Null arguments and the inverse problem

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Abstract. Native speakers can reconstruct null arguments (pro, PRO) from a linear string of words where they are notoriously absent. How they solve this problem remains an unsolved and largely unaddressed issue. This article argues for a unified analysis of null arguments that relies on bare PF objects. The key assumption is that antecedent recovery takes place at LF if and only if unvalued φ-features (e.g., number, person) of a lexical element cannot be valued from the PF-input. The analysis unifies the theory of pro and PRO and further interprets null subject sentences without generating actual null subject pronouns. Evidence is considered from three languages each with distinct null argument profile: English (non-pro drop), Italian (consistent pro-drop) and Finnish (partial pro-drop). The model was formalized and tested deductively by a computer simulation.

Keywords: null arguments; control; pro-drop; top-down derivation; computational linguistics

1 Introduction

The notion of "recovery" plays a role in the theory of null arguments. Being inaudible, their syntactic and semantic properties must be recovered from an "overt linguistic context," as observed by Rizzi (1986: 520). To illustrate, consider the examples in (1)-(2).

(1)

a. *John wants to leave.*

b. *John wants Mary to leave*.

(2)

a. **John orders to leave*.

b. *John promises Mary to leave*.

A grammatical theory must explain why the thematic agent of *leave* is *John* (1a) but *Mary* in (1b), and why *John* does not constitute a possible antecedent in (1b). Furthermore, the antecedent relations change as a function of a change in the main verb (e.g., *want* → *order, promise*)(2a-b). Yet, the surface strings contain no direct cues for any of these properties while speakers still infer them effortlessly. How they accomplish this "inverse problem," as I will call it here, remains an unsolved and largely unaddressed issue that this article proposes to solve in a linguistically informed way. The solution argued for in this paper and developed on the basis of Borer (1986, 1989) is that null argument recovery is caused by the presence of an unvalued φ-set of a lexical item that cannot be valued morphosyntactically by using the resources available at the input. They are valued at LF, which results in the phenomenon known as control (here generalized and called "LF-recovery”). The analysis unifies the theory of pro and PRO. The system is then formalized within a framework developed on the basis of Phillips (1996, 2003) and Cann et al. (2005), in which syntactic derivation proceeds in a left-to-right order on the basis of the bare PF-input object, and is tested by computer simulation.

The material is organized in the following way. Section 2 reviews and elucidates the linguistic background, considering data from three languages with distinct null subject/object properties: English, Italian and Finnish. This section functions also to set the agenda by narrowing the empirical material that will be specifically addressed in this article. Section 3 presents the hypothesis, keeping with core ideas, while Section 4 addresses the details of formalization and simulation. Detailed properties of the computational simulation are reported in the supplementary document associated with this article and available online.

2 Background

2.1 The inverse problem

I will begin by illustrating some of the problems associated with the inverse problem solved by any competent native speaker. Let us consider one type of null argument, the little-pro. At first approximation, pro occurs in the position of the finite clause subject in the presence of subject-verb agreement. It is available in Italian (3a) and Finnish (3b), but not in English (3c).

(3) a. *(Io) parl-o.* (Italian) b. *(Minä) puhu-n.* (Finnish) c. **(I) speak-∅.*
I speak-1SG I speak-1SG
‘I speak.’ ‘I speak.’

We might therefore consider that the native speaker processing these sentences generates a null argument into the subject position on the basis of two facts accessible from the input: (i) presence of rich agreement (3a-b) and (ii) absence of an overt pronoun/subject. This initial guess turns out to be deceptively simple. Consider (4a-b).[1]

(4)
a. *Sembra essere io.* (Italian)
seems to be I
’It seems to be me.’

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[1] The following abbreviations are used in this article: 1/2/3 = first, second and third person; ADV = adverbial suffix/head (used here in connection with Finnish adverbial suffixes); A/INF = Finnish *A*-infinitival (roughly a ‘desirative’ *to*-infinitival); ACC = accusative case; GEN = genitive case; MA/INF = Finnish *MA*-infinitival; NOM = nominative case; PAR = partitive case; PL = plural; SG = singular; VA/INF = Finnish *VA*-infinitival (a ‘propositional’ infinitival complement).

b. *Nämä* *kirja-t* *ol-i* *halunnut* *ostaa* *Merjalta* *Jari.* (Finnish)
these book-PL.ACC had-3SG wanted to.buy from.Merja Jari.NOM
'Jari had wanted to buy these books from Merja.'

These sentences do contain an overt grammatical subject, but it occurs in a noncanonical position. For example, while the canonical word order in Finnish is SVO, the preverbal position in (4b) is occupied by the direct object, and the grammatical subject is in the last position of the clause, behind a sequence of finite and non-finite verbs. Because the subject occurs in the last position, speakers must analyze the whole sentence to judge if a subject is missing. The parser must, furthermore, provide the sentence with a real parse in order to recognize that 'these books' constitutes a direct object and 'Jari' could potentially fill in the role of the grammatical subject. It must do this without assuming that neither of these phrases are proper names or prototypical and/or simple DPs: "these books" could be substituted with "the book that I discussed yesterday with Bill" and "Jari" with "the president of an association I am a former member of," showing that the first pass parse must perform real parsing with no artificial limit imposed on complexity. Simple cues such as case marking are insufficient: Finnish has both nominative direct objects and non-nominative subjects/thematic agents (Vainikka 1989; Nelson 1998). Finally, the first pass parse must be correct. If the parser errs, conditions for the null subject could be satisfied in the wrong way. Thus, the simple task of finding out whether a grammatical subject is missing, just to mention one example, represents a nontrivial challenge for the human language comprehension system. I will call this *the inverse problem*: how the human language system infers properties of null arguments and/or associated semantic interpretations from the bare PF input where they are absent.

2.2 Introduction to null subjects

Before looking at the inverse problem it is useful to gather the basic linguistic facts concerning null arguments. The several decades of work that began with the discovery of null arguments (Rosenbaum 1967; Postal 1970; Rosenbaum 1970; Brame 1976; Perlmutter 1971) and continued during the GB-era and beyond (e.g., Chomsky 1980, 1981; Rizzi 1982; Hyams 1989; Jaeggli 1980; Chomsky 1982, to mention a few sources) have provided an overall taxonomy of null arguments that I will use as a starting point in this work.

The finite null subject pro illustrated by the example (3) constitutes a subtype of null arguments connected in some way to subject-verb agreement (Perlmutter 1971; Rizzi 1982, 1986; Chomsky 1982; Taraldsen 1980; Huang 1984; Jaeggli and Safir 1989). In a language such as Italian with rich verbal agreement, the subject pronoun of a finite clause can be omitted or silenced phonologically. In a language such as English and French with meager agreement, subjects cannot be silenced. Matters are complicated by the existence of partial pro-drop languages, such as Finnish or Hebrew, in which only a subset of finite subject pronouns can be silenced (Vainikka and Levy 1999; Holmberg 2010). The third person pronoun can be silenced in Finnish if and only if there is both subject-verb agreement *and* a suitable antecedent (5). The second condition distinguishes Finnish from a consistent pro-drop language such as Italian.

(5)

a. *pro *halua-a* *ostaa* *kirja-n*./ pro *halua-n* *ostaa* *kirja*-n.
want-3SG to-buy book-ACC want-1SG to-buy book-ACC
'He wants to buy a book.' 'I want to buy a book.'

b. *Jari*$_1$ *sanoi* *että* [pro$_1$ *halua-a* *ostaa* *kirja-n*.]
Jari said that want-3SG to-buy book-ACC
'Jari said that he (=Jari) wants to buy a book.'

Only the coreference reading (*John* = pro) is available in (5b). This example shows that, at least in some languages, pro requires both formal licensing, a set of grammatical properties which determine when it is available (compare 5a-b), and antecedent recovery. The data in (5) further complicates the inverse problem, because the acceptability of the third person null argument in Finnish depends on the larger context, not only on the local agreement or case assignment.

Pro can be distinguished from a different type of null argument that is not licensed by agreement and exhibits (at least in appearance) different recovery behavior. It is illustrated by (1-2) and (6) below.

(6)

a. *John*$_1$ *wants* PRO$_1$ *to leave*.

b. **John orders to leave*.

c. *John wants Mary to leave*.

d. *John*$_1$ *promises Mary*$_2$ PRO$_{1,*2}$ *to leave*.

PRO, which is often used to signify the missing argument, occurs in subject positions of infinitival verbs and gerundive nouns that exhibit neither morphosyntax nor impoverished morphosyntax (see, e.g., Boeckx and Hornstein 2004; Culicover and Jackendoff 2001; Landau 2000, 2003, 2004, 2013; Hornstein 2001, 1999; Manzini and Roussou 2000; Chomsky 1980, 1981; Martin 1996; Rosenbaum 1967, 1970; Postal 1970). Recovery cannot rely on agreement suffixes. Recovery, called *control* in the literature, is a matter of prototypically local, finite clause-bound dependency that selects for c-commanding subjects and direct objects, although both c-command and locality can be regarded only as typical and not necessary properties of control (see Landau 2013, ch. 4.1.2).[2] This makes it possible to hypothesize, however, that pro and PRO

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[2] Nonlocal control is illustrated by examples such as *John thinks that it will be difficult PRO to leave*. Chomsky (1981) notices several pragmatic factors that regulate long-distance recovery and suggests that the null anaphor (PRO) "searches for a possible antecedent within its own clause, and if it can't find one there, looks outside" (p. 78). The LF-recovery algorithm proposed in the present work to account for control

share an anaphoric component (Borer 1989; Huang 1989). However, Italian finite null subjects are not anaphoric in this sense, and in Finnish and Hebrew anaphoricity is limited to third person null subjects.

If no antecedent is present, an impersonal or arbitrary interpretation results that refers to 'people in general'. This is illustrated by (7a). The same interpretation results when an object is null (7b). This construction is not grammatical in English.

(7)

a. PRO$_{arb}$ *to give up too easily would be a mistake.*
   'For people in general, it would be a mistake to give up too early.'

b. *Epäonnistuminen* *pakotta-a* __ [*harjoittelemaan* *enemmän.*] (Finnish)
   failure forces-3SG to.pracise more
   'A failure forces *(one) to practice more.'

Another similarity between PRO and pro is the fact that in Finnish also a pro-construction can create the generic or impersonal interpretation (8), corresponding perhaps best with the English 'one'.

(8) *Tässä* *istuu* *mukavasti.*
   in.here sit-3SG comfortably
   'One can sit here comfortably.'

This observation presents a further challenge to the solution of the inverse problem. Sentences like (8) involve third person agreement without grammatical subject and/or an antecedent, yet the sentence is not ungrammatical. It is grammatical, however, only if interpreted as generic or impersonal. In addition, the sentence evaluates as ungrammatical if the preverbal position is not filled in by the locative PP or by another suitable phrase (see Holmberg and Nikanne 2002 and Huhmarniemi 2019 for useful discussion).

Although the verbal sequence 'want – to leave' can occur either with or without the infinitival agent argument in English (*John wants Mary to leave*, *John wants to leave*), in Finnish only the controlled version is grammatical (9). This creates *obligatory control* (also referred to as "OC constructions" in the literature).

(9)

a. *Jari halusi lähteä.* (Finnish)
   Jari wanted to.leave
   'Jari wanted to leave.'

b. **Jari halusi Merja-n lähteä.*

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dependencies will not be sensitive in any way to the finite clause boundary, accepting the general line of thought in Landau (2013) that dispenses with the idea that control were confined to infinitival domains.

Jari wanted Merja-GEN to.leave

'Jari wanted Merja to leave.'

The pattern reverses if we use a different infinitival construction, the "VA-infinitival" (10).[3]

(10)

a.	**Jari*	*halusi*	*lähte-vän.*	(Finnish)
	Jari.NOM	wanted	leave-VA/INF	
b.	*Jari*	*halusi*	*Merja-n*	*lähte-vän.*
	Jari.NOM	wanted	Merja-GEN	leave-VA/INF
	'Jari wanted Merja to leave.'			

Thus, whether the subject of an infinitival is null obligatorily or optionally depends in some manner on the constitution of the selecting item and the selected item; neither is sufficient if considered in isolation.

The above discussion neither assumes nor presupposes that the null arguments are silenced pronouns. Indeed, several grammatical theories do not make that assumption, and I will reject it as well. How null arguments are represented in grammar is the problem a theory of null arguments must solve, not assume. The interest is, instead, in deriving the syntactic and semantic properties for sentences in which we 'hear' the presence of an argument that does not correspond to one visible in the surface string. For example, something must tell an Italian speaker that *adori Luisa* 'admire.2sg Luisa' means that 'you admire Luisa' and a Finnish speaker that *Pekka sanoi että ihailee Merjaa* 'Pekka said that admire.3sg Merja' means that the main clause subject and the agent of admiring must be the same. A theory of null arguments, whether it takes the inverse perspective assumed here or something else, must describe and explain these dependencies.

3 Null arguments and the inverse problem

3.1 Introduction

In this and the next section I will look at the problem of null arguments reviewed in the previous section from the point of view of the inverse problem. When analyzed from such vantage point, every rule or principle must be formulated by referring exclusively to overt PF-objects or to a structural interpretation generated directly from such objects. The justification for this assumption is the fact that native speakers can provide correct structural and semantic interpretation for sentences in their own language without consulting

[3] Finnish A-infinitivals, such as *want*, are often desirative in meaning, or perhaps they have future tense, whereas the VA-infinitival is more propositional and exhibits overt past-present tense alteration (but not finiteness properties). In both cases, the thematic agent of the infinitival is located inside the infinitival phrase by all syntactic tests, and further contrasts with infinitivals in which the thematic agent is part of the main clause. For Finnish infinitivals, see Koskinen (1998) and Vainikka (1989).

anything else expect the surface string. Moreover, the process is effortless; null arguments do not create garden paths, not at least in the standard cases that constitute the empirical corpus of the examples addressed in this study.

A theory of this type must contain two ingredients. It must contain a formal framework implementing a *parser* (i.e. function from PF-objects into sets of LF-objects) and an embodiment of an analysis of null arguments within that framework. I will begin by formulating the analysis of null arguments and then turn to the implementation of the PF-LF function, which I develop on the basis of Phillips (1996, 2003) and the dynamic syntax framework (Kempson et al. 2001, Cann et al. 2005). I will provide an overview of the formalization of the proposed analysis later in Section 4, but leave the details to the supplementary document since the analysis itself proposed in this article could be implemented within a wide variety of parser frameworks.

3.2 pro

A necessary first step in solving the inverse problem is the retrieval of lexical items and their features on the basis of phonological words occurring at the PF-input. In addition, agreement suffixes must also be extracted and isolated in order to handle the pro-drop phenomenon. Let us therefore begin from the assumption that phonological words occurring in the input are matched with a linear string of *lexical items* (LIs) retrieved from the *surface vocabulary*, each lexical item consisting of a set $\{f_1, \ldots, f_n\}$ of features. If the phonological word contains several primitive grammatical items, they are decomposed before being matched with lexical items fed into syntax. The process is illustrated in Figure 4.

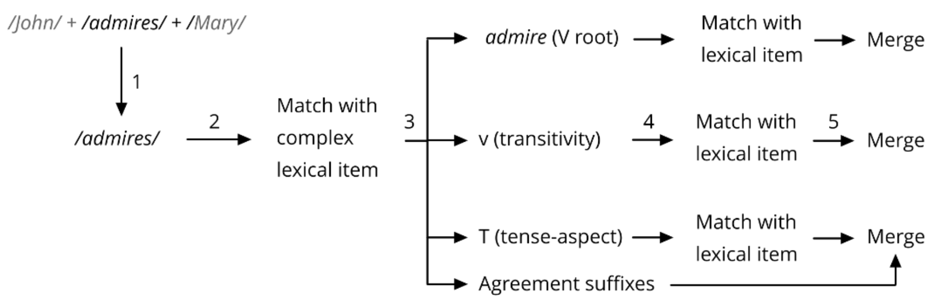

Figure 4. A schematic overview of the structure of the surface vocabulary and the computational operations involved in lexical decomposition. The pipeline contains the following steps: (1) consume a phonological word from the input; (2) match the word with a lexical entry, or a list of lexical items if it is ambiguous, in the surface vocabulary; if the matched lexical entry was complex, break it into primitive parts (3), each of which is then matched with a primitive lexical item (4); Merge (i.e. attach) the lexical item into the phrase structure. If a component of a word maps to an inflectional affix, it creates a corresponding feature. This means that a feature can appear through the "lexical route" (i.e. from the lexicon) or through the "input route" (i.e. as an element, such as a suffix, in the PF-input).

Morphological decomposition, Step 3 in Figure 4, can be established at least in two ways. One way is to match a complex phonological word directly by its morphological decomposition. Perhaps such ‘automatized’ processing applies when the word is already well-known and in regular use within a community of speakers. Another way is to perform explicit morphological decomposition. The latter operation could be in operation during language acquisition (L1, L2) and when the word contains something that is not recognized, such as a new stem. Both processes we applied in the present study, but I will nevertheless ignore most of the details of the morphological decomposition, as the main analysis does not depend on any particular theory or implementation of morphology. What matters is that there is a way to transmit agreement features appearing at the PF-input into syntax.

To establish a connection between pro-drop and agreement, let us assume that agreement suffixes are extracted from phonological words and stored as features of grammatical heads, as shown by the arrow “agreement suffixes” in Figure 4. There are two types of φ-features. A proper name retains its *interpretable* φ-features no matter where it occurs in the structure, whereas the same features at the finite verb are *uninterpretable* and reflect those of a local argument. Let us assume, therefore, that proper names and other nominals obtain their φ-features via the lexical route, whereas the finite verb gets them via the input route (Figure 4). The received view maintains that finite T comes with an *unvalued* φ-set (denoted by φ_ in this article) that will reflect the intrinsic φ-features of a local argument. I assume this framework here. Whether a functional head has φ_ is determined lexically. We say that an element with intrinsic φ-set *values* an unvalued φ_ by an operation *Agree* (Chomsky 2000, 121–26). The operation is illustrated in (11). The element with unvalued features is called the *probe*, its counterparty the *goal*.

(11)	*John*		*admire-s*	. . .
	3SG	←Agree→	φ_	
	goal		probe	

The mechanism in (11) assumes that φ_ is valued by the intrinsic/interpretable φ-features of *John*. If we look at the situation from the inverse perspective, then another possibility is that φ_ is valued by the overt verbal agreement features (*admire+s*) that was extracted from the PF input according to the architecture proposed in Figure 4. That feature arrives via the input route and not by the lexical or syntactic route. Let us assume, tentatively, that φ_ can be valued *either* (i) by a local DP-argument (if any) by means of Agree *or* (ii) by overt φ-features of the head itself, if present in the input and thus part of the feature composition of T. The second route is illustrated by the Finnish pro-drop sentence (12).

(12)	*Ihaile*	*-n*	*Merja-a.*	(Finnish, grammatical pro-drop construction)
	admire	-1SG	Merja-PAR	

φ_ ← 1SG
‘I admire Merja.’

Given that there is a connection between pro-drop and agreement, we can now make the crucial hypothesis that valuation by agreement suffixes in the absence of overt subject provides a derivational path for sentences like (12). This in turn means that valuation by means of an overt pronoun and by means of overt agreement suffixes must be “equivalent” with respect to the output of the operation. No null pronoun is projected. The necessary and sufficient conditions for determining whether the subject *is* missing (a property that we do not get for free, see Section 2.1) will be addressed later in Section 4.

This analysis of pro-drop agrees with the style of analysis developed by Alexiadou and Anagnostopoulou (1998), Barbosa (1995, 2009), Manzini and Savoia (2002), Borer (1986, 1989) and Platzack (2004), all which differ from each other in details but are united by the assumption that agreement suffixes are ‘pronominal’ enough to assume the role of a full subject pronominal. The analysis disagrees with Holmberg (2005) and most of the literature on Finnish (Vainikka 1989; Vainikka and Levy 1999; Vilkuna 1989, 1995) and other analyses (Cardinaletti 2004; Sheehan 2006) that claim that the clause must contain a covert phrasal subject at Spec,TP. The issue is nontrivial, because Finnish exhibits a strong ban on verb-initial clauses and hence has some type of finite EPP condition in operation. The issue and the proposed hypothesis are, therefore, nontrivial. I will return to this matter later.

The overt φ-cluster at T has no anaphoric properties, which means that the analysis still fails to capture properties of the Finnish/Hebrew third person pro. There must be some condition that comes into play and is not present in Italian. Holmberg (2005) and Holmberg and Sheehan (2010) propose a solution that I will adopt here. They propose that the Finnish third person pro contains an unvalued D-feature (here denoted by D_) that must be valued by means of an antecedent. To transform this idea into the inverse comprehension perspective, we must posit a condition to the effect that the overt Finnish third person agreement suffix in the input values the person and number features but does not value D_. This would make the third person suffix a “variable-like,” in the sense that it misses at least one referential feature.[4] Suppose, furthermore, that the presence of an unvalued and hence uninterpretable D-feature triggers a *recovery mechanism* at LF that attempts to locate a suitable antecedent, providing the missing value. The idea is illustrated in (13).

(13) *Jari* *sanoo* *että* *ihaile-e* *Merja-a.*
[Jari [says [that admire-3SG Merja-PAR]]]

[4] I am assuming that D_ hosts values such as ‘definite’, ‘indefinite’ and ‘generic’, but the list is not meant to be interpreted as exhaustive. If the absence of any of these values makes the element to behave like a variable, then D_ (or at least some of its values) must be the locus of referentiality (i.e. constant interpretation under the standard Fregean first-order logic).

D ⟵———Recovery———⟶D_ (3SG)

‘Jari says that he (=Jari) admires Merja.’

The LF-recovery mechanism constitutes a last resort operation that deals with an uninterpretable feature. What constraints it? One condition is c-command: if an argument with a matching φ-set is found that c-commands $T_{D\_}$, that element will be selected as the antecedent (Vainikka and Levy 1999; Holmberg 2005, 2010; Holmberg, Nayudu, and Sheehan 2009). Thus, in example (13), Jari *must* be the antecedent. An element that is c-commanded by the variable can never be selected, for example. On the other hand, very few reliable locality conditions have been reported in the literature, so I will assume that the antecedent search for D_ is in principle unlimited in upward distance, as argued by Holmberg and Sheehan (2010). Any c-commanding third person antecedent can be selected as a legitimate target.[5] This property will be later used to capture the phenomenon of finite control.

The pro-drop phenomenon is absent in English. Adopting the basic idea of Jaeggli and Safir (1989), I rely on the fact that the English agreement suffixes are ambiguous: *admire* is consistent with several pronouns, *admires* with two gender features (*he* or *she*). If the agreement features at a head, as seen by syntax during the derivation (in whichever way they have originated), cannot be associated with an unambiguous pronoun, then the null argument reconstruction from φ-features at the head fails. Conflicting or incoherent phi-sets block pro-reconstruction, as they would lead into an uninterpretable and/or impossible pronoun; otherwise the mechanism is available, thus “by default.” If a lexical item contains no φ-features, no conflict arises and null arguments are automatically licensed.[6] This will be used to capture completely agreementless radical pro-drop languages such as Chinese, Japanese and Korean (Rizzi 1986; Huang 1984). This system provides a reinterpretation of the morphological uniformity hypothesis of Jaeggli and Safir (1989). I will return to the derivation of radical pro-drop languages later in this article.

The analysis presupposes a theory of Agree and its inverse version, call it Agree^{-1}. I assume that φ_ can agree with (i) a sister DP, (ii) DP inside its sister, and with (iii) the specifier DP, and in this order, with successful match blocking further operation. These options are illustrated in (14), with the possible goals being α, β and γ. The operation searches the sister first (β, γ), then SPEC (α).

(14) [$SPEC_{\alpha}$ [T(φ_) [$_{\beta}$. . .DP_{γ}. . .]

[5] Holmberg and Sheehan (2010) have reported several examples in which an antecedent is selected that does not c-command the D_, but in these examples no structural c-commanding antecedent is present.

[6] Unless, of course, there is another condition that blocks it. No such condition was assumed in this study, but I do not rule them out either.

While the theory of Agree is usually formulated so that it only allows (i-ii), condition (3) constitutes a useful or perhaps only heuristic starting point when working with PF-objects that will often have arguments at specifier positions in the surface string. It should be emphasized that I am not insisting that (14) constitutes the best, optimal or even a good formulation of Agree^{-1}; rather, it was found to work with the dataset included into the present study while it still left certain exceptional constructions in Finnish unaccounted for. I discuss the matter in detail in the supplementary document.

I assume the *phase impenetrability condition*, which prevents Agree^{-1} from searching below/above vP and CP (Chomsky 2008, 2000: 108). This prevents T from agreeing with an argument over an arbitrary distance (e.g., **we think-s that John admires Mary*, with Agree^{-1} (*thinks*, *John*)). To rule out sentences in which the verbal agreement suffixes and the φ-features of a local DP argument do not match (e.g., **John leave*), I assume that the final φ-set at any given head, resulting from Agree^{-1} and local φ-features, must not involve a feature conflict. For example, a situation in which a third person subject is combined with first person agreement will be filtered out.

Not all heads trigger agreement, less so carry overt agreement suffices. An agreeing head must have some property allowing it to host and express φ-features. I do not know what this property is, but because it is needed in the calculations I will assume that it is represented by a lexical feature ±VAL(uation). A head marked for –VAL will not be able/will not to value φ_ and Agree^{-1} is not triggered. Agreementless particles, connectives and other such items are also marked for –VAL. The feature also distinguishes object-verb agreement languages from languages that only allow subject-verb agreement. The former, and not the latter, have VAL-marking in some of the verbal components (v, V). Similarly, Finnish, like Hungarian, exhibits a wide variety of infinitival finite agreement (discussed briefly later) which will be captured by assuming that these infinitival heads are marked by +VAL. In English and Italian, most or all infinitival heads are marked for –VAL.

To summarize, lexical items may enter the derivation from the sensory system/lexical system with an unvalued φ-set that requires valuation. Whether a lexical item has an unvalued φ-set (φ_) and whether it required it to get valued by Agree^{-1} is decided in the lexicon.[7] The former property is controlled by the presence/absence of φ_, the latter by feature ±VAL. I will use the abbreviation ±PHI for the former property (presence and absence and φ_). An unvalued φ-set in the category (+PHI, +VAL) may get valued either by overt argument or by verbal agreement suffixes, the latter option creating a necessary condition for pro-drop. If a feature arrives at LF unvalued, antecedent recovery attempts to value the features semantically by

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[7] This hypothesis is problematic because it implies that the distribution of ±VAL should be completely random. It is not. Hence, I suspect that there is more to this than just a lexical feature, but I do not understand the matter enough to propose anything.

searching for an antecedent. This explains what happens for φ_ features in the category (+PHI, –VAL): they do not get valued by Agree^{-1} (–VAL), hence valuation will be attempted at LF.

Table 1. Four types of predicates posited in this study

	–VAL	+VAL
–PHI	Frozen particles that do not introduce or are not linked with arguments (e.g., *and*, *but*, *that*)	Words that agree by concord?
+PHI	Predicates that are linked with arguments but do not exhibit Agree-1. This category will play a key role in PRO/control	Predicates linked with arguments by valuation of phi-features and exhibit Agree-1 (e.g. finite verbs in Finnish, Italian, English).

The whole analysis works, in principle at least, by proceeding from nothing but bare PF-objects. There is no stage at which the existence of an invisible/inaudible pro is assumed. Features ±ARG and ±VAL are lexical and retrieved on the basis of the sensory input, whereas Agree^{-1} is formulated so that it applies to a phrase structure reconstructed form the overt PF-input.

3.3 Control

An unvalued feature at the LF interface was assumed to trigger LF-recovery. In the case of Finnish/Hebrew third person pro, the triggering feature was D_. Let us generalize this proposal and say that if all φ-features (at least D, number, person) remain without value at LF, then the closest c-commanding argument that can value these features (and does not have conflicting valued phi-features) is selected as an antecedent. The proposed mechanism is based on the Minimal Distance Principle (MDP) originally proposed by Rosenbaum (1967, 1970; see also Lasnik 1991), well-known for its shortcomings but useful as a starting point and attractive in its simplicity. Consider a situation in which the PF-interface is provided with (15). I will ignore, for the time being, the syntactic status of the infinitival marker *to*. It is assumed that the infinitival verb *leave* contains φ_ as a lexical feature, hence it is a +PHI, –VAL head.

(15) *John$_{\varphi}$ wants$_{\varphi_}$ to leave$_{\varphi_}$*

The infinitival verb *(to) leave* does not exhibit overt agreement and there is no local argument in the sense of (14) that Agree^{-1} could detect. Feature φ_ will arrive at LF unvalued. This triggers the LF-recovery algorithm which selects the closest antecedent, which is *John* in (15-16). I notate LF-recovery antecedents in the examples by writing "*φ_=John*", with the identity symbols signaling the output of LF-recovery and not morphosyntactic feature valuation by Agree^{-1}.

(16) *John$_{3sg}$* [*wants$_{\varphi_=3sg}$ to leave$_{\varphi_=John}$*].

If an argument occurs between the agent of the main verb and the infinitival, then it will be selected as an antecedent (*John wants Mary to leave*$_{\varphi\_=Mary}$). This will provide an antecedent for the infinitival verb and link it with an argument missing from the input. No PRO is projected; we keep within the framework in which everything is reconstructed form the overt PF-input. The analysis is crucially based on earlier work by Borer (1986, 1989), who proposed that null pronouns themselves are not anaphoric; instead, anaphoric behavior emerges from agreement features of functional heads. Borer assumes, furthermore, that each functional head with agreement features comes with the property that it must be "linked" with an argument (that she calls "I-subject") in its "accessible domain." The agreement reconstruction process (Agree^{-1}, (14)) proposed in the present work can be thought of an inverse variation of Borer's linking principle.

The analysis presupposes that we distinguish antecedent recovery for D_(definiteness) and φ_ (person, number): the latter will create standard control, the former a more liberal antecedent recovery observed in connection with Finnish partial pro-drop. The fact that Finnish third person null subject antecedent differs from obligatory control (OC) and non-obligatory control (NOC) PRO constructions was argued convincingly by Holmberg and Sheehan (2010). Landau (2013, 93–94) argues for the same conclusion. I assume, following these works, that the nature of recovery depends on the nature of unvalued φ-features arriving at the LF-interface: D_ valuation alone creates the Vainikka-Holmberg-Sheehan signature of the Finnish partial third person control, whereas additional features, such as number and person, require strictly local antecedents. Further distinctions are of course possible (e.g., logophoric and/or topic-based antecedents), but they should ultimately depend on a more rigorous theory of the interpretation and function of phi-features that I do not attempt to deal with here and do not know how to approach. The present dataset, containing expressions from English, Italian and Finnish, was deduced without further distinctions.

What happens if φ_ cannot be valued even at LF? This situation occurs if morphosyntactic valuation fails and recovery finds nothing. I will assume that if φ_ remains unvalued, a *generic interpretation* is created by recovery.

An obligatory control structure (OC) arises under this analysis if (and only if) a lexical item has φ_ but neither thematic subject argument nor agreement suffixes can be projected. These must be (+PHI, –VAL) predicates (Table 1). This results in a clause that cannot host a subject argument (a property still to be captured) or generate agreement suffices (–VAL) but still requires an antecedent (+PHI). Sentence (17) provides two examples of obligatory control structures.

(17)

a. *John began (*Mary) to leave*$_{\varphi\_}$.

(+PHI, –VAL)

b. *John tried (*Mary) to* *leave*$_{\varphi\_}$.
(+PHI, −VAL)

The class is syntactic: even when a thematic subject argument is available, it can co-refer with the main clause agent (compare *John wanted himself to resign* vs. *John wanted to resign*). It cannot be, then, that only *began* (and not *want*) is compatible with a 'reflexive meaning' in which the main clause subject and the embedded subject denote the same thing. On the other hand, the meaning of *began* does imply that the 'agent of beginning' and the 'agent of the event that thereby begins' are connected *conceptually*: it is not possible to begin something if the 'agent of doing' is separated conceptually from the 'agent of beginning' (see Farkas 1988 for a similar proposal). Furthermore, it is not required that the two agents are the same; only that they cannot be separated conceptually. This is due the existence of partial control, which requires internal conceptual connection without identity (Landau 2000; Wilkinson 1971).[8]

We now have to formalize these assumptions. There are again several possible implementations. Let us assume that a verb such as *begin* has a lexical feature 'SEM:internal', and a head with the opposite profile (e.g. *persuade*) will have the feature 'SEM:external'. Feature 'SEM:internal' means that the agent of the verb and the selected infinitival must be linked conceptually; 'SEM:external' forces the opposite behavior, forcing non-conceptual, external linking. Thus, the intuition that *begin* requires that its agent is connected conceptually with the agent of the complement clause is formalized by assuming that *begin* has a lexical feature 'SEM:internal', whereas *persuade* has the opposite property 'SEM:external'. The verb *want* has neither, because it is compatible with both interpretations (*John wants to leave*, *John wants Mary to leave*). A formal mechanism is then required for connecting the presence of this feature at the main verb to the absence of an independent θ-role inside the vP/VP of the selected infinitival. Let us assume that the relevant feature is ±ARG such that −ARG renders the selected VP unable to project a separate thematic argument to its specifier while +ARG forces projection of a thematic agent. For example, if the infinitival *to* is marked for +ARG, then the infinitival verb it selects is able to project an independent thematic agent; if the specification is −ARG, we get a truncated structure 'to+V' with no argument between. We can then capture the phenomenon by providing that 'SEM:internal' requires the selected head to have −ARG (18).

(18)

a.	*John*	*tries*	*to*	*leave*.
		[SEM:internal]	−ARG	V (with no SPEC)
		$\longrightarrow$	$\longrightarrow$	

[8] When the agent of the infinitival is reflexive (*John wanted himself to resign*), conceptual separation is possible, and thus it feels as if the agent targets himself 'externally', in a way in which the identity between the agent of wanting and the agent of resigning is accidental.

b. *John* *persuades* *Mary*$_1$ *to* ___$_1$ *leave.*
[SEM:external] +ARG V (with SPEC)

It follows that the φ_ features at the embedded infinitival *leave* in the example (18a) will have to be valued by the main clause subject by LF-recovery, and we get the OC-signature.

It is not absolutely necessary to handle these dependencies by assuming the ±ARG mechanism: we could instead posit a direct nonlocal, non-selection based link between the main verb and the VP. What matter is that there *is* a grammatical dependency between the lexical feature at the verb and the projection of a thematic argument inside the VP. The details will depend also on the analysis of the grammatical structures involved, in particular, the analysis of the infinitival complement clause.[9]

To summarize, the SEM creates three classes of control predicates: SEM:internal (*John tried (*Mary) to leave*$_{\varphi\_}$), SEM:external (*John persuaded *(Mary) to leave*$_{\varphi\_}$) and neither (*John wanted (Mary) to leave*$_{\varphi\_}$). Because SEM:external requires that the argument it projects and the argument below are *not* connected conceptually, the presence of this feature must limit upward antecedent search at LF. This restriction was added as a formal condition to the antecedent search at LF. The search is blocked by the presence of 'SEM:external' at a head. Symbol v* is used in this study for a transitivizer with this feature (e.g. *order* = v* vs. *want* = v).

One detail of this analysis left unaddressed was the question of whether LF-recovery leads into formal valuation or whether it is something that only the semantic component (outer edge of the LF, conceptual-intentional system) handles. If LF-recovery does not change the feature composition of any element inside narrow syntax, then no grammatical operation inside NS can see its output. I will leave the matter largely unanswered since the proposed algorithm does not generate formal compositional interpretations and the matter can therefore be modeled freely either way.

3.4 Mapping PF-objects into LF-objects: left-to-right architecture

An analysis was proposed in the previous sections that could, at least in theory, work within the inverse framework. Everything that is required is put together from overt components available in the PF-input. To show that the proposed system solves the inverse problem, we must show that the correct antecedent properties are derived from nothing but PF-inputs and that, furthermore, the system rules out ungrammatical variations. To construct an argument of this kind, certain minimal requirements must be satisfied. First, we need a function that maps incoming words into plausible phrase structure objects that contain lexical items

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[9] The inverse perspective nevertheless pressures one to work without positing too much covert structure that cannot be inferred directly from the PF-input.

with the relevant features (e.g., ARG, VAL, φ_, D_, D, φ) and structural configurations presupposed by Agree^{-1} and antecedent search. There are several ways to implement the mapping. A left-to-right architecture of Phillips (1996, 2003) was adopted in this study. According to this system, Merge can operate in tandem with reading words from the input in a left to right order. The process is illustrated in (19).

(19)	*John*		*admires*	*Mary*	(Input sentence read from left to right)
	|		|	|	
	[John		admires]	|	(First Merge)
	[John	[	admires	Mary]]	(Second Merge…)

On the other hand, a parser of this type cannot know *a priori* how the incoming words should be merged. Ambiguous inputs must be mapped to several phrase structure objects. The system was enriched with basic recursion that reads words from the input, matches them with lexical items in the lexicon, creates a search space based on the possible and plausible merge sites in the existing phrase structure (following Phillips' left-right architecture), explores the search space in a well-defined order, and consumes the next word until all words have been processed. The parser backtracks if the output is not well-formed; the input is judged ungrammatical if no solution if found. The algorithm explores all solutions that can be created from any given input string. More detailed discussion of the parser framework is available in an online supplementary document to this article.

4 Formalization and testing

4.1 Introduction

The analysis elucidated in the previous sections was formalized in order to verify that it can solve the inverse problem. This formalization and the results will be discussed in this Section. I used a machine-readable formalization (Python programming language) to automatize all calculations. A machine-readable formalization does not differ from regular linguistic formalization; on the other hand, it provides several advantages over purely symbolic formalization. Running calculations becomes a matter of starting one script. The second advantage is that a machine-readable formalization requires the researcher to be fully explicit about every assumption, principle, and computational step in the analysis. Since there is no ambiguity in the analysis, verification and replication becomes trivial. Third, the calculations can be done efficiently, with the speed of ~10ms per sentence in the present study. Finally, the whole formalization can be deposited into public domain where it can be shared, examined, criticized, and developed.

The deductions were done in the following way. The input consists of a *test corpus* containing 2512 null argument sentences from Italian, Finnish and English that captured the various properties relevant to the proposed analysis. These are summarized in Table and discussed in more detail in the supplementary document.

Table 1. Structure of the test corpus as categorized by the construction type.

Sentences	Pro-drop	Agreement	Word order	Embedding	Control	Comment
1-82	n/a	n/a	n/a	n/a	n/a	Sentences cited in the main article
83-103	No	Grammatical	Canonical	No	No	Canonical agreement
104-130	No	Grammatical	Canonical	No	Yes	Canonical control
131-144	No	Grammatical	Canonical	Yes	No	Canonical embedding
145-171	No	Grammatical	Canonical	Yes	Yes	Control under embedding
172-246	No	Grammatical	Noncanonical	No	No	Noncanonical word order
247-1186	No	Grammatical	Noncanonical	No	Yes	Control with noncanonical order
1186-1261	No	Grammatical	Noncanonical	Yes	No	Embedding and noncanonical word order
1262-1503	No	Grammatical	Noncanonical	Yes	Yes	Embedding, control and order
1504-1541	No	Ungrammatical	Canonical	No	No	Agreement errors
1542-1568	No	Ungrammatical	Canonical	No	Yes	Control with agreement errors
1569-1600	No	Ungrammatical	Canonical	Yes	No	Agreement errors and embedding
1601-1627	No	Ungrammatical	Canonical	Yes	Yes	Control with agreement errors and embedding
1628-1807	No	Ungrammatical	Noncanonical	No	No	Noncanonical order with agreement errors
1808-2051	No	Ungrammatical	Noncanonical	No	Yes	Control, agreement and noncanonical order
2052-2081	No	Ungrammatical	Noncanonical	Yes	No	Embedding, order and agreement errors
2082-2099	No	Ungrammatical	Noncanonical	Yes	Yes	Control, agreement, order and embedding
2100-2116	Yes	Grammatical	Canonical	No	No	Basic pro-drop
2117-2143	Yes	Grammatical	Canonical	No	Yes	Pro-drop with control
2144-2151	Yes	Grammatical	Canonical	Yes	No	Pro-drop with embedding (partial pro-drop)
2152-2178	Yes	Grammatical	Canonical	Yes	Yes	Pro-drop with embedding (partial pro-drop)
2179-2194	Yes	Grammatical	Noncanonical	No	No	Pro-drop with noncanonical word order
2195-2260	Yes	Grammatical	Noncanonical	No	Yes	Pro-drop, word order, and control
2261-2266	Yes	Grammatical	Noncanonical	Yes	No	Embedding, word order and pro-drop
2267-2510	Yes	Grammatical	Noncanonical	Yes	Yes	Pro-drop, order, control and embedding
-	Yes	Ungrammatical	Canonical	No	No	n/a (i.e. pro-drop and agreement error)
2511-2512	n/a	n/a	n/a	n/a	n/a	Miscellaneous items (two adverb tests)

The model processed, by one run, the whole corpus and produced two files as output, one which contained the solutions together with deduced null arguments and antecedents, and another which contained detailed derivational logs. These, together with all input files, are provided in the public domain. They constitute the raw data of this study; the results are discussed selectively in the main article.

Each sentence processed by the model was numbered consecutively during the execution, and these number identifier (#1-2512) were used by the algorithm in the output (see also Table 1). Thus, it is possible to find a step-by-step derivation for any sentence by searching for its identifier string (e.g. "# 5", "# 2313") from the log file. These numbers and sometimes even the line numbers in the log files are referred to in the main text in the subsequent chapters, so that a reader can find the exact corresponding entries in the case further details are sought for. On the other hand, the text is written in such a way that consultation of these raw data files should not be necessary. Finally, the test corpus is organized so that the sentences discussed in the main article, beginning from (1a-b), are listed as separate entries in the order of their presentation in the beginning of the test corpus and can thus be found more easily. The methodological framework is illustrated in Figure 1.

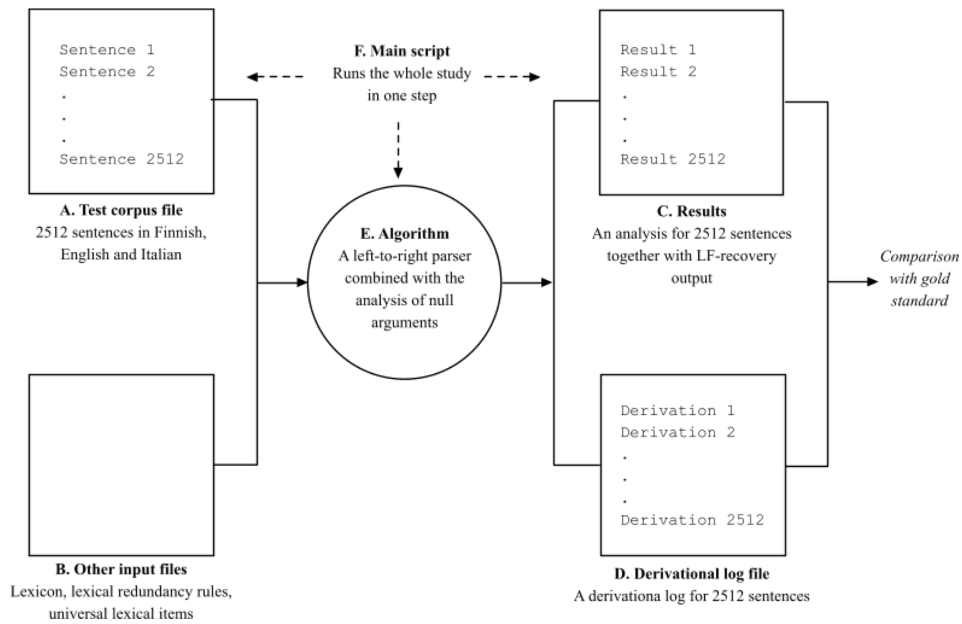

Figure 1. The general methodological framework. The two output files C and D constitute the raw data of a study of this kind. See the main text and the supplementary document for discussion.

4.2 Baselining the model without null subjects

The mechanisms were verified independently without the presence of null arguments. Example (20) shows how the formalization deduces S-V agreement patterns in Italian when the subject is overt. Both matches (*John admires*) and mismatches (**John admire*) were tested. The same tests were run for all person and number combinations and for all three languages (items #83-103, #1506-1541 in the input-output). I will elucidate the derivations here to a moderate degree of detail, but the discussion is not absolutely essential and may be skipped.

(20)

a.	*Noi ador-iamo Luisa.*	(Input, #101)
	Noi$_{1,\varphi}$ [T$_{\varphi}$ [__$_{1}$ [v$_{\varphi_=noi}$ [adora$_{\varphi_=Luisa}$ Luisa]]]]]	(Output)
	'We admire Luisa.'	
b.	**Io ador-ate Luisa*	(Input, #1540)
	I admire-2PL Luisa	(Judged ungrammatical)

The left-to-right algorithm produces a fairly standard bare phrase structure interpretations for the input sentences. After creating the subject for the input (20a), Steps 1-7, lines 45285-45310 in the derivational log file, the input word *adoriamo* 'admire-v-T-3pl' (Step 8) is decomposed into a complex head 'V-v-T' by the lexical-morphological component, with T containing φ-features {φ_, φ:1pl}(Step 8). Feature {φ_} is provided by the lexicon, {φ:1pl} by the suffix *iamo* extracted from the input and arriving through the morphosyntactic route, as assumed in the analysis (Step 8, line 45312).[10] These grammatical heads are fed individually to the algorithm (Steps 9, 10, 11), where they are ‘repackaged’ into a complex head TvV (see line 45348). The direct object *Luisa* is treated in the same way (Steps 12-18). The result is (21), with “DN” and “φTvV” denoting complex polymorphemic words in the input (D = determiner, N = noun head, T = tense, v = transitive verbal head, V = verb root). This provides a formalization of the lexical decomposition procedure illustrated in Figure 4.

(21) *we* *admire* *Luisa* (#101, Step 18, line 45408)
[DN [φTvV DN]]

Complex heads are reverse-engineered by a head movement reconstruction (lines 45411-45415). DP arguments are spread into [D N] (=DP) structures, while the TvV complex generated the familiar head chains. The result is (22).

(22) [We [T [v [admire(V) Luisa]]]] (line 45415)

The algorithm reconstructs the preverbal subject *noi* ‘we’ into the canonical thematic position at Spec,vP, as indicated by the reconstructed position $\_\__1$ (lines 45423-4). Agreement reconstruction (valuation by Agree^{-1} and/or by means of input suffixes) will be applied to the structure (lines 45426-45433). Heads with φ_ and +VAL trigger morphosyntactic valuation. Valuation is sought from DP arguments according to (14). The result is (23)(line 45435).

(23) $(\text{Noi}_1)_{\varphi}$ [$\text{T}_{\varphi\_=1\text{pl}}$ [$\_\__1$ [$\text{v}_{\varphi\_}$ [$\text{adora}_{\varphi\_}$ Luisa]]]]]

Notice that T, v and V are assumed to have φ_, but only T seeks morphosyntactic valuation. I will use the notation ‘φ_=1pl’ to mark the output of Agree^{-1}. Unvalued features at v and V are valued by recovery: the antecedent for v is *noi* ‘we’ (lines 45438-9), whereas the closest antecedent for V is *Luisa* (lines 45440-1). This provides (24)(line 45448). The antecedent relations can be found also from the results file (entry #101, lines 1125-1131), where they are expressed in a nontechnical way.

(24) $(\text{Noi}_1)_{1\text{pl}}$ [$\text{T}_{\varphi=1\text{pl}}$ [$\_\__1$ [$\text{v}_{\varphi\_=\textit{noi}}$ [$\text{adora}_{\varphi\_=\textit{Luisa}}$ Luisa]]]]]
’We admire Luisa.’

LF-recovery stars from the element triggering the operation and by examining if its sister can provide an antecedent; if not, the operation is applied iteratively to the mother. It will therefore try to establish an

[10] Unvalued phi-features were represented as separate features PHI:NUM:_, PHI:PER:_, PHI:GEN:_ (when applicable) and PHI:DET:_, not as a single feature. They are referred as φ in the main text for simplicity.

upward "path" from the triggering element into the an antecedent.[11] I will use notation 'φ_=DP' to represent LF-recovery, where the DP (here *noi* and *Luisa*) refers to the whole argument with which the feature is linked with. The agent argument for v is identified and reconstructed by means of control: φ_ links automatically with the closest DP at Spec,vP, if present. If a verb V contains φ_ and does not trigger Agree^{-1}, LF-recovery will associate it potentially with the complement DP. Thus, there is a control relation between the verb *admire* and its object in (24). The operation may be semantically redundant, because the same head-complement relation is interpreted also thematically: the complement denotes the patient of the head. This thematic interpretation is visible in the results file, thus it states that *Luisa* was the patient of *admire*. If this redundant control relation were ignored, the verb $V_{\varphi\_}$ would target a nonlocal antecedent and create a reflexive meaning 'We admire ourselves'.

S-V agreement sentences were processed in all three languages, both grammatical (#83-103) and ungrammatical (#1506-1541) combinations. In the actual testing, agreement sentences were also crossed with other structural variables, such as embedding, word order and control. For example, it was verified that the proposed agreement mechanisms did not interact in an incorrect way with (*wh*-) operator movement. This was checked by feeding it with sentences (25-26), which the algorithm handled correctly.

(25) *Kuka* *ihaile-e* *Merja-a?* (#36)
who.NOM admire-s Merja-PAR
'who admires Merja?'

(26) *Ketä* *hän* *ihaile-e* *__?* (#37)
who-PAR he.NOM admire-s
'Who does he admire?'

These matters are discussed in the supplementary document. Overall, however, these tests provided that the basic mechanisms were operating correctly in connection with sentences that did not involve null arguments. Few problems were encountered with noncanonical word orders in Finnish that I was not able to solve, and are addressed in the supplementary document as they are not directly relevant to the computational of null arguments.

4.3 Pro-drop

The model was next examined in connection with subjectless sentences in each three languages and in each person and number combination (items #2100-2116 in the output). The key results are summarized in (27).

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[11] Upward paths are created by an upstream walk function in the implementation. The term "walk" refers to the fact that the operation is implemented in a step-by-step fashion, so that it literally walks, one step at a time, upwards in the phrase structure.

The first line contains PF-objects, second is an English gloss, and the third is the output provided by the model and simplified by the author. I only provide a selection of the complete output here, as the complete machine-generated output is available as a separate file.

(27)

a.	*Ihaile-n*	*Merja-a.*	(#2100, Finnish pro-drop)
	admire-1SG	Merja-PAR	(Gloss)
	[T_{1sg} [$v_{\varphi\_=1sg}$ [$admire_{\varphi\_=Merja}$ Merja]]]		(Simplified output)
b.	**Ihaile-e*	*Merja-a.*	(#2102, Finnish third person pro-drop)
	admire-3SG	Merja-PAR	
	(No parsing solution found.)		
c.	*Ador-a*	*Luisa.*	(#2112, Italian third person pro-drop)
	admire-3SG	Luisa	
	[T_{3sg} [$v_{\varphi\_=3sg}$ [$adora_{\varphi\_=Luisa}$ Luisa]]]		
d.	**Admire Mary*		(#2106, English non-pro-drop profile)
	(No parsing solution found.)		
e.	**Admires Mary*		(#2107, English non-pro-drop profile)
	(No parsing solution found.)		

The model is able to deduce pro-drop clauses correctly in Italian and Finnish, whereas they are rejected in English. It is not self-evident that the syntactic analysis provided by the model in which both the Italian and Finnish pro-drop sentences are headed by T_{φ} (or perhaps better represented as T_{pro}) without a phrasal subject at SpecTP is the correct one. It has been argued, convincingly, that Finnish T has an EPP feature that requires its subject-specifier position to be filled by a syntactic phrase (Holmberg and Nikanne 2002; Vilkuna 1989; Vainikka 1989, Huhmarniemi 2019). There is no such phrase at the preverbal subject position in the pro-drop sentences above.

The general solution to this problem pursued in this study is to redefine the EPP (and other specifier requirements in grammar) in such a way that the pronominal elements inside heads can satisfy them. Consider the English examples (27d-e) first. If neither the agreement affix nor an overt subject argument is present, as is the case here, then, all being equal, φ_ should remain unvalued and create the generic interpretation. The sentences are judged ungrammatical instead. The reason is because only non-conflicting φ-features at the probe head can check the EPP. The morphosyntactically impoverished verb form is unable to determine an unambiguous conflict-free pronoun: *admire* creates conflicts in two types of φ-features, matching with two person features (first and second: *I/we/you admire*), two number features (singular and plural: e.g., *I/we admire*), whereas *admires* conflicts with gender features (masculine and feminine: *she/he admires*). These clauses are therefore ungrammatical because there is nothing (DP argument, agreement features in the input) to check the EPP. The same general reasoning applies to Finnish: the model does impose an EPP requirement to T in Finnish, in agreement with previous literature, but satisfies it by constructing an unambiguous pronominal element from the agreement suffixes extracted from the input. Thus, no EPP violation is marked in the derivational log. For example, *ihaile-n* ‘admire-1sg’ reconstructs an unambiguous first-person singular pronoun (gender being not grammaticalized in this language).

The Finnish third person pro-drop construction (28b) is correctly deduced as ungrammatical. The third person suffixes present in the input values the number and person features at T (lines 1446497-9), but D_ remains unvalued and this triggers recovery at LF (line 1446506). No antecedent is found, and the input is judged ungrammatical (line 1446507). The mechanism was further tested with a complex clause in which an antecedent was available. The model handles these correctly, as shown in (28).

(28)

a. *Pekka sano-o että ihaile-e Merja-a*. (#25, 43)
Pekka say-3SG that $T_{D\_=Pekka}$-3Sg Merja-PAR (D_ valued by nonlocal antecedent)
’Pekka says that he (=Pekka) admires Merja.’

b. **Minä sanon että ihaile-e Merjaa*. (#44)
I say-1SG that $T_{D\_}$-3SG Merja-PAR (D_ remains unvalued)
‘I say that (he) admires Merja.’

Example (28b) is ruled out because the φ-features of the antecedent (first person singular) do not match with the φ-features at the probe (third person singular) and the D_ remains unvalued. This illustrates the principle that the valued features of the antecedent and the controlled element can never conflict. Notice that in a sentence in which there are two potential c-commanding antecedents, this version of the model can only select the local one:

(29) *Pekka sanoo että Jukka sanoo että ihaile-e Merjaa* (#45)
Pekka says that Jukka says that admire-$s_{D\_=Jukka}$ Merja-par

To me, the non-local argument is marginally possible when the main verb selection leans towards such interpretation.[12] This aspect of Finnish pro-drop is left unexplained, but the alternative nonlocal antecedents are registered and shown in the logs.

The above explanation presupposes some formulation of the EPP condition, which must be regarded as a rather controversial and contested issue in and itself. In the standard syntactic literature, the EPP condition is

[12] ?*Murhaaja$_1$ uskoi yhä että poliisi$_2$ luulee että pro$_{1,2}$ ei ole syyllinen* ’murderer.nom believes still that police.nom thinks that _ not be guilty’, i.e. the murderer claimed that the police thinks that he (=murderer, not the police) is not guilty.

often defined as requiring that a nominal feature, such as D, N or φ, must be checked at Spec,TP (see, for example, Chomsky 1995). Holmberg & Nikanne (2002), which presents the standard analysis of Finnish EPP at the time of writing assume that T checks a discourse topic feature [non-focus] from its specifier position. To capture a condition of this type, the algorithm posits a lexical *specifier selection feature* forcing a phrase with some feature (e.g., D, non-focus) to occur at Spec. This alone is now insufficient, because also agreement features *at the head* can satisfy the same condition. A formal solution was adopted in this study in which the notion of "specifier of head H" was generalized so that it refers to both the specifier (in the ordinary sense of the term) and consistent pronominal elements inside the head H (this is called "edge of HP" in the literature).[13] This is why the algorithm reports satisfying a "specifier selection requirement" by a pronominal feature that occurs inside the head. The discourse feature non-focus posited by Holmberg and Nikanne played a secondary role and was only "read off" from the output; it did not play a causal role in the model.

Let us consider Finnish generic null pronouns next. The phenomenon is illustrated in (30) and has been discussed especially by Holmberg (2010), whose work I rely on here.

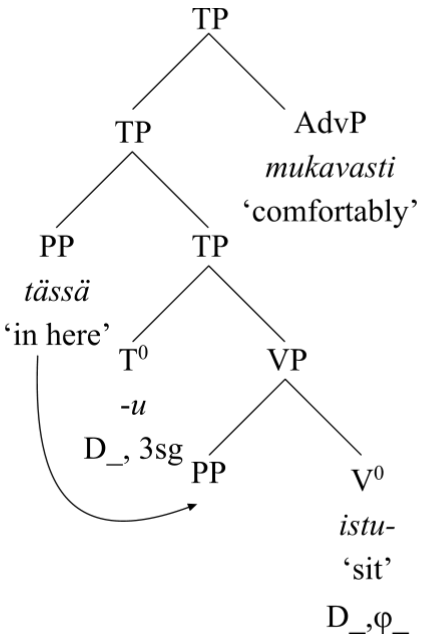
(30)

a.	*Pekka*	*sanoo*	*että* [*istu-u*	*mukavasti*.]		(#46)
	Pekka	says	that sit-3SG	comfortable		
	'Pekka says that he (=Pekka) sits here comfortably.'					
b.	**Istu-u*	*tässä*	*mukavasti*. (Holmberg 2010, ex. 1a)			(#47)
	sit-3SG	here	comfortably			
c.	*Tässä*	*istu-u*	*mukavasti*.			(#48)
	here	sit-3SG	comfortably			
	'People sit here (e.g., in this chair) comfortably.'					
d.	*Pekka*	*sanoo*	*että tässä*	*istu-u*	*mukavasti*.	(#49)
	Pekka	says	that here	sit-3SG	comfortably	
	'Pekka says that one can sit here comfortably.'					
	*'Pekka says that he (=Pekka) sits here confortably.'					

[13] This means that all specifier conditions, in whatever component they are invoked in the algorithm, register the presence of such pro-elements. This is far from being trivially true, has many far-reaching conclusions, and it is clearly not the only possible solution. A less radical proposal would be to limit the generation of pro-elements to more specific circumstances, say to finite heads or to heads with overt agreement. A more radical version would be to define even more fundamental notion of phrase structural 'sisterhood' so that that involved pro-elements.

Example (30a) exhibits standard recovery: D_ remains unvalued, triggers antecedent search which finds *Pekka* from the main clause. Example (30b) shows that a third person pro-drop without antecedent leads into ungrammaticality. This is because D_ remain without an antecedent (while person and number are valued by the third person agreement suffixes via the input route). The interesting example is (30c). The third person pro-drop is not ungrammatical when the preverbal subject position is filled in by a locative PP, but the interpretation comes out as generic. Control is not possible; the PP must "intervene" LD-recovery (30d). The model deduces the correct solutions. Virtually any phrase can (as long as it constitutes the topic) satisfy the EPP condition of Finnish, hence the locative PP will do as well. The specifier condition is, therefore, satisfied. This PP cannot, however, value D_ at T by Agree^{-1} because it is not a DP. Agree^{-1} targets only DPs (more exactly, φ-features at D). D_ therefore enters LF-interface unvalued, seeks an antecedent and finds the PP, which leads to the generic interpretation.[14] The analysis is shown in (31).

(31)



This deduction cannot be assumed to be uncontroversial. No generic null pronoun fills in an argument position; the generic interpretation is created at LF as a last resort. Holmberg (2010) considers a number of arguments suggesting that generic pronouns must be present. The argument relies on the fact that anaphoric elements, such as reflexives, possessive suffix, or adverbial null arguments, can take the generic agent as their antecedent. The author then immediately notices, however, that whether this argument goes through depends on independent assumptions concerning anaphor binding (e.g., whether it takes place at LF, whether it can target pronominal φ-sets inside heads, and so on). The fact that an ordinary null subject in Finnish can

[14] I have not been able to find a general rule from which this condition would follow. Example (30d) shows clearly that the presence of a phrase at SpecTP intervenes and blocks further LF-recovery.

function as a regular antecedent for such elements means that, if we assume the present analysis, a pronominal φ-set inside a head must be able to function as an antecedent. Thus, heads with valued φ-features are accepted as antecedents by LF-recovery (only if the valued phi-features between the antecedent head and the triggering element do not conflict).

The analysis has no derivational path for interpreting an 'object pro construction'. A sentence such as (32) will be classified as ungrammatical because the necessary complement selection feature of the main verb *want* is not satisfied.

(32) **Minä* *halua-n*. (#50)
I.nom want-1SG
'I want'

There is no deductive path for generating a pronominal complement from the φ-set of a head, and even if there were, there are no such features at V due to the lack of object-verb agreement. The system does, however, contain a derivational path for generating null object constructions: a null object construction can be derived if and only if the complement selection feature of V is satisfied by another (non-argument) phrase. This alternative, which is attested, will be examined in the next section.

Radical pro-drop languages license null arguments despite exhibiting no agreement morphology. The analysis licenses pro when a consistent pronominal element constructed from phi-features residing in a head satisfies conditions involved in checking the presence of a phrasal subject (e.g., EPP). In the examples analyzed so far the mechanism works by constructing φ-features from the input. If a head has consistent and valued φ-feature(s) as a *lexical* property, then a null argument with those features will be generated. The crucial assumption is that complete loss of agreement must eliminate conflicting φ-features from the lexicon (contrary to Swedish, English and French).[15] Holmberg (2005) seems to propose something similar when he claims that radical pro-drop languages have lost unvalued φ-features and have "unspecified" (null) subjects that check syntactic conditions. Another possibility is that radical pro-drop languages project unvalued φ-features which are linked to arguments via LF-recovery that accesses discourse, perhaps in a way comparable to Finnish third person null argument with an unvalued D_. To show that the analysis works in principle I constructed an imaginary 'radical pro-drop English' in which all morphosyntactic valuation (all agreement) is lost and in which lexical elements have no conflicting phi-features. I tested both hypotheses, one in which the imagined finite verbs had only valued person feature, corresponding to the first hypothesis,

[15] Conflicting or non-conflicting φ-features are required as long as some SV combinations are ruled out, otherwise there is no way of pairing specific subjects with specific verb forms (or checking compatibility, as is the case here). But once all agreement is lost, all SV combinations are possible, and selective φ-features can be eliminated from the heads.

and another in which they had an unvalued person feature, corresponding to the second (person feature was selected only for testing purposes). Since no agreement was received from the PF-input, no phi-feature conflict could arise and thus both constructions admitted pro-drop (see #79-82 in the output, with imaginary verbs *admire´* (with unvalued person feature) and *admire´´* (with lexically valued person feature), both found from the lexicon file). The four possible routes for licensing null arguments, as predicted on the basis of the analysis, are summarized in Table 2.

Table 2. Four types of pro-drop predicted in this study.

	OVERT AGREEMENT	
LEXICALLY VALUED φ-FEATURES	No (−VAL)	Yes (+ VAL)
No	Null argument by LF-recovery (control, discourse antecedent, depending on unvalued φ). If no antecedent is found, interpretation is generic or arbitrary (not distinguished in this study).	Null argument by rich agreement (Italian), with partial LF-recovery possible (Finnish, Hebrew) and conflicting φ-features blocking the null argument (Swedish, English, French).
Yes	Null argument by lexical valued φ-feature(s), interpretation depends on the nature of φ (Chinese, Korean, Japanese?).	Null argument licensed by both overt agreement and lexical φ-features, which must match with each other. Corresponds to "frozen agreement."

4.4 Control

Let us next consider how the model deduces the properties of control. Consider the following examples of standard control (33), #51-52 in the input/output. The second line presents the (simplified) output generated by the model, not by the author.

(33)

a. *John wants to leave*.
   [John$_1$ [T$_{\varphi_:3sg}$ [__$_1$ [V$_{\varphi_=John}$ [to leave$_{\varphi_=John}$]]]]] (#51)

b. *John wants Mary to leave*.
   [John$_1$ [T$_{\varphi_:3sg}$ [__$_1$ [v$_{\varphi_=John}$ [V$_{\varphi_=John}$ [Mary$_2$ [to [__$_2$ leave$_{\varphi_=Mary}$]]]]]]]] (#52)

T values its phi-features from the PF-input. If we leave the subject out, the input evaluates as ungrammatical due to an EPP failure at T. v finds an antecedent at Spec,vP into which the model reconstructs the subject (the chain marked by subscript 1). The lower verb *leave* is linked with *Mary* at LF in (b). Example (34) shows noncanonical but grammatical word orders in connection with control that the model also deduces correctly. The model solves this problem, discussed in Section 2.1, by applying phrasal reconstruction before Agree^{-1} and LF-recovery.

(34)

a.	*Huomenna*	*halua-a*	*lähte-ä*	*Pekka*.	
	tomorrow	want-3SG	leave-A/INF	Pekka.NOM	
	'Tomorrow Pekka wants to leave.'				
b.	*Huomenna*	*käske-e*	*Merja-n*	*lähte-ä*	*Pekka*.
	tomorrow	order-3SG	Merja-GEN	leave-A/INF	Pekka.NOM
	'Pekka orders Merja to leave.'				
c.	*Huomenna*	*käske-e*	*Pekka*	*Merja-n*	*lähte-ä*.
	tomorrow	order-3SG	Pekka.NOM	Merja-GEN	leave-A/INF
	'Pekka orders Merja to leave.'				
d.	*Huomenna*	*käske-e*	*Merja-n*	*Pekka*	*lähte-ä*.
	tomorrow	order-3SG	Merja-GEN	Pekka.NOM	leave-A/INF
	'Pekka orders Merja to leave.'				

Examples (35) represents the core cases of Finnish control and cover the selection and selectee dependencies discussed in Section 3. The grammaticality judgments and analyses are deduced by the model, not by the author; model judgment matches with native speaker judgment. This dataset and the results are further explained below.

(35) (Finnish)

a. *Pekka halusi* [*lähte-ä*.] (#57)
Pekka wanted leave-A/INF
'Pekka wanted to leave.'

b.	**Pekka*	*halusi*	[*Merja-n*	*lähte-ä*.]	(#58)
	Pekka	wanted	Merja-GEN	lähte-A/INF	
c.	*Pekka*	*käski*	[*Merja-n*	*lähte-ä*.]	(#59)
	Pekka	ordered	Merja-GEN	leave-A/INF	
	'Pekka ordered Merja to leave.'				
d.	**Pekka*	*käski*	[*lähte-ä*.] (#60)		
	Pekka	ordered	leave-A/INF		
e.	*Pekka*	*halusi*	[*Merja-n*	*lähte-vän*.]	(#61)
	Pekka	wanted	Merja-GEN	leave-VA/INF	
	'Pekka wanted Merja to leave.'				
f.	**Pekka*	*yritti*	[*Merja-n*	*lähte-vän*.]	(#62)
	Pekka	tried	Merja-GEN	leave-VA/INF	
g.	**Pekka*	*yritti*	[*lähte-vän*.]	(# 63)	
	Pekka	tried	leave-VA/INF		

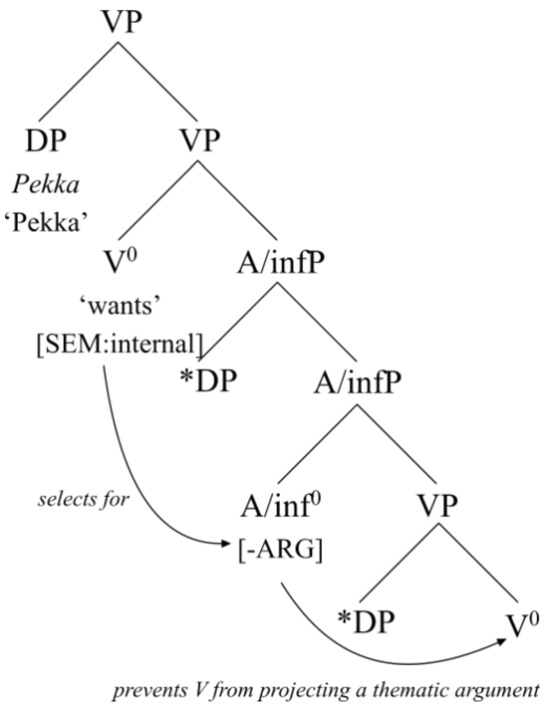
h. *Pekka yritti. (#64)
Pekka tried

j. *Pekka uskoo lähte-vä-nsä.* (#65)
Pekka believes leave-VA/INF-PX/3SG
'Pekka$_1$ believes that he$_{1,*2}$ will leave.'

k. **Pekka uskoo lähte-vän*. (#66)
Pekka believes leave-VA/INF

The Finnish verb *haluta* 'want' is marked for 'SEM:internal' (in contrast to English *want*), hence it disambiguates the selected A-infinitival into –ARG (35a-b). This prevents the underlying VP from projecting an external argument, as shown in (36).

(36)



Sentence (35b) is judged as ungrammatical, as the argument *Merja-n* 'Merja-gen' reconstructs into Spec,VP but will be left without thematic role due to the selecting –AGR head. The derivation crashes at the LF-interface without interpretation. The verb 'order' (35c-d) is marked for 'SEM:external' and disambiguates the selected infinitival into +ARG. This has the opposite effect: V projects a thematic role to its specifier and a DP argument may appear there and is interpreted at the LF-interface as the agent of the infinitival event. The VA-infinitival (35d-e) is marked lexically for +ARG, hence a separate subject occurs inside the infinitival. Examples (35f-h) are ungrammatical because 'try' requires an obligatory A-infinitival complement and is marked for SEM:internal. Examples (35i-j) illustrate the effects of infinitival (possessive) agreement, glossed as px/3sg. The VA-infinitival can be used as a subject control verb if it exhibits overt agreement (35i); without agreement it requires an overt argument (35j). The explanation for (35j) parallels Finnish finite partial control: overt infinitival agreement leaves D_ unvalued and LF-recovery targets the main clause subject as an antecedent. If there is no agreement, the VA-infinitival head cannot check its EPP feature against anything. Notice that since the VA-infinitival does exhibit overt agreement, it is marked for +VAL.

Examples (37a-b) below illustrate subject and object control in English, respectively. The object antecedent (37a-i) works as expected: the closest antecedent is selected. The reason *persuade* (transitive v* verb) is not compatible with a control clause without an argument is again due to SEM:external (37a-ii). Subject control, illustrated by (37b-i), is often regarded as surprising because recovery seems to skip a potential antecedent.

(37)

a. i. *John persuades Mary to leave*. (#67) ii. **John persuades to leave*. (#68)

b. i. *John promises Mary to leave*. (#69) ii. *John promises to leave*. (#70)

There are at least two in principle ways to handle subject control (37b-i) under the present framework (that is, if we do not propose radical modifications). One is to substitute MDP with a principle that distinguishes subject and object control from each other. This could be done by adding further criteria to the antecedent selection, allowing recovery to target objects and subjects specifically. This selection must then be made sensitive to a lexical feature, categorizing any given head as subject- or object oriented (or neutral). An alternative is that the infinitival is merged into a higher position in the clause in which the direct object is rendered invisible for MDP recovery. The model, when provided with no additional assumptions or mechanisms, adopts the second alternative. A solution is then calculated in which *to leave* is adjoined (extraposed) to the clause. The analyses provided by the model are shown in (38).

(38)

a. *John persuades* [*Mary to leave*$_{\varphi\_=\text{Mary}}$] (=(34)a-i, #67)

b. *John promises* [*Mary*] (*to leave*$_{\varphi\_=\text{John}}$) (=(34)b-i, #69)

This does provide correct antecedent properties, although the solutions are not unproblematic. Solution (38b) is reminiscent of Larson (1991), who proposed that at the level at which recovery applies (LF-interface here) the infinitival occurs at high enough adjoined position such that the object antecedent is invisible. The algorithm clearly adopts this type of Larsonian solution. (38a) is problematic. The parser is only allowed to create binary branching trees and cannot, therefore, create a structure in which the verb *persuade* takes two complements (*John persuades* [*Mary*][*to leave*]). It handles an input of this type in one of two ways. If the verb is forced to select for a DP-complement, then the infinitival will be right-adjoined (*John persuades* [*Mary*] ⟨*to leave*$_{\varphi\_}$⟩) and the antecedent of the infinitival is determined by its structural position so that a higher attachment site will find the main clause subject (38b), lower attachment site the object (discussed below). If, on the other hand, the verb selects for an infinitival (either obligatorily or optionally), *Mary* will be generated inside the infinitival and, although the control properties are derived correctly, there is no selection dependency between the main verb and that subject. This resembles the situation with the Finnish examples in (35c), where we notice a similar mismatch between (unambiguous) syntactic structure and semantic intuition.

The φ_ of controlled adverbials are valued by the same mechanism, with antecedent selection sensitive to the adverbial attachment site. Consider an input such as (39).

(39) *Pekka*$_1$ *etsii* *Merjaa* [PRO$_1$ *juost-en*.] (#73)
Pekka search-3SG Merja-PAR run-ADV
'Pekka searches Merja by running.'

The model deduces the correct solution. The TP-adverbial in the example (41) has a feature forcing it to occur inside the TP, which puts it into a high enough position at which recovery can only see the subject. An adverbial phrase that has a feature forcing it to occur inside VP (e.g. manner adverbials) will put it into a lower position where it could take the direct object as an antecedent, as shown by (40). The same mechanism could be applied to (38a).

(40) Pekka$_2$ ei nähnyt [Merja-a]$_1$ ⟨PRO$_{1,*2}$ kävele-mässä⟩
Pekka not see Merja-PAR walk-MA/INF
'Pekka did not see Merja walking (lit. 'see Merja *in walk-ing*')

The model calculates arbitrary or generic control sentences such as (41), with the structure and interpretation provided as given.

(41) *To leave is a mistake*. (#74)
[to leave]$_1$ $T_{\varphi\_}$ __$_1$ be [a mistake]
'For people in general to leave is a mistake.'

Finite T fails to value φ_, being unable to find φ-features from the infinitival clause, and the sentence comes out as generic. The infinitival will be interpreted in the same way.[16] Null objects are also known to evoke the generic interpretation. Null objects are not licensed in English, unlike in Italian and Finnish, where they are. The null object construction (43) comes from Finnish.

[16] This depends on the assumption that BE constitutes a phase head, so that the finite T cannot agree with the DP *a mistake*. If we remove this assumption then T will agree with the DP.

(42) *Pekka* *pyytää* [*lähtemään*.] (#75)
Pekka asks leave.MA/INF
'Pekka asks people to leave.'

The transitive verb projects a v*-V structure, which leaves the φ_ of main clause V and the embedded infinitival without value. It cannot recover an antecedent from above v*, which then results in an interpretation in which both the thematic object of 'ask' and the thematic agent of 'leave' become generic, referring to 'people in general'. They remain unvalued throughout the derivation. The sentence is interpreted, by the model and by native speakers, so that Pekka is asking 'people in general' to leave. This interpretation depends on the presence of v* (=v with SEM:external); a verb with v will correctly allow control, as shown in (43):

(43)
a. *Pekka* *pyytää* *laulamaan.*
Pekka asks(v*) to.sing
'Pekka asks (people, one) to sing.'
b. *Pekka* *haluaa* *laulamaan.*
Pekka wants(v) to.sing
'Pekka wants to sing.'

All these sentences are ungrammatical if there is nothing at the complement position of the main verb. Thus, the model does not have a derivational path for generating Finnish/Italian/English sentence such as 'John wants PRO'.

4.5 Mixed cases

The model was tested with sentences containing both pro (φ_ valued by agreement) and PRO (φ_ valued by antecedent)(#2117-2143). The algorithm correctly deduces sentences of the type (44), in which the infinitival control verb must be linked with a null subject antecedent. Third person null subjects are ungrammatical.

(44)
a. *Halua-n* *lähte-ä*. (#76)
want-1SG leave-A/INF
'I want to leave.'
b. **Halua-a* *lähte-ä*. (#77)
want-3SG leave-A/INF
'He wants to leave.'
c. *Pekka*$_{\text{3sg}}$ *sano-o*$_{\varphi\text{:3sg}}$ *että* *halua-a*$_{\varphi\_\text{=Pekka}}$ *lähte-ä*$_{\varphi\_\text{=Pekka}}$.(#78)

Pekka say-3SG that want-3SG leave-A/INF
'Pekka says that he wants to leave.'

In the example (a), the derivation values φ_ at T by the agreement suffixes (1sg), and then uses the features as an antecedent for the infinitival. In (b), the lack of an antecedent for the D_ results in ungrammaticality; the infinitival receives a generic interpretation, which is irrelevant as the clause is judged ungrammatical. Finally, sentence (c) is correctly judged as grammatical and interpreted so that Pekka constitutes an antecedent for every predicate (say, *want* and *leave*).

4.6 Finite control, tense and agreement

Finnish third person null subject exhibits nonlocal control. The null subject is typically bound by a c-commanding argument from the next finite clause up. This could be argued to constitute a form of "finite control," but Landau (2013) shows that the phenomenon does not exhibit the "finite control signature" he finds from other languages exhibiting finite control. The main point of divergence is that the antecedent in Finnish, which must be present, need not be local or perhaps not even constrained by the c-command condition, because discourse antecedents seem to be marginally possible. Furthermore, Landau argues that prototypical finite control signature emerges if and only if the controlled finite clause is deficient either in terms of tense specification (–T+Agr) or agreement specification (+T–Agr) (or both –T–Agr), but this is not true of Finnish, in which the embedded finite clause is fully specified for agreement (possibly with the exception of D) and tense (+T+Agr). Thus, I assumed, following Holmberg et al., that the Finnish finite control results from the deficient third person agreement that behaves like a variable with D_. LF-recovery pairs the D_ feature with the closest antecedent. Landau's finite control signature must be derived by something else.

The assumption that deficient agreement (Landau's group +T–Agr) leads into control follows directly from the analysis: an agreementless and argumentless finite verb (T) is unable to value φ_ by Agree^{-1} and triggers LF-recovery. Finite boundary does not limit LF-recovery in any way, in the current formalization. If T is marked lexically for –VAL, we derive a finite OC signature. The situation with Landau's –T+Agr alternative is not straightforward, however, and raises further questions. If +Agr denotes full agreement in such constructions, these data constitute a fundamental difficulty to the present analysis because full agreement should, all else being equal, block control, leaving nothing unvalued at LF. The data is therefore puzzling. Second, there is nothing in the analysis that connects deficient tense –T to control. What makes the matter untrivial is the fact that in Finnish what looks to be full agreement, both finite agreement and infinitival agreement, triggers LF-recovery, here assumed to be due to deficient agreement. I can only speculate that Landau's –T+Agr condition refers to similar deficient agreement – perhaps there is a connection between D_ and T – but I leave the problem unsolved.

4.7 Summary

The algorithm classifies various control constructions in the manner summarized in Figure 2. If an antecedent cannot be found, the interpretation is generic or arbitrary (the distinction was not modeled in this study).

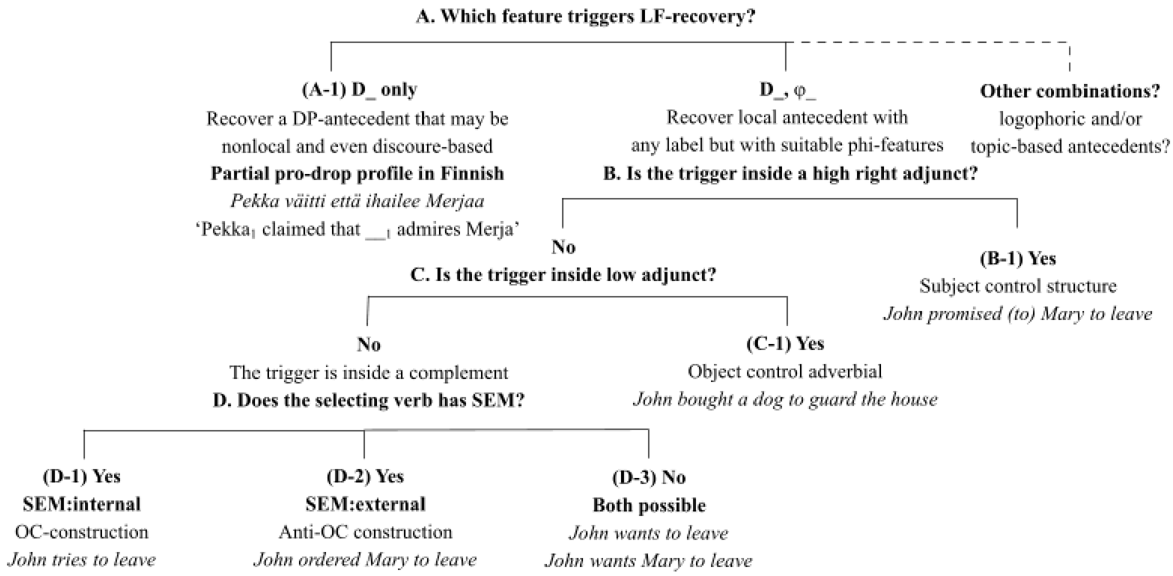


Figure 2. Classification of control construction by the algorithm and the analysis

I would like to stress that the classification illustrated in Figure 2 is not meant to be interpreted as a proposal for a complete, final or even correct classification of control constructions; rather, it should be viewed as a logical implication of the analysis that was designed as a solution to the inverse problem. Thus, *any* change to the above schema is acceptable within the design of the present study as long as the revised algorithm still solves the inverse problem and is empirically plausible. In other words, I do not argue specifically for the above schema.

5 Conclusions

The issue of licensing and recovering null arguments was analyzed from the point of view of PF-objects. An analysis was proposed based on the earlier proposals by Borer (1986, 1989), Phillips (1996, 2003) and Cann et al. (2005). The algorithm was able to deduce correct phrase structures, null arguments and their antecedents for the input sentences. Three languages were examined in detail: Italian, English and Finnish, each with different behavior with respect to their null argument behavior (non-pro-drop, consistent pro-drop and partial pro-drop languages). The solution is based on the following propositions.

A null argument is generated during the derivation when an unvalued φ_ feature associated with a lexical item cannot be valued from the resources available at the PF-input. Unvalued φ-features trigger recovery at LF, a process that attempts to locate antecedents, resulting in finite and non-finite control. The theory unifies the explanation of pro and PRO under one system. The Finnish partial pro-drop profile together with generic pro-constructions in the same language indeed suggest that the two share a core set of features, as both are involved in the computation of anaphoric dependencies and the creation of the generic interpretation as a last resort. In addition, the analysis projects no null arguments, hence it reduces the number of syntactic objects stipulated by the analysis.

Although this study was limited to proposing a solution to the inverse problem – understood in rather technical and limited sense – it raises the larger question of the possible role of PF/parsing approaches in grammatical theorizing. It would be a mistake reconstruct this question as concerning only the division of labor between competence and performance, as no performance properties (e.g., efficiency, errors, garden-paths, irrationality, suboptimal sensory conditions) were addressed in this work; rather, the issue is whether we can learn anything useful about the human language faculty by shifting the perspective from an enumerative approach to that of the inverse recognition problem. My own view is that this is an empirical matter only. The answer depends on what type of system the language faculty ultimately is. If the principles of the UG are principles of efficient parsing and/or processing of the sensory/PF-input – that is, if language is primarily a perceptual system – then we could learn something by shifting the perspective; if they are not, then the principles emerging from the inverse framework, if correct, are likely to receive more elegant formulations within the enumerative approach. It is also possible, perhaps even likely, that the truth falls somewhere between. Then a useful approach would be pursue both approaches while simultaneously trying to converge them towards one unified theory.

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