \text{if } \delta = \langle \langle s, NP \rangle \rangle \\ \langle t\hat{\;}\text{-}erg, KPe \rangle & \text{if } \delta = \langle \langle \text{-}erg, K \rangle, \langle t, NP \rangle \rangle \\ \langle t\hat{\;}\text{-}dat, KPd \rangle & \text{if } \delta = \langle \langle \text{-}dat, K \rangle, \langle t, NP \rangle \rangle \end{cases}$$
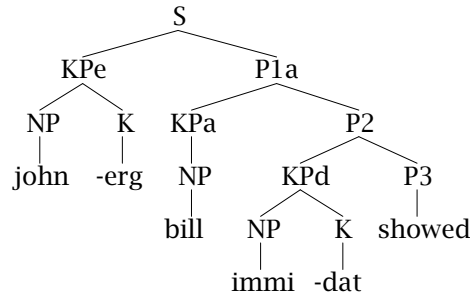
$$DomPA = \{\langle \sigma, \tau \rangle | \; cat(\sigma) = KPa \; \& \; cat(\tau) \in \{P1a, P1d, P2\}, \text{ or} \\ \text{for } \alpha \in \{e, d\}, \; cat(\sigma) = KP\alpha \; \& \; cat(\tau) = P1\alpha, \text{ or} \\ cat(\sigma) = KPd \; \& \; cat(\tau) = P3\}$$
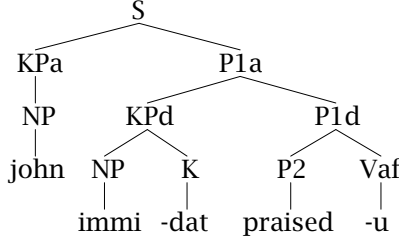
$$PA(\sigma, \tau) = \begin{cases} \langle str(\sigma)\hat{\;}str(\tau), S \rangle & \text{if } cat(\sigma) = KPa, \; cat(\tau) \in \{P1a, P1d\} \\ \langle str(\sigma)\hat{\;}str(\tau), P1e \rangle & \text{if } cat(\sigma) = KPa, \; cat(\tau) = P2 \\ \langle str(\sigma)\hat{\;}str(\tau), S \rangle & \text{if } cat(\sigma) = KPe, \; cat(\tau) = P1e \\ \langle str(\sigma)\hat{\;}str(\tau), P1a \rangle & \text{if } cat(\sigma) = KPd, \; cat(\tau) = P1d \\ \langle str(\sigma)\hat{\;}str(\tau), P2 \rangle & \text{if } cat(\sigma) = KPd, \; cat(\tau) = P3 \end{cases}$$

$$DomBOOL = \{\langle \sigma, \tau, \eta \rangle | \; cat(\sigma) = CONJ, \\ cat(\tau) = cat(\eta) \in \{S, KPa, KPd, KPe, P1a, P1e, P1d, P2, P3\} \}$$

$$BOOL(\sigma, \tau, \eta) = \begin{cases} \langle both\hat{\;}str(\tau)\hat{\;}and\hat{\;}str(\eta), cat(\tau) \rangle & \text{if } str(\sigma) = and \\ \langle either\hat{\;}str(\tau)\hat{\;}or\hat{\;}str(\eta), cat(\tau) \rangle & \text{if } str(\sigma) = or \\ \langle neither\hat{\;}str(\tau)\hat{\;}nor\hat{\;}str(\eta), cat(\tau) \rangle & \text{if } str(\sigma) = nor \end{cases}$$

With these rules, we get derivations like the following:

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```
                         S
              ┌──────────┴──────────┐
            KPa                    P1a
             │            ┌─────────┴─────────┐
            NP          KPd                  P1d
             │       ┌───┴───┐          ┌─────┴─────┐
           john     NP       K         P2          Vaf
                     │       │          │           │
                   immi    -dat      praised       -u
```

In this language, the semantic object of a *-u*-marked binary predicate can optionally be specified by a dative NP. We accordingly interpret this verbal affix as mapping binary relations to functions which can take as arguments either absolute NP denotations or dative NP denotations. With this idea, it is easy to set out a simple model theory for Inuit languages, with an appropriate treatment of both detransitivizing affixes and of reflexive binding.

For $C \in \{S, CONJ, NP\}$, we can just keep the same definitions of Den_C that we had for Little Korean and Little Batak. We interpret predicates as functions which will combine with their arguments to form predicates of 1 less arity, much as was done for Little Batak. Given any model $\mathcal{M} = \langle E, \mu \rangle$

$$Den_E P1a = Den_E P1e = \mathcal{R}_1$$
$$Den_E P2 = \mathcal{R}_2$$
$$Den_E P3 = \mathcal{R}_3$$

The $P1d$ denotations are functions with larger domains, since these predicates can combine with absolute or dative arguments. So let $Dom_E P1d = GQ \cup Den_E KPd$ and $Rng_E P1d = \{0, 1\} \cup \mathcal{R}_1$. Turning to the KPs, define for any model $\mathcal{M} = \langle E, \mu \rangle$,

$$Den_E K = \{erg, dat\} \qquad \text{(as defined below)}$$
$$Den_E KPa = Den_E KPe = GQ$$
$$Den_E KPd = \{dat(f)|\ f \in GQ\}$$
$$Den_E Vaf = \{u\} \qquad \text{(as defined below)}$$

We now define the functions associated with the case markers. For each $f \in Den_E NP$, we can let erg be the identity on GQ. And for any f in GQ we let $dat(f)$ just be the restriction of f to the domain $\mathcal{R}_2$ and $\mathcal{R}_3$ – so $dat(f)$ is exactly like f except that it does not apply to elements of $\mathcal{R}_1$.

Now it is easy to see what the detransitivizing function u must be. It's domain is $\mathcal{R}_2$. For any R in $\mathcal{R}_2$, the function $u(R)$ maps any g in $Den_E KPd$ to the property $g(R)$, and it maps any g in GQ to the truth value $g(something(R))$, where $something(R)$ is the set of things that bear R to something, i.e. $DomR$.

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Finally, a model $\mathcal{M} = \langle E, \mu \rangle$ for Little Inuit is given by a nonempty set E and a mapping μ from expressions to denotations as follows:

Lexical Conditions:

(a) for all $\langle s, C \rangle \in Lex$, $\mu(s, C) \in Den_E C$

(b) $\mu(\text{-}erg, K) = erg$

(c) $\mu(\text{-}dat, K) = dat$

(d) $\mu(immi, NP) = SELF$

(e) $\mu(and, CONJ)$ maps σ, τ from $Den_E C$ to $\mu(\sigma) \wedge_C \mu(\tau)$

(f) $\mu(or, CONJ)$ maps σ, τ from $Den_E C$ to $\mu(\sigma) \vee_C \mu(\tau)$

(g) $\mu(nor, CONJ)$ maps σ, τ from $Den_E C$ to $\neg_C(\mu(\sigma) \vee_C \mu(\tau))$

Conditions on Derived Expressions:

(h) for $\langle \sigma, \tau \rangle \in DomNM$, $\mu(NM(\sigma, \tau)) = \mu(\sigma)(\mu(\tau))$, and for $\langle \sigma \rangle \in DomNM$, $\mu(NM(\sigma)) = \mu(\sigma)$

(i) for $\langle \sigma, \tau \rangle \in DomVM$, $\mu(VM(\sigma, \tau)) = \mu(\sigma)(\mu(\tau))$

(j) for $\langle \sigma, \tau \rangle \in DomPA$,

$$\mu(PA(\sigma, \tau)) = \begin{cases} \mu(\sigma)(\mu(\tau)) & \text{if } cat(\sigma) = KPa \ \& \ cat(\tau) = P1a \\ \mu(\tau)(\mu(\sigma)) & \text{otherwise} \end{cases}$$

(k) for $\langle \sigma, \tau, \eta \rangle \in DomBOOL$, $\mu(BOOL(\sigma, \tau, \eta)) = \mu(\sigma)(\mu(\tau), \mu(\eta))$

By this definition of models for Little Inuit, it is easy to calculate that in any model $\mathcal{M} = \langle E, \mu \rangle$, the sentence *john -abs immi -dat praised -u* has the desired interpretation:

$\mu(john \ immi \ \text{-}dat \ praised \ \text{-}u, S)$
$\quad = \mu(PA(\langle john, KPa \rangle, \langle immi \ \text{-}dat \ praised \ \text{-}u, P1a \rangle))$
$\quad = \mu(john, KPa)(\mu(immi \ \text{-}dat \ praised \ \text{-}u, P1a))$
$\quad = \mu(john, NP)(\mu(PA(\langle immi \ \text{-}dat, KPd \rangle, \langle praised \ \text{-}u, P1d \rangle)))$
$\quad = \mu(john, NP)(\mu(praised \ \text{-}u, P1d)(\mu(immi \ \text{-}dat, KPd)))$
$\quad = \mu(john, NP)(\mu(VM(\langle \text{-}u, Vaf \rangle, \langle praised, P2 \rangle))(\mu(immi \ \text{-}dat, KPd)))$
$\quad = \mu(john, NP)(\mu(\text{-}u, Vaf)(\mu(praised, P2))(\mu(immi \ \text{-}dat, KPd)))$
$\quad = \mu(john, NP)(u(\mu(praised, P2))(\mu(immi \ \text{-}dat, KPd)))$
$\quad = \mu(john, NP)(SELF(\mu(praised, P2)))$

Here the reflexive has an absolutive antecedent *john*. But a similar calculation shows that the reflexive in the sentence *john -erg bill immi -dat showed* takes the ergative antecedent. So generalization (16) holds in this simple language.

As for the structure of Little Inuit, we note first that reference to the noun- and verb- markers is structural:

Theorem 8 *In Little Inuit, expressions* $\langle \text{-}u, Vaf \rangle$, $\langle immi, NP \rangle$ *and* $\langle immi \ \text{-}dat, KPd \rangle$ *are grammatical constants.*

Let's say that α is an **argument** iff it has category KPe, KPa or KPd, and α a **predicate** iff it has category $P3, P2, P1d, P1e, P1a$ or $P1n$. Then define α and β to be **co-arguments** (of γ) in σ just in case all of the following conditions hold: α and β are arguments, γ is a predicate, for some τ that occurs in σ, either $\tau = PA(\eta_1, PA(\eta_2, \eta_3))$ or $\tau = PA(\eta_1, PA(\eta_2, PA(\eta_3, \eta_4)))$, where finally, $\alpha, \beta, \gamma \in \{\eta_1, \eta_2, \eta_3, \eta_4\}$. we can define the possible antecedent relation AA_{INU} as follows: $\alpha \, AA_{\mathrm{INU}} \, \beta$ iff α and β are co-arguments of γ where $\beta \in KPd$ and either $\alpha \in KPe$ or else $\gamma \in P1d$ and $\alpha \in KPa$. Notice how this corresponds to the informal generalization stated in (16).

Theorem 9 AA_{INU} *is structural in Little Inuit.*

4 Conclusions

Derivationally defined constituent structure relations are always "structural" in the sense that they are "identified" by the syntax. What is more surprising is that sometimes the property of being a particular morpheme is structural in the same sense. We presented 3 simple languages in which different lexical elements are structural in this sense. These languages are simple enough that the structural status of these elements can be demonstrated conclusively. In these same cases, the simplest descriptions of anaphor-antecedent relations (and many other properties that we did not explore) refer to these elements directly. This fits naturally with the idea that people interpret the structures they hear. There is no need to propose complex inaudible structures just so that the relevant properties are always coded in phrase structure (cf. Chomsky, 1991; Bittner & Hale, 1994).

The example languages raise many questions that are beyond the scope of this short paper. The semantics of each language uses a simple "lifting" operation to, in effect, allow functions to sometimes apply to their arguments in an order that does not match syntactic constituency. Finding a suitably restricted range of such interpretive options remains an open problem. For example, the set GQ characterized in section 3.1 is very much larger than necessary, as are most of the other sets $Den_E C$ for various categories C (Keenan & Westerståhl, 1994). And some of the work on syntactically scope in phrase structure based theories should find a formulation in this framework.

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