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35. The Syntax-Semantics Interface

Abstract

This article discusses central aspects of the syntax-semantics interface in derivational theories of the grammar. We describe the main theoretical tools for translating surface representations into abstract, transparent logical forms which can be directly interpreted in the semantic component. Following some brief remarks on the pedigree of this notion *of the interface, the article surveys central characteristics of logical forms as they manifest themselves in the interaction between quantifier scope, binding and coreference, and explicates the way in which these results have been interpreted in current minimalist models. Topics to be discussed include scope inversion, covert movement, strategies for delayed structure building, Copy Theory, and referential opacity.*

1. Introduction: different conceptions of the interface

Natural language syntax represents a discrete, deterministic, combinatorial system that generates representations inside an autonomous, informationally encapsulated module (Fodor 1983) of the language faculty. The output of the syntactic component is mapped to possibly non-linguistic representations of other cognitive modules at designated points in the computation. These points are defined as the *interfaces.* The present survey of the *syntax-semantics interface* focuses on aspects of the translation procedure from syntax to the *conceptional-intentional* system (Chomsky 1995), which is responsible for model-theoretic interpretation (semantics in the narrow sense), the calculation of logical inferences, the representation of concepts and intentions, and possibly other functions.

All meaningful theories of the syntax-semantics interface adopt in one version or the other the principle of compositionality, which requires that the meaning of complex expressions is functionally dependent upon the meaning of its immediate parts and the way these parts are combined (Frege 1892; Montague 1970). Apart from this requirement, current models of the grammar vary substantially both in the perspective they take on the role of syntax in the architecture of the grammar, as well as in the semantic principles of interpretation they admit. This makes it difficult to provide a uniform, universally applicable definition of the syntax-semantics interface. Still, it is possible to discriminate between two groups of approaches which are characterized by their diverging views on how to treat mismatches between syntax and semantics. Such contexts, prototypically exemplified by quantifier scope ambiguity in sentences like *A critic liked every movie* are informative about the nature of the interface because the syntactic parse fails to uniquely identify a semantic interpretation, requiring resolution of this conflict in one of the two components.

On the one side, monostratal, *lexicalized* models such as Categorial Grammar (CG; Adjukiewicz 1935; Jacobson 1996, 2002), Combinatory Categorial Grammar (CCG; Steedman 2000; Steedman and Baldridge 2011), Lexical Functional Grammar (LFG; Bresnan 1982, 2001), Montague Grammar (Montague 1970, 1973; Partee 1976), and Head-driven Phrase Structure Grammar (HPSG; Pollard and Sag 1994) assume that syntactic and semantic operations are computed from a single linguistic tree representation. In classic Montague Grammar, for one, syntactic and semantic representations are built simultaneously such that at each stage of the computation, the input of a syntactic rule also serves as the input of a corresponding semantic rule (*rule-by-rule* approach; cf. Bach 1976 or *direct compositionality*; cf. Barker and Jacobson 2007). These surface oriented, non-derivational approaches characteristically operate on the hypothesis that linguistic representations do not contain hidden structure, keeping the amount of abstractness in the object language expressions to a minimum. Potential mismatches between syntax and semantics are typically not resolved in syntax, but by employing a semantic meta language enriched with type adjustment operations (s. section 3) or additional composition rules. Moreover, theories in this tradition often guard against overgeneration by limiting the application of certain semantic rules to specific syntactic environments (meaning postulates). As a consequence, for lexicalized models, the study of the syntax-semantics interface primarily consists in investigating the semantic rules and their combinatorial properties, and not in exploring the nature of the relation between these rules and the operations generating overt syntactic expressions.

By contrast, in syntacto-centric models, the syntactic component precedes model-theoretic interpretation, which essentially has two effects. First, core syntactic operations cannot be made contingent on semantic factors without further additions. Second, communication between syntax and semantics is possible only at designated points of interaction that can be accessed from the semantic component. In *derivational* theories, this interface function is served by the abstract linguistic representations referred to as *LFs* (*logical forms*).

Since LFs by assumption consist of abstract objects formed within the syntactic component, they are subject to the laws of natural language syntax. Derivational models differ in this respect from lexicalized theories, which predominantly contest the existence of both hidden syntactic structure and operations manipulating (abstract) object language expressions. It is for this reason that although there is no uniformly shared conception of LF at the moment (see below), one can identify a pair of guiding, methodological principles common to all LF-based approaches: (i) the willingness to admit more abstractness in syntax than surface oriented lexicalized approaches, and (ii) a tendency to resolve mismatches between syntax and semantics, if they arise, in course of the syntactic derivation, instead of in the interpretive component. Thus, as a rule of thumb it can be observed that derivational and categorial theories differ in that the former admit a greater degree of abstractness in syntax, where the latter tend to accept more complexity in semantics.

The objective of this article consists in summarizing central aspects of the theory of LF as it has been emerging over the last three decades in syntacto-centric, derivational models of the grammar. Following some remarks on the historical roots of the notion logical form, intended to anticipate potential terminological confusion (section 2.1), the semantic background assumptions will be made explicit (section 2.2). Section 3 presents the standard treatment of quantifier scope in syntacto-centric models, while section 4 provides an overview of the main properties commonly held to be associated with scope extension by quantifier raising (section 4). In section 5, it will be seen how opacity effects arising from the interaction between scope inversion, binding and coreference patterns can be used as a diagnostic for hidden structure and abstract LF-representations. Section 6 reviews different strategies of reconstruction. Finally, section 7 briefly draws attention to two recent developments in the study of the syntax-semantics interface. Unfortunately, limitation of space makes it impossible to expand the discussion to alternative views of the syntax-semantics interface (e.g. Discourse Representation Theory). For further surveys of the syntax-semantics interface see Enç (1988); Fox (2003); Huang (1995); May (1993); Sauerland and von Stechow (2001); von Stechow (2011); and Szabolzsi (2001, 2011).

2. History and semantic background

2.1. The use of *logical form* in philosophy and linguistics

Philosophers have been using the term logical form for a wide variety of concepts only loosely related to their linguistic namesake (Lappin 1993; May 1999; Pietroski 2009). On the most general interpretation, logical forms reveal fundamental regularities of propositions, rendering visible unifying logical properties that are masked by what were at times considered inherent irregularities of natural language. Only the logical form underlying the translation into (1c) would e.g. bring to light the similarities between the first order interpretation of universal quantification ([1a]) and conditionals ([1b]):

(1) a. *All dogs are awake.*
 b. *If something is a dog, it is awake.*
 c. $\forall x[\text{dog}(x) \rightarrow \text{awake}(x)]$

Closely related to this view is the claim that logical forms are not part of the object language, but are schemata that are uniquely determined by propositions and belong to logic, where they serve to compute inferences and meaning relations. (On the history of *logical form* see Lappin 1993; Menzel 1998; Pietroski 2009; Preyer and Peter 2002.)

The term "logical form" was first employed in a meaning close to its modern linguistic usage in Russell (1905) and Wittgenstein (1929). Russell observed that the translation from natural language expressions into a regimented formal language sometimes displays invariant regularities suggesting a systematic relationship between object and meta language. It is this systematicity in the meaning-form correspondence that distinguishes Russell's conception of logical forms from earlier approaches, and makes it resemble modern linguistic views. The specific phenomena that Russell considered included definite descriptions and names. For instance, a formula akin to (2b) was seen as the underlying logical form for the surface string (2a).

(2) a. *The dog is awake.*
 b. $\exists x[\text{dog}(x) \wedge \text{awake}(x) \wedge \forall y[[\text{dog}(y) \wedge \neg x{=}y] \Leftrightarrow \neg\text{awake}(y)]]$

However, in their early logico-philosophical incarnation (Tarski 1936; Carnap 1934), logical forms were neither compositionally derived from sentences, nor part of object language, but merely encoded hidden properties of the proposition expressed by a sentence. This was so as the correspondences between natural language and logical syntax were thought to be too irregular and idiosyncratic for defining a systematic mapping between them (*Misleading Form Hypothesis*, Russell 1905; this position was famously held by Tarski; Fefermann and Fefermann 2004). For instance, (2a) and its logical form (2b) differ in that the subject DP *the dog* forms a constituent to the exclusion of the VP in syntax, while no such bracketing can be found in the logical representation. The solution to this problem consists in Frege's analysis of quantifiers as second order properties and the λ-calculus (see section 2.3).

Resolving such mismatches between the logical meta-language syntax and constituency in natural language is a central goal common to all sufficiently precise, compositional theories of language. Lexicalized models are set apart from syntacto-centric derivational (Chomsky 1995) and some representational systems (Brody 1995; Haider 1993; Koster 1986; Williams 1986) by the fact that the latter adopt as a heuristics for conflict resolution the hypothesis that not all aspects of linguistic meaning are phonetically represented:

(3) Abstractness Hypothesis
Linguistic representations contain abstract objects.

In derivational theories, the Abstractness Hypothesis found its most prominent expression in the idea that the grammar includes a post-syntactic component (LF) which encodes "grammatically determined aspects of meaning" (Chomsky 1976; May 1977). The Principle and Parameters model (Chomsky 1981) treated LF as a separate level of representation located between syntax and model-theoretic interpretation. In minimalist grammars (Chomsky 1995), LF is incorporated in the syntactic component, and defined by the point in the derivation at which Spell-Out applies: LF comprises of all operations that follow Spell-Out, and therefore have no effect on pronunciation.

It has become common practice to use the term LF to refer either to the class of all well-formed LF-representations, or to individual members thereof, without any commitment as to whether LF is taken to be a separate level of representation or not.

Integrating LFs into the object language generates the expectation that the logical syntax of the formal interpretation language is co-determined by natural language syntax, as expressed by the *Transparent Interface Hypothesis* (4):

(4) Transparent Interface Hypothesis
Interpretive properties are co-determined by properties of natural language syntax.

In derivation models, the task of defining the logical syntax of an expression can therefore be partially relegated to the rules of natural language syntax operating on this expression. Demonstrating that such a division of labor between syntax and semantics in fact exists has been a central objective for adherents of LFs (see section 4 for additional details). Anticipating some other results to be addressed in detail below, the analytic techniques legitimized by the conjunction of (3) and (4) include silent movement operations; invisible syntactic structure inside traces, elliptical nodes and pronouns; unpronounced variables and variable binders (λ-operators) in the object language; and lexical decomposition in the object language, usually in combination with silent operators.

As was seen above, the logico-philosophical tradition and current versions of generative grammar assign to logical form fundamentally distinct functions. While on the former, logical forms are equivalence classes of properties that reside in the logical meta language, the linguistic notion describes complex natural language objects which can be manipulated by the principles of grammar. There is also a second difference between modern conceptions of LF and the classical philosophical view on logical form apart from their ontological status. While logical forms were meant to represent the logical skeleton of propositions on the basis of which inferences could be calculated, LFs in generative linguistics did at least initially (Chomsky 1976) explicitly not encode meaning relations. Rather, LFs are purely syntactic objects that have not been assigned a model theoretic interpretation yet, in line with the hypothesis that syntax operates inside an informationally encapsulated system that does not accept instructions from other modules.

Some qualifying remarks are in order regarding the role of LF in current models. Notably, the LF-interface may diverge in at least two ways from the standard minimalist model. First, there are also “flatter” versions of derivational grammars which give up the assumption that the division between overt and covert operations reflects a key characteristic of the model. Unlike lexicalized theories, these single output theories still admit abstract, hidden information to be part of linguistic representations (Bobaljik 1995; Groat and O’Neil 1996; Pesetsky 2000). However, unlike in earlier incarnations of minimalism, the derivation is no longer partitioned into a visible and an invisible section, with the result that abstractness becomes a pervasive property of the grammar. Empirically, such a conception leads one to expect systematic interaction between overt and covert processes. As will be seen in section 4, evidence to that effect has indeed been isolated in various domains.

Second, there is a growing amount of evidence that the computations mapping from syntax to semantics can also be dependent upon factors external to the syntactic system proper. This option has recently been explored in areas where choices within core syntax that are relevant to the determination of model-theoretic interpretation are either informed by contextual factors (Reinhart 2006) or by results provided by a non-domain specific deductive system computing logical inferences (Chierchia 1984: 40; Fox 2000; Fox and Hackl 2005; Gajewksi 2002; see section 7).

The next subsection outlines some of the main developments in semantics that resulted in the inception of compositionally interpretable LF in the early 1990ies, to be discussed in section 2.3.

2.2. Lambda Calculus

Prior to the late 1960ies, the consensus was that natural language semantics could not be regimented by the strict methods developed in formal logic. Extending the formal rigor from logic to natural language was made possible by the combination of two components, though (Montague 1973; Lewis 1970; see Gamut 1991; Partee 1996; Partee and Hendriks 1997 for surveys): λ-calculus and Frege’s view of quantifier meanings as higher order functions. Adopting compositionality as its main heuristic guideline, Montague Grammar (MG) was the first explicit theory that treated natural language as the input of an interpretation function which recursively assigns meanings to complex expressions.

The combination of λ-calculus and the Fregean theory of quantification in MG was instrumental in identifying compositional translation procedures for complex expressions which previous logic based analyses could only treat in terms of construction specific (syncategorematic) meaning rules. To illustrate, up to that time, a simple quantificational statement such as (5) could not be given a compositional analysis, because it was not possible to assign the quantificational determiner *every* (and, as a result the whole quantifier phrase *every dog*) an interpretation independently of the meaning of its common noun sister *dogs*:

(5) *Every dog is awake.*

This in turn was a consequence of the fact that pre-Fregean logic was only equipped to generate first order predicates and therefore lacked the formal power to refer to the two place higher order function denoted by *every.* Hence, the meaning of the proposition expressed by (5) could not be compositionally derived from the meaning of its parts, a fact which was taken to indicate that the computation of natural language meanings involves intrinsically non-compositional aspects.

A related problem in mathematics had led to the formulation of the λ-calculus (Church 1936). Consider the function in (6a), which can also be written as (6b):

(6) a. $f = \{<1, 2>, <2, 5>, <3, 10>, <4, 17>, \ldots\}$
b. $f(x) = x^2 + 1$
c. $f = \lambda x[x^2 + 1]$

The classical function notation is not optimally transparent, though, in that the function symbol (f in [6b]) cannot be separated from the independent variable (x in [6b]). An expression such as $f = x^2 + 1$ is not admissible. In absence of a suitable notational device, there is no way to refer to the function in isolation. The λ-calculus filled this gap by severing the function from its variable, illustrated by (6c). The right-hand side of (6c) is to be interpreted as "the smallest function mapping x to $x^2 + 1$", which is, as desired, a description of the function f itself (on the history of λ-calculus see Cardone and Hindley, to appear).

Applied to natural language semantics, the λ-calculus supplies a method for referring to functions independent of their arguments, and can therefore be used to design appropriate meanings for sub-constituents such as the quantificational determiner *every* (Montague 1973). As demonstrated by (7b), *every* is translated as a second-order two place function which, if combined with the common noun meaning *dogs*, yields a *Generalized Quantifier* denotation (GQ; Mostowski 1957), characterizing the semantic contribution of *every dog* ([7c]). GQs denote functions from properties to sentence denotations (i.e. truth values). In the case of (7c), the function maps any property, if it holds of every dog in the domain to 1 (or True), and to 0 (False) otherwise. The GQ meaning (7c) is then applied to the predicate denotation ([7d]), resulting in the appropriate truth conditions for the proposition expressed by (7a) (intensional aspects of meanings not represented; for a survey of the analysis of quantifiers see Peters and Westerstahl 2006).

(7) a. *Every dog is awake.*
b. $[\![\text{every}]\!] = \lambda P \lambda Q \forall x[P(x) \rightarrow Q(x)]$
c. $[\![\text{every dog}]\!] = \lambda Q \forall x[\text{dog}(x) \rightarrow Q(x)]$
d. $[\![\text{every dog}]\!]\ ([\![\text{is awake}]\!]) =$
$= \lambda Q \forall x[\text{dog}(x) \rightarrow Q(x)](\lambda x.\text{awake}(x)) =$
$= \forall x[\text{dog}(x) \rightarrow \text{awake}(x)]$

To recapitulate, the λ-calculus provides a method for "splitting up" the meanings of complex expressions, while Frege's conception of quantification specifies where to apply the split (*every* applies to *dog*, and the combined result to *awake*), as well as how to interpret the components. In combination, these theories specify a step-by-step translation procedure from natural language syntax to semantics that proceeds compositionally, assigning a suitable meaning to each node in the syntactic tree. Moreover, in derivational models, this transition is mediated by LFs. Section 2.3 addresses in more detail the internal composition of LFs and the semantic rules rendering them interpretable.

2.3. Transparent logical forms

Up to the late 1980ies, the principles relating LFs and model-theoretic semantics were generally left vaguely defined. An explicit system restricting the class of possible LFs to *transparent logical forms* was articulated in von Stechow (1993) and Heim and Kratzer (1998). Transparent logical forms are abstract linguistic representations derived from surface syntactic trees (i) whose shape is co-determined by the principles of natural language syntax and (ii) which satisfy the additional criterion of being compositionally interpretable without further modification. Since compositionality describes a functional dependency, this in turn entails that each transparent LF functionally determines a (single) truth-conditional meaning (*modulo* context). A first effect of transparency will be made explicit in the treatment of scope and variable binding, two concepts to be introduced in turn.

Apart from rendering possible a transparent mapping from syntax to semantics in the first place, the λ-calculus is helpful in modeling probably the two most important syntactic relations encoded by LFs − semantic variable binding and the syntactic notion of the *scope* of an operator. The scope of an operator defines the domain (i.e. the set of nodes) in an LF-tree in which this operator can bind semantic variables. Structurally, this set corresponds to the c-command domain of the operator. Semantic variables are objects that are dependent upon their (semantic) binders for meaning assignments, and include certain overt pronouns as well as traces left by various movement operations (question formation, relativization, etc…). To illustrate, the subject quantifier *everybody* in (8) binds the inalienable pronoun *his* as a variable. As a result, the valuation of the pronoun co-varies with the valuation of the antecedent subject, as shown by the paraphrases in (8a) and (8b), respectively:

(8) *Everybody*$_1$ *is trying his*$_1$ *best.*
 a. ∀x[person(x) → x is trying to do x’s best]
 b. “Every individual x is such that if x is a person, then x is trying to do x’s best”

It is important to note in this context that not all syntactic coindexing results in variable binding. Unlike (8), example (9) is ambiguous between a bound variable construal and a coreferential interpretation (Geach 1962). In the case at hand, this difference is truth-conditionally significant. If John and Bill tried on John’s vest and nobody else dressed up, sentence (9) is evaluated as true on the bound reading paraphrased in (9a), yet not on the coreferential interpretation (9b). Conversely, models in which John and Bill each tried on their own vest verify the sentence on its coreferential reading (9b), but fail to satisfy the criteria for the bound interpretation (9a). Thus, coindexing in syntax expresses the semantic notions of coreference or binding (Partee 1970; Büring 2005).

(9) *Only John*$_1$ *is trying on his*$_1$ *vest.*
 a. No person x except for John has the property of trying on x’s vest.
 b Nobody except for John has the property of trying on John’s vest.

Turning to some semantic details, coreferential pronouns are treated as individual variables that are evaluated relative to the context. Technically, this is implemented with the help of contextually given *assignment functions* which map the numerical indices of free variables to members of the individual domain (Tarski 1936; Büring 2005; Heim and Kratzer 1998). Coreference arises if an antecedent DP and the index on a pronoun are mapped to the same individual. By contrast, the denotation of trees that include bound variable pronouns does not depend on assignment functions, reflecting the insight that semantic binding is not contingent upon contextual factors. Rather, binding is the result of two variables (x in [9a]) being captured by the same λ-operator. Hence, the difference between bound and coreferential readings of pronouns semantically reduces to whether their meaning is assignment dependent (referential pronoun) or not (bound pronoun).

Returning to the relation between scope and λ-calculus, notice that in the formal translation of (8), repeated in (10a), the pronoun is bound by the λ-operator which is introduced by the quantifier *everybody*, as in (10b). More precisely, the λ-binder (λx) in the formal metalanguage corresponds to the index on *everybody*.

(10) a. *Everybody*$_1$ *is trying his*$_1$ *best.*
b. $\lambda Q \forall x[\text{person}(x) \rightarrow Q(x)](\lambda x.\text{x is trying x's best})$
c. [Everybody [1 is trying his$_1$ best]]

But while the index is part of the quantificational DP in (10a), the λ-binder λx is bracketed with the *argument* of the quantifier denotation in (10b), resulting in a mismatch between syntactic structure and the logical syntax underlying semantic interpretation. In order to ensure compositional translation, it has therefore, following Heim and Kratzer (1998), become common practice to reanalyze the syntactic relation between the index and its host DP at LF as given in (10c). The syntactic representation in (10c) is then transparently interpretable by the semantic rules of *Predicate Abstraction* (11) and *Function Application* (12); adapted from Heim and Kratzer (1998):

(11) Predicate Abstraction
For any index n: $[\![\, n\ _{\beta}[\ \dots_{n} \dots\ ]\,]\!]^{g} = \lambda x.\ [\![\beta]\!]^{g[n \rightarrow x]}$

(12) Function Application
For any nodes α, β, γ, such that α immediately dominates β and γ, and
$[\![\beta]\!] \in D_{<\delta,\,\varepsilon>}$ and $[\![\gamma]\!] \in D_{\delta}$: $[\![\alpha]\!] = [\![\beta]\!]\,([\![\gamma]\!])$

As detailed by the sample derivation under (13), Predicate Abstraction serves two purposes: First, the modified assignment function ($g^{[1\rightarrow x]}$), which maps values to variables, replaces all occurrences of index 1 in (13c) by the variable x, resulting in (13d). Second, the λ-operator abstracts over this variable in (13d), creating a derived predicate of individuals. Following Heim and Kratzer (1998), these λ-binders will be included in the object language at LF:

(13) a. $[\![1\ [\text{is trying his}_1\text{best}]\ ]\!]^{g}$ =
b. $\lambda x.[\![\text{is trying his}_1\ \text{best}]\!]^{g[1\rightarrow x]}$ = (by Predicate Abstraction)
c. $\lambda x.\text{is trying } g^{[1\rightarrow x]}(\text{his}_1)\text{ best}$ = (applying assignment function g to pronoun)
d. λx.is trying x's best (calculating result of g)

This derived predicate combines then with its sister node, the denotation of the quantifier *everybody*, by Function Application. The relevant steps in the compositional derivation are detailed in (14):

(14) a. ⟦[Everybody [1 [is trying his$_1$ best]]] ⟧^{g} =
b. ⟦Everybody⟧^{g} (⟦1 [is trying his$_1$ best] ⟧^{g}) = (by Function Application)
c. λQ∀x[person(x) → Q(x)] (λx.is trying x's best = (interpretation of subject
d. ∀x[person(x) → x is trying x's best] and substitution of
argument by [13d])

Adopting a widely used notational convention intended to improve readability, indices will from now on be rendered as subscripts to the λ-prefix, writing for example λ_1 instead of 1.

In current LF-models, index reanalysis of the type exemplified in (10b/c) is not limited to binding relations, but also at work in contexts involving (certain types of) movement. The standard procedure for interpreting movement involves a rule that separates the index from its host category and re-attaches it to the sister node of the host, as shown in the transition from (15a) to (15b) (Heim and Kratzer 1998):

(15) a. $[_{TP}$ John$_1$ $[_{vP}$ t_1 is awake]]
b. $[_{TP}$ John $[_{T'} = \lambda_1$ $[_{vP}$ t_1 is awake]]]

Given this tight structural correspondence between index and λ-binder, it becomes now possible to define the scope of a variable binding operator (e.g. a quantifier) as the scope of the λ-binder associated with that operator. This shift in perspective resonates with the view that one defining property of LFs consists in their ability to match λ-binding relations with explicit syntactic representations. LF-approaches differ here once again from surface oriented, categorial approaches, for which abstraction and variables are purely semantic notions.

Explicit representation of λ-binding relations in the object language has three immediate consequences. First, it extends the notion of scope from the scope of a quantifier (as it was used for a long time in the generative syntactic literature) to the scope of a λ-binder, thereby rendering more transparent the semantics of binding and quantification. Second, privileging the status of the λ-binder over the lexical operator in defining LFs forges a close link between movement and binding. Many movement dependencies can now be interpreted as involving variable binding, and v.v. Adopting this view, it becomes immediately evident that empty operator movement in relative clauses is the syntactic reflex of derived predicate formation by λ-abstraction. As detailed by (16), which tracks the evolution of a relative clause at the interface, the index on the fronted empty operator in (16a) creates a derived λ-predicate (16b/c), while the operator itself remains semantically vacuous (Heim and Kratzer 1998; von Stechow 2007).

(16) a. Overt syntax: the book [OP$_3$ she read t$_3$]
b. LF: the book [λ_3 she read t$_3$]
c. Semantics: the ((λx.book(x))(λx.read(x)(she))

But the analytical options also expand in the other direction, in that relations that have previously been thought to implicate binding, like e.g. control, become now amenable to a movement analysis. If PRO is assumed to move short distance ([17a], Heim and Kratzer 1998), the widely shared assumption that control complements denote properties ([17b], Chierchia 1984, 1989) can be made to follow from the general interpretation rules for movement:

(17) a. Overt syntax: Sally tried [PRO$_2$ t$_2$ to win]
b. LF: Sally tried [λ_2 t$_2$ to win]
c. Semantics: tried(λx.win(x))(Sally)

Thus, the transparent LF model emphasizes the relevance of abstraction by λ-binding in the analysis of relative clauses, control, and many other constructions, thereby anticipating aspects of the compositional interpretation in the syntactic component.

A third consequence of representing λ-binding at LF is that quantifier scope must be explicitly represented at LF, which in turn entails syntactic disambiguation of relative quantifier scope. Since the proper treatment of quantifier scope constitutes one of the core areas of any theory of the syntax-semantic interface, and also aids in discriminating among different theories, the issue will be taken up in detail in the section to follow.

3. Quantifier scope and the model of the grammar

The current section embeds a survey of different strategies for determining quantifier scope (section 3.1) into a general discussion of the criteria that distinguish between models of the grammar that admit LFs and those that do not (3.2).

3.1. Quantifier scope and scope ambiguity

The principle of compositionality dictates that the meaning of each complex expression is only dependent upon the meaning of its immediate parts and the way they are combined. This leads to the problem that quantifiers in object position, illustrated by (18), cannot be interpreted without further additions to the theory:

(18) *John liked every movie.*

The problem resides in the incompatibility of the verb meaning and the object denotation, which can be expressed in terms of mismatches between their logical types. On their standard interpretation, transitive predicates such as *like* denote (Curried or Schönfinkelized) two place relations between individuals (logical type <e,<e,t>>), and therefore need to combine with an individual denoting term (type e) as their first argument. Generalized Quantifiers such as *every movie* denote second order properties, i.e. functions of type <<e,t>,t>. Such functions require properties (<e,t>) as input. Thus, the verb meaning is looking for an e-type argument, while the sister of *every movie* must be in the domain of <e,t>-type expressions, resulting in conflicting type requirements.

In most theories, the conflict is resolved by adopting one of two strategies. First, on the transparent LF approach, documented in (19), the object quantifier *every movie* is removed from its base position by an application of *Quantifier Raising* (QR; [19a]; Chomsky 1976; May 1977). QR is a movement operation that targets quantifiers, and covertly raises them into positions where they are interpretable, possibly crossing other operators. In this particular case, the trace of *every movie* is interpreted as an e-type variable bound by the λ-binder of the fronted quantifier ([19b]), which may then be combined with the quantifier denotation, yielding the desired interpretation outlined in (19c):

(19) a. [Every movie$_2$ [John liked t$_2$]]
b. [Every movie λ_2 [John liked t$_2$]]
c. $\lambda Q \forall x[\text{movie}(x) \rightarrow Q(x)](\lambda x.\text{John liked } x) = \forall x[\text{movie}(x) \rightarrow \text{John liked } x]$

Thus, the LF-approach resolves the type conflict − in line with the general method outlined in the introduction − by adopting an abstract movement operation, i.e. QR, modulating the syntax. QR can in turn be motivated by a general requirement that derivations generate semantically interpretable results.

Alternatively, (18) can be given a compositional interpretation by type shifting operations which adjust the meaning of one of the expressions triggering a type mismatch (*every movie* and *like*). This strategy is particularly popular in surface oriented theories, among them Montague Grammar (MG) and various current (type-logical or combinatory) versions of Categorial Grammar, which tend to avoid hidden complexity or abstract representations. In these frameworks, transitive verbs can e.g. be mapped to the higher type <<et,t>,<e,t>>, such that verb denotations and quantifier denotations may combine without altering surface constituency. Moreover, it is also possible to shift the denotation of the object quantifier (to type <<e,<e,t>>,<e,t>>), keeping constant the verb denotation. Detailed discussion of the treatment of scope in categorial grammar can be found in Hendriks (1993), Jacobson (1996), Steedman (2012) and Szabolcsi (2010, 2011), among others.

As compositionality also entails that each expression translates into a single meaning (*modulo* lexical ambiguity and context), it follows that structurally ambiguous sentences such as (20) have to be disambiguated before they are submitted to the semantic interpretation function.

(20) *Some critic liked every movie.*

Disambiguation can be achieved in various ways. To begin with, on the transparent LF approach, QR optionally places the object quantifier either inside ([21a] or outside [21b]) the scope of the subject quantifier, yielding two disambiguated LFs which in turn result in two truth-conditionally distinct interpretations (May 1977):

(21) a. LF1: [Some critic$_1$ [every movie$_2$ [t$_1$ liked t$_2$]]]
LF1 (index reanalysis): [Some critic λ_1 [every movie λ_2 [t$_1$ liked t$_2$]]]
Translation 1: $\exists x[\text{critic}(x) \wedge \forall y[\text{movie}(y) \rightarrow x \text{ liked } y]]$

b. LF2: [Every movie λ_2 [Some critic λ_1 [t$_1$ liked t$_2$]]]
Translation 2: $\forall y[\text{movie}(y) \rightarrow \exists x[\text{critic}(x) \wedge x \text{ liked } y]]$

The LF analysis generates what is called a *prenex normal form* for quantified expressions in which all quantifiers precede the open formula containing their bound variables (the vPs in [21]). Semantically, this account is similar to MG, historically the first compositional theory of natural language quantification, in that scope relations are mapped into binding relations between quantifiers and individual variables. MG is representative of a radically different view on the interaction between syntax and semantics, though. Designed as a non-derivational categorial system, each step in the computation of a sentence generates a syntactic object as well as its pertaining interpretation. The specific implementation employed by MG rests of the concept of rule-by-rule interpretation (Bach 1976), on which each input expression simultaneously induces the application of a syntactic rule and its corresponding semantic partner rule. Generating (20) e.g. involves the rule (scheme) of *quantifying-in*, an operation that translates sentences containing unbound variables or pronouns into quantified formulas. The syntactic part of quantifying-in introduces a quantifier directly into its prenex (read: scope) position ([22a]), while the semantic rule simultaneously assigns the emerging structure a Tarskian model theoretic interpretation, paraphrased in (22b):

(22) a. [*some critic* α] $\rightarrow$ *some critic* ($\lambda x. [_{\alpha} \ldots x \ldots]$) (where α is an open formula)
b. "There is an individual which is a critic and which has property $\lambda x. [_{\alpha} \ldots x \ldots]$"

Applying quantifying-in twice to (20) generates two relative scope orders. Quantifying-in the object first, followed by quantifying-in the subject yields the surface scope reading, while the reverse sequencing results in the inverted scope interpretation. Sentences with more than one quantifier are accordingly associated with multiple derivational histories (*analysis trees*), and not multiple linguistic representations. Thus, MG produces results that are for all means and purposes semantically undistinguishable from the ones generated by its descendant QR − yet, these results are obtained by different means. While in derivational approaches, the meanings are disambiguated at LF, such that each LF-tree functionally translates into a single scope order, MG and other categorial theories derive the two readings of (20) from a single surface representation.

Moreover, differences between quantifying-in and QR also manifest themselves on the syntactic side of the derivation. Most notably, the MG strategy for representing scope needs to stipulate that the quantifier surfaces in the position of the coindexed variable, and not in its prenex position. For further in-depth discussion of scope in different versions of CG such as Flexible Categorial Grammar, type-logical grammar, and CCG see Jacobson (1996), Partee and Hendriks (1997), Steedman and Baldridge (2011) and Szabolcsi (2011), among others.

In addition to QR, type shifting and Quantifying-in, various other strategies for analyzing quantifier scope phenomena have been proposed in the literature, including Cooper Storage (Cooper 1975, 1983); Scope Indexing (Cooper and Parsons 1976; van Riemsdijk and Williams 1981; Ruys 1992); Quantifier Lowering (Lakoff 1971; May 1977, 1985); Semantic Reconstruction (Cresti 1995; Hendriks 1993; Rullman 1995; von Stechow 1991; see section 6); syntactic reconstruction by copies; decompositional approaches, which generate the quantificational determiner in a position above the quantifier restrictor (Kratzer and Shimoyama 2002; Sportiche 2005); underspecification (Egg

2010) and Game theoretic accounts (Hintikka 1997). For an overview of these and other analytical tools for modeling scope see Szabolcsi (1997, 2001, 2010, 2011); Enç (1987); Ruys and Winter (2011), among many others.

3.2. The model of the grammar (evidence for LF)

As was seen above, there are various analytical options for coding scope and scope ambiguity, with derivational models on one side of the spectrum, and strictly surface oriented, non-derivational, categorial theories on the other. Even though the two groups are, due to fundamental differences in their axioms and empirical coverage, to a large degree incommensurable, it is possible to isolate some diagnostics that aid in adjudicating between the competing models. The most important of these match the profile of one or more of the criteria in (23):

(23) a. There are syntactic principles that treat overt and covert expressions alike.
b. Division of labor: the syntactic component assumes functions otherwise left to semantics.
c. Existence of hidden structure: surface representations contain hidden structure.
d. Opacity effects: covert operations display opaque rule orderings.

Anticipating the results of section 4 and 5, these criteria will be seen to provide strong support for the *Transparent Interface Hypothesis* (repeated from above as [24]), which is in turn best compatible with a model that admits abstract LF-representations, as expressed by the *Abstractness Hypothesis* (25):

(24) Transparent Interface Hypothesis
Interpretive properties are co-determined by properties of natural language syntax.

(25) Abstractness Hypothesis
Linguistic representations may contain abstract objects.

It should be noted at this point that the distinction between theories is not as categorical as the presentation above might have suggested. In particular, there are also monostratal, non-derivational models that do not espouse the concept of LF, but still admit hidden complexities such as traces and empty operators (Brody 1995; Haider 1993; Koster 1986), in line with the Abstractness Hypothesis. Furthermore, multiple (possibly abstract) representations can also be linked by other mapping principles apart from movement (Williams 2003). This expanded topology is consistent with the observation that the criteria in (23) divide the logical matrix of plausible theories into more than two cells, and are therefore not exclusively symptomatic for the LF model. Although space precludes a detailed discussion of criteria for these alternatives, it should be in most cases evident which specific analyses presuppose the notion of LF, and which ones are also compatible with other theoretical choices.

The remainder of this article presents a review of selected pieces of evidence for the Abstractness Hypothesis from the literature, which match one or more of the criteria in (23). At the same time, and of at least equal significance, the survey aims at (i) exposing the most important analytical tools and methods used in current research on that topic and at (ii) introducing some of the basic phenomena that define the syntax-semantic interface. For expository convenience, the presentation will not proceed from criterion to criterion, but will follow the order intrinsic in the analyses.

4. Properties of QR

4.1. Locality matches that of certain overt movements

The present section reports similarities between QR and overt movement that contribute both a "QR is syntactic" ([23a]) as well as a division of labor argument for LF ([23b]). Before doing so, two remarks on the method used to diagnose non-surface scope are in order.

First, following Reinhart (1976), the examples will throughout be designed in such a way that the non-surface interpretation is logically weaker than (does not entail) the surface interpretation (Cooper 1979; Reinhart 1976; Ruys 1992). This ensures that the existence of a designated LF-representation for non-surface scope can be directly inferred from the existence of models that only satisfy the derived scope reading. (20), for one, meets the criterion (the non-surface reading [21b] does not entail the surface interpretation [21a]), supporting the assumption that the inverted reading is structurally represented in form of the LF in (21b). By contrast, examples like (26) fail to elicit evidence for a non-surface LF, because the derived scope order (26b) entails the surface reading (26a). As a result, it is not possible to identify scenarios that can only be truthfully described by the inverse reading (26b).

(26) *Every critic liked a movie.*
a. Surface interpretation: $\forall x[\text{critic}(x) \rightarrow \exists y[\text{movie}(y) \wedge x \text{ liked } y]]$
b. Non-surface interpretation: $\exists y[\text{movie}(y) \wedge \forall x[\text{critic}(x) \rightarrow x \text{ liked } y]]$

More generally, on this methodology, combinations of universals in subject position and (monotone) existential objects are not suited as diagnostics for the existence of LF-representations that code non-surface scope. (Such examples can still be found in the syntactic literature, though; for discussion see e.g. Ruys 1992).

A second, widely used strategy testing for wide scope apart from judgements related to relative quantifier scope is provided by the use of the relational modifier *different*, which displays ambiguity between a distributive ([27a]) and a deictic interpretation ([27b]; Carlson 1987; Beck 2000). As revealed by the first order translation of (27a) in (28), the former involves an implicit variable (y) in the denotation of *different* that is bound by the universal:

(27) *Every critic liked a different movie.*
a. Every critic liked a movie and no two critics liked the same movie.
b. Every critic liked a movie that was different from *that* (contextually salient) movie.

(28) $\forall x[\text{critic}(x) \rightarrow \exists y[\text{movie}(y) \wedge x \text{ liked } y \wedge$
$\neg\exists a, b[\text{critic}(a) \wedge \text{critic}(b) \wedge a{\neq}b \wedge a \text{ liked } y \wedge b \text{ liked } y]]]$

As a result, distributive *different* must reside inside the scope of a distributive operator. It is this requirement which distinguishes between (29) and (30). While scope shift by QR is licensed in (29), resulting in LF (29a) with associated translation (29b), no standardly sanctioned syntactic operation may extend the syntactic scope of quantifiers across sentence boundaries, accounting for the deviance of (30) (but see [42]):

(29) *A different critic liked every movie.*
a. LF: every movie λ_2 [a different critic liked t_2
b. $\forall y[\text{movie}(y) \rightarrow \exists x[\text{critic}(x) \wedge x \text{ liked } y \wedge$
$\neg\exists a, b[\text{movie}(a) \wedge \text{movie}(b) \wedge a{\neq}b \wedge x \text{ liked } a \wedge x \text{ liked } b]]]$

(30) *#A different critic arrived. Every movie looked interesting to him.*

The distribution of *different* accordingly supplies an independent gauge for measuring the LF c-command domain of (at least a certain group of) quantifiers and will be used in the discussion of movement by QR below (Johnson 1996).

The classic argument for modeling scope extension by QR is based on the observation that scope of certain QPs is restricted by the same syntactic conditions which limit overt movement. Among others, QR is subject to the *Complex NP Constraint* and the *Subject Condition*. Thus, the fact that (31a, b) and (33a) lack the inverted scope reading can be taken to indicate that the representation of object wide scope ([32b]) involves movement, and that movement is blocked in these instances for the same reason that it is unavailable in analogous examples of overt dislocation ([31c] and [33b]):

(31) Complex NP Constraint
a. *Some actress made [$_{DP}$ the claim that she liked every movie].* ($\exists > \forall$ / $*\forall > \exists$)
b. *#A different actress made [$_{DP}$ the claim that she liked every movie].* ($\exists > \forall$ / $*\forall > \exists$)
c. **Which movie$_2$ did some actress make [$_{DP}$ the claim that she liked t_2]?*

(32) a. LF 1: some actress made [$_{DP}$ the claim that [every movie$_2$ [she liked t_2]]]
b. LF 2: *[every movie$_2$ [$_{IP}$ some actress made [$_{DP}$ the claim that she liked t_2]]]

(33) Subject Condition
a. *[[That she disliked every movie] convinced some actress to become a critic.* ($\exists > \forall$ / $*\forall > \exists$)
b. **Which movie$_2$ did [[that she disliked t_2] convince some actress to become a critic?*

A second standard argument for covert displacement comes from the interaction between pronominal variable binding and scope. Just like overt wh-movement, QR feeds pronominal variable binding only if the base position of the operator (*wh*-phrase or quantifier) c-commands the variable, as in (34a) and (35a). Absence of c-command leads to violations of the Weak Cross Over (WCO; Wasow 1972) condition ([34b] and [35b]), which characteristically involve mild ungrammaticality.

(34) a. *Who*$_1$ t_1 *likes his*$_1$ *mother?*
b. **?Who*$_1$ *does his*$_1$ *mother like* t_1*?*

(35) a. *Everyone/Noone*$_1$ *dislikes his*$_1$ *mother.*
b. **?His*$_1$ *mother dislikes everyone/noone*$_1$*.*

Assuming that WCO effects are induced by moving operators across pronominal variables they bind, the observation that the behavior of quantifiers parallels that of overtly fronted *wh*-phrases supports the claim that quantifiers reach their scope position by covert movement.

Note in passing that if the structural relations between trace and pronoun are reversed, i.e. if the pronoun c-commands the trace left by displacement, Strong Crossover (SCO) effects emerge. The symptoms of SCO are robust judgements of unacceptability.

(36) a. *Who*$_1$ t_1 *thinks she likes him*$_1$*?*
b. **Who*$_1$ *does he*$_1$ *think she likes* t_1?

(37) **He*$_1$ *thinks she dislikes noone*$_1$*.*

SCO is usually interpreted as a reflex of Principle C, on the assumption that the descriptive content of *wh*-phrases and quantifiers makes them behave like names for the purposes of Binding Theory. Unlike WCO, SCO does therefore not elicit further evidence for QR.

Ruys (1992) observes that a particular combination of the island diagnostic with pronominal variable binding generates at first sight unexpected results, which at closer inspection further strengthen the covert movement hypothesis, though. The contrast (38) demonstrates that QR is, just like overt movement, regulated by the Coordinate Structure Constraint (CSC). Curiously, quantifier exportation out of the initial conjunct all of a sudden becomes licit if the wide scope object binds a variable inside the second conjunct ([39a]):

(38) a. *Some student likes every professor*$_2$ *and hates the Dean.* ($\exists > \forall$ / $*\forall > \exists$)
b. **She asked, who*$_2$ *some student likes* t_2 *and hates the Dean.*

(39) a. *Some student likes every professor*$_2$ *and wants him*$_2$ *to be on his committee.*
b. every professor$_2$ [some student [likes t$_2$] and [wants him$_2$ to be on his$_2$ committee].

Identical contrasts can be replicated for *wh-in-situ*:

(40) a. **I wonder who [took what from Mary] and [gave a book to Jeremy].*
b. *I wonder who [took what*$_2$ *from Mary] and [gave it*$_2$ *to Jeremy].*

The sudden emergence of the wide scope reading in (39) and (40b) can be explained on the assumption that pronominal variables and traces are sufficiently similar for the purposes of the CSC (both are interpreted as variables), and that the CSC is a representational condition which is evaluated subsequent to covert movement ([39b]), and not a constraint on syntactic derivations (Fox 2000: 52; Ruys 1992). On this analysis, the existence of selected island violations with QR and *wh-in-situ* provides an independent argument for an abstract representation such as LF.

Even though not strictly necessary for the Abstractness Hypothesis, it would be interesting to be able to pair QR with one of the various overt movement processes. The search for a suitable overt analogue has proved difficult, though. In some ways, QR behaves like A-movement in that it generally observes clause boundedness (Hornstein 1995; example from Johnson 2000, [6b]):

(41) *I told someone you would visit everyone.* $(\exists > \forall \,/\, {}^*\forall > \exists)$

There are however various exceptions to this generalization. Reinhart (2006: 49), for one, surveys cases in which QR appears to be able to cross finite sentence boundaries (see also Wilder 1997):

(42) *A doctor will make sure that we give every new patient a tranquilizer.* $(\exists > \forall \,/\, \forall > \exists)$

More crucially, the motivation behind this alleged parallelism remains obscure. Triggering QR by the same mechanism that drives A-movement (Case), as suggested in Hornstein (1995), fails to provide a complete analysis, because QR is also attested with categories that do not require Case (Kennedy 1997). The indirect object of (43) can e.g. be construed with wide scope even though it has already been assigned Case in its base position by *to*:

(43) *Someone gave this to every student.* $(\exists > \forall \,/\, \forall > \exists)$

Similarly, in contexts of *Inverse Linking* (Larson 1987; May 1986; May and Bale 2005), the embedded quantifier *every city* may scope out of its containing DP even though it is case marked as the prepositional complement of *from:*

(44) a. *Someone from every city$_2$ hates it$_2$.* $(\#\exists > \forall \,/\, \forall > \exists)$
b. [every city$_2$ [[Someone from t$_2$] t$_2$ hates it$_1$]].

For these reasons, Kennedy (1997) concludes that QR cannot consist in A-movement.

An alternative group of approaches tries to assimilate QR to the kind of *Mittelfeld* scrambling phenomena known from continental Western Germanic (Diesing 1992; Johnson 2000). In German, objects may e.g. move across subjects ([45b]) and scramble out of restructuring infinitivals ([45c]). Scrambling must however not cross finite sentence boundaries ([45d]; the control in [45e] shows that long extraction is generally licit):

(45) a. *weil Peter den Zaun reparierte* [German]
since Peter the fence mended
'since Peter mended the fence'

b. *weil den Zaun$_1$ Peter t$_1$ reparierte*
since the fence Peter mended

c. *weil den Zaun$_1$ Peter [$_{TP}$ PRO t_1 zu reparieren] hoffte*
since the fence Peter to mend hoped
‘Peter hoped to mend the fence’

d. **weil den Zaun$_1$ Peter hoffte [$_{TP}$ würde Maria t_1 reparieren]*
since the fence Peter hoped would Mary mend

e. *Den Zaun$_1$ hoffte Peter [$_{TP}$ würde Maria t_1 reparieren]*
the fence hoped Peter would Mary mend
‘Peter hoped that Mary would mend the fence’

Moreover, scrambling is also blocked if the infinitival is introduced by a complementizer (Johnson 2000; example from Dutch, as German lacks infinitival complementizers):

(46) **dat Jan Marie$_1$ heeft geprobeerd [om t_1 te kussen]* [Dutch]
that John Mary has tried C° to kiss
‘that John has tried to kiss Mary’

As pointed out by Johnson (2000), the same restrictions are also characteristic of QR. QR may extend the scope of a quantifier beyond non-finite clause boundaries ([47]), but typically not across finite predicates ([48]) or complementizers ([49]):

(47) a. *At least one American tourist expects to visit every European country this year.*
($\exists > \forall$ / $*\forall > \exists$)
b. *At least one American tourist hopes to visit every European country this year.*
c. *Some government official is required to attend every state dinner.*
(Kennedy 1997, [46], [47], [50])

(48) *A different student claimed that she had read every book.* ($\exists > \forall$ / $*\forall > \exists$)

(49) *A different student wanted for you to read every book.* ($\exists > \forall$ / $*\forall > \exists$)

Finally, in those languages that admit the operation, scrambling, just like QR, feeds scope. Scrambling languages such as German or Japanese are scope rigid in that under normal intonation, base word order is only compatible with the surface scope interpretation ([50a]). Scope ambiguity is contingent upon overt inversion of the quantifiers by scrambling ([50b]), or some other rearrangement operation (Frey 1993; Haider 1993; Kiss 2000; Krifka 1998; Wurmbrand 2008):

(50) a. *weil **irgendeiner** jedes Buch mit Freude gelesen hat* [German]
since someone every book with joy read has ($\exists > \forall$ / $*\forall > \exists$)
‘since somebody read every book with joy’

b. *weil **irgendein Buch$_1$** jeder t_1 mit Freude gelesen* ($\exists > \forall$ / $\forall > \exists$)
Since some book everybody with joy read
hat
has
‘since everybody read some book with joy’

This has been taken as evidence that scrambling languages lack QR unless required for resolving type conflicts that arise with Inverse Linking or *in-situ* object quantifiers. On this view, all non-surface scope orders are derived by *reconstruction*. (Inverse scope has also been attributed to a non-compositional Scope Principle, which maps configurations with multiple operators to multiple interpretations; Frey 1993; Aoun and Li 1993.) Reconstruction denotes a group of operations which restore (parts of a) dislocated category into one of its pre-movement configurations for the evaluation of scope, binding or referential opacity effects (section 5 and section 6). For the German string (50b), this has the consequence that the inverse reading, on which the universal distributes over the existential (such that books may potentially vary with readers), results from reconstructing the fronted object into a position below the subject (t_1). Scrambling now resembles QR in that it feeds new scope relations.

The QR-as-covert-scrambling analysis has the additional benefit of supplying a division of labor argument for LF (Diesing 1992; Johnson 2000). If scope is determined by QR, and QR is the covert counterpart of scrambling, languages differ only in a single parameter: whether they admit overt scrambling (German) or covert scrambling (QR in English). This perspective dovetails, for one, with a *single output model* of the grammar (Bobaljik 1995; Groat and O'Neil 1996; Pesetsky 2000), in which overt and covert movement operations are not discriminated by relative timing, but apply in a single cycle and are distinguished only by whether the higher or the lower movement copy is pronounced. Cross-linguistic variation is thereby restricted to different parameter settings in syntax, while the semantic component can be kept uniform across all language types, presumably a desirable result in itself.

By contrast, surface oriented categorial approaches not only need to find an explanation for why English type languages employ a strategy of scope extension which is missing in German, but also have to provide an (unrelated) answer as to why scrambling is limited to German. This effectively amounts to admitting cross-linguistic variation both in the component that generates word order variation, as well as in semantics, where scope extension is computed. Thus, even though it postulates an additional, mediating level between syntax and semantics, the LF-approach eventually turns out to be more parsimonious in its design.

4.2. Types of quantifiers

It has been observed that QR reveals its nature most transparently when it targets distributive universals (*each*, *every*), but is subject to various distortions with other classes of DPs. On the one hand, singular indefinites freely scope out of islands, indicating that they do not reach their scope position by QR (Farkas 2000; Fodor and Sag 1982; Kratzer 1998; Reinhart 1997, 2006; Ruys 1992; Winter 2001).

(51) *If a relative of mine dies, I will inherit a house.*
(Ruys 1992)

Cardinal plural indefinites are on the other hand much more limited in their scope taking options than distributive universals. For instance, Ruys (1992) notes that (52) lacks the interpretive signature of the inverse scope reading (52b), the sentence cannot be used to characterize situations in which six critics reviewed two movies (s. a. Reinhart 2006: 110). (52) minimally differs in this respect from structurally isomorphic examples with universals in object position ([20], repeated from above as [53]):

(52) *Three critics liked two movies.* $(\exists_3 > \exists_2 \, / \, {*}\exists_2 > \exists_3)$

a. $\exists X[|X|=3 \wedge \text{critics}(X) \wedge \forall a \leq X \rightarrow \exists Y[|Y|=2 \wedge \text{movies}(Y) \wedge \forall b \leq Y \rightarrow a \text{ liked } b]]$

b. $\exists Y[|Y|=2 > \wedge \text{ movies}(Y) \wedge \forall b \leq Y \rightarrow \exists X[|X|=3 \wedge \text{critics}(X) \wedge \forall a \leq X \rightarrow a \text{ liked } b]]$

(53) S*ome critic liked every movie.* $(\exists > \forall \, / \, \forall > \exists)$

The inability of plural indefinites to obtain wide scope is also responsible for the deviance of (54):

(54) *#Three different critics liked two movies.*

Moreover, even if the cardinal were allowed to escape islands, the truth conditions delivered by these readings would be too weak (Ruys 1992). The wide scope distributive formula (55a) is already satisfied on the condition that a single relative of mine dies. But this is not what (55) means. Rather, (55) expresses the proposition that an inheritance is dependent on the death of all three relatives, which is only captured by the wide scope collective construal (55b):

(55) *If three relatives of mine die, I will inherit a house.*

a. $\exists X \, [|X|=3 \wedge \text{relatives of mine}(X) \wedge \forall y \leq x \, [\text{die}(y) \rightarrow \text{I will inherit a house}]$

b. $\exists X \, [|X|=3 \wedge \text{relatives of mine}(X) \wedge [[\forall y \leq x \rightarrow \text{die}(y)] \rightarrow \text{I will inherit a house}]$

(Ruys 1992)

Thus, treating cardinal indefinites as ordinary generalized quantifiers fails to provide the means for excluding unattested interpretations. It has therefore been suggested to analyze plural indefinites as existentially closed wide scope choice functions (Kratzer 1998; Reinhart 2006; Ruys 1992; Winter 1997). In its simplest incarnation, a choice function (CH) applies to a non-empty set of individuals and returns a member of that set ([56]). For (55), the choice function account delivers the desired collective interpretation on the assumption that the function ranges over pluralities:

(56) f is a choice function (CH) iff for any non-empty X: $f(X) \in X$

(57) $\exists f_{<et,e>} \, [\text{CH}(f) \wedge [\text{die}(f(\text{relatives of mine})) \rightarrow \text{I will inherit a house}]$

To recapitulate, QR does not affect all noun phrases uniformly, motivating the introduction of new semantic techniques (such as choice functions) for modeling certain aspects of the translation from natural language syntax to the interpretive component. For further discussion of the logical syntax of plural noun phrases and distributivity see Landman (2003); Winter (2001); Reinhart (2006); von Stechow (2000) among many others. For the question of how far QR takes different types of quantifiers see Ioup (1975); Szabolcsi (1997, 2010); Beghelli and Stowell (1997); Kamp and Reyle (1993); and Reinhart (2006).

4.3. Order preservation effects

A number of syntactic configurations impose ordering statements on relative quantifier scope, resulting in *scope freezing* phenomena. This observation provides further support for the view that quantifier exportation is the result of a syntactic operation that behaves like overt movement.

Order preservation restrictions are known, among others, to limit the relative scope options of the two internal arguments in the double object construction ([58]; Barss and Lasnik 1986). The same condition blocks the theme in (59b) from binding an implicit variable inside the goal:

(58) a. *I gave a child each doll.* (∃ > ∀ / *∀ > ∃)
b. *The judges awarded a athlete every medal.* (∃ > ∀ / *∀ > ∃)
(Bruening 2001, [2a], [28c])

(59) a. *I gave every girl a different marble.*
b. *#I gave a different girl every marble.*
(Johnson 1996)

Interestingly, the direct object may scope over the subject, though, as shown by (60):

(60) a. *A (different) teacher gave me every book.* (∀ > ∃)
b. *At least two judges awarded me every medal.* (∀ > *at least 2)*
(Bruening 2001, [28a], [28c])

This indicates that the relevant constraint does not put an upper bound on the scope domain of direct objects *per se*, but has to be formulated in such a way that it requires the relative order between the two internal arguments to be preserved. Before turning to a specific account of scope freezing, it is instructive to digress briefly into order preservation effects with overt movement.

In English multiple interrogatives, structurally higher arguments must precede lower ones. This generalization, known as the *Superiority Condition* (Chomsky 1973; Hornstein 1995; Shan and Barker 2006), forces the subject of (61) to surface to the left of the object. Analogous considerations hold for (62) and (63). Note incidentally that (61b)−(63b) are interpretable by standard techniques of question semantics, thus the constraint is unlikely to be semantic in nature.

(61) a. *Who bough what?*
b. **What did who buy?*

(62) a. *Who did she give t what?*
b. **What did she give who t?*

(63) a. *Whom did Bill persuade to visit whom?*
b. **Whom did Bill persuade whom to visit?*

A prominent strand of analyses relates this pattern to a general principle of economy preferring shorter movement paths over longer ones, which is variably referred to as *Shortest*, *Shortest Move*, *Shortest Attract*, or the *Minimal Link Condition* (Chomsky 1995; Richards 2001). Shortest accounts for the contrasts above because subject movement in (61a) e.g. creates a shorter movement path than object movement in (61b). In (64a), the subject crosses only a single maximal projection on its way to SpecCP, while the object in (64b) has to traverse at least three nodes:

(64) a. [$_{CP}$ who$_1$ [$_{TP}$ t$_1$ [$_{vP}$ t$_1$ [$_{VP}$ bought what$_2$]]]]
b. *[$_{CP}$ what$_2$ did [$_{TP}$ who$_1$ [$_{vP}$ t$_1$ [$_{VP}$ buy t$_2$]]]]

One group of languages that permit overt fronting of more than one *wh*-phrase, among them Bulgarian and Romanian, reveal another important restriction: multiple movement generally proceeds in such a way that it preserves the original serialization of the *wh*-phrases.

(65) a. *Koj kogo vižda?* [Russian]
who whom sees
'Who sees whom?'

b. **Kogo koj vižda?*
whom who sees
(Rudin 1988, [45a, b])

Richards (2001) demonstrated that these order preservation effects also fall out from the economy condition Shortest. The derivation of (65a) is schematized in (66). Whenever a higher category α and a lower node β are attracted by the same c-commanding head ([66a]), the metric that minimizes the length of movement paths dictates that α move prior to β ([66b]). Moreover, Shortest forces the second movement, which affects β, to "tuck in" below α, rather than passing over β, yielding the crossing dependency (66c):

(66) a. head … [α … [β (head attracts α and β)
b. [α$_1$ head … [t$_1$ … [β (α moves first)
c. [α$_1$ [β$_2$ head … [t$_1$ … [t$_2$ (β moves second, tucking in below α)

Returning at this point to scope freezing in double object constructions, Bruening (2001) argues that multiple applications of QR and wh-movement can be given a common analysis in terms of (66) if it is assumed that quantificational DPs need to check a Q(uantificational)-feature on v°. Then, the indirect object (IO), which is generated above the direct object (DO), undergoes QR first ([67b]), landing in an outer specifier of vP, followed by movement of DO ([67c]). Since the second application of QR tucks in below the first one, the two internal arguments end up in an order-preserving configuration ([67c]):

(67) a. [$_{vP}$ SUB V$_{[Q]}$ [$_{VP}$ IO$_{2,[Q]}$ [DO$_{3,[Q]}$]]]
b. [$_{vP}$ IO$_2$ [$_{vP}$ SUB V$_{[Q]}$ [$_{VP}$ t$_2$ [DO$_{3,[Q]}$]]]]
c. [$_{vP}$ IO$_2$ [$_{vP}$ DO$_3$ [$_{vP}$ SUB [$_{vP}$ t$_2$ [t$_3$]]]]]

On this view, QR is also feature driven, and not exclusively motivated by the need to repair type clashes.

Even though attractive, the feature analysis also encounters complications. First, Sauerland (2000) notes that Bruening's account is challenged by (68a), which can, among others, be assigned a reading on which the subject scopally interferes in between the indirect and the direct object. This is unexpected inasmuch as the LF (68b) fails to preserve the base order:

(68) a. *Two boys gave every girl a flower.* ($\forall > \exists_2 > \exists$)
b. [$_{vP}$ IO$_2$ [$_{vP}$ SUB [$_{vP}$ IO$_3$ …
(Sauerland 2000, [49])

Second, the assumption that quantifier movement is driven by the need to check Q-features in addition to the requirement to avoid type mismatches duplicates the motivation for object QR, thereby introducing redundancy into the system. For further discussion and alternative solutions see Lechner (2012); Sauerland (2000); Williams (2005).

Finally, a number of additional structural restrictions on quantifier scope have been identified in the literature, two of which will be briefly addressed below. To begin with, predicate fronting ([69a]) systematically bleeds inverse scope readings (Barss 1986; Huang 1993).

(69) a. *... and [$_{VP}$ teach every student$_2$]$_3$, noone$_1$ will t$_3$* ($\neg\exists > \forall$ / $*\forall > \neg\exists$)
b. *… and noone$_1$ will [$_{VP}$ teach every student$_2$]* (subsequent to reconstruction)

The topicalized VP of (69a) needs to reconstruct for reasons of interpretation, restoring the base word order, as in (69b). Scope freezing can then be interpreted as a consequence of the descriptive generalization in (70), according to which VP-movement renders ineligible the object *every student* (α) for long QR across the subject *noone* (β) in representation (69b).

(70) If XP contains α, moves and is interpreted below the overt position of β, α cannot extend its scope over β.

A similar restriction applies to Inverse Linking, where the two quantifiers affected are in a dominance, instead of a c-command, relation. In (71), the direct object *someone from every city* needs to cross the (VP-internal trace of the) subject in order to resolve a type mismatch. At the same time, *every city* may be inversely linked across its container *someone* ([71a, b]). However, the subject must not scopally interfere between the inversely linked node *every city* and the container ([71c], Larson 1985):

(71) *[$_\beta$ Two policemen] spy on [$_{XP}$ someone from [$_\alpha$ every city]].*
a. $\exists_2 > \forall > \exists$ (inverse linking, wide scope for subject)
b. $\forall > \exists > \exists_2$ (inverse linking, narrow scope for subject)
c. $*\forall > \exists_2 > \exists$ (inverse linking, intermediate scope for subject)

Just like (69), sentence (71) bears the signature of (70), the only difference being that in (71), XP moves covertly and not overtly. In (71), the quantifier *someone from every city* (XP) contains *every city* (α) and needs to move for type reasons. Moreover, in the relevant reading (71c), XP is interpreted below the position the subject (β) resides in. Thus, (70) prohibits *every city* from obtaining scope over the subject, excluding (71c).

As for their theoretical relevance, scope freezing effects expose once again the parallelism between overt and covert movement operations. On the one side, it was seen that in double object constructions, both visible wh-movement and multiple QR display order preservation effects. On the other side, embedding a quantifier inside a container that moves prevents that quantifier from crossing higher operators, irrespective whether the container moves overtly (predicate fronting; [69]) or covertly (inverse linking; [71]). These observations contribute further arguments for the position that QR obeys the same, or very similar, laws that are typical of overt movement processes (s. [23a]).

4.4. Scope Economy

VP-ellipsis denotes the process by which a VP is phonologically suppressed under identity with an antecedent VP:

(72) a. *John liked the movie. Mary liked the movie, too.*
b. *John liked the movie. Mary did ⌂, too.*
(⌂ = like every movie)

On the standard analysis, the terminals inside the elided VP are syntactically projected, but the ellipsis operation instructs them to forgo pronunciation. The elided VP is moreover subject to a semantic *parallelism* condition which is commonly taken to be satisfied whenever the denotation of the antecedent VP is an element of the focus semantic value of the elided VP (Rooth 1992).

What is of relevance for the present purposes is that VP-ellipsis reveals a further constraint on relative quantifier scope. As first observed by Sag (1976) and Williams (1977), VP-ellipsis leads to disambiguation in the antecedent clause if the elliptical clause is unambiguous ([73b]).

(73) a. *A critic liked every movie. An actress did, ⌂ too.* $(\exists > \forall \, / \, \forall > \exists)$
b. *A critic liked every movie. Mary did ⌂, too.* $(\exists > \forall \, / \, {*}\forall > \exists)$
(⌂ = liked every movie)

On an influential idea developed in Fox (1995, 2000), the contrast under (73) follows from parallelism in conjunction with the principle of *Scope Economy.* Scope Economy demands that all applications of QR, except for movements that resolve type conflicts, must have a semantic effect. This requirement is met by long object QR inside the elliptical clause of (73a), because long QR generates a new interpretation, which is distinct from (and weaker than) the surface reading ([74a]). Thus, Scope Economy licenses wide scope for the object in (73a). In (73b), on the other hand, locating the object quantifier above or below the subject does not have any consequences for interpretation, the two LFs translate into synonymous formulas ([74b]). As a result, wide object scope for *every movie* is blocked in (73b).

(74) a. ⟦[every movie$_2$ [an actress$_1$ [t$_1$ liked t$_2$]]]⟧ ≠
actress$_1$ [every movie$_1$ [t$_1$ liked t$_2$]]]⟧
b. ⟦[every movie$_2$ [Mary$_1$ [t$_1$ liked t$_2$]]]⟧ =
⟦[Mary$_1$ [every movie$_2$ [t$_1$ liked t$_2$]]]⟧

Just like Shortest, Scope Economy minimizes movement paths. However, unlike Shortest, Scope Economy applies relative to an interpretation. If two competing derivations end up with scopally indistinguishable results, the longer, more costly one is blocked by Shortest. The verdict of Shortest is suspended, though, for derivations that create new, distinct interpretations.

Similar observations have been made for overt wh-movement (Golan 1993). While the formation of multiple interrogatives in English is arguably shaped by Shortest (see [61] above), Superiority effects are systematically cancelled if costly movement leads to an interpretation which could not have been achieved by a more economical strategy. Observe to begin with that (75) can be either answered as in (75a) or as in (75b), indicating that the sentence is ambiguous between a single and a multiple question interpretation (Baker 1970). Descriptively, the two readings differ in whether the *wh-in-situ* object *what* is assigned embedded scope ([76a]) or matrix scope ([76b]; for discussion see also Reinhart 2006):

(75) *Who remembers where we bought what?*
a. Sally remembers where we bought what, John remembers where we bought what, …
b. Sally remembers where we bought fish, John remembers where we bought bread, …

(76) a. Who$_1$ [t$_1$ remembers [where *what$_2$* we bought t$_2$]] (object narrow scope)
b. Who$_1$ *what$_2$* [t$_1$ remembers where we bought t$_2$] (object wide scope)

By contrast, (77) can only be interpreted with matrix scope for the embedded subject ([78a]), as seen by the fact that (77b) does not constitute a felicitous answer to (77) (Hendrick and Rochemont 1982; Lasnik and Saito 1992):

(77) *Who remembers what$_2$ who$_1$ t$_1$ bought t$_2$?*
a. Sally remembers that Bill bought fish, John remembers that Sue bought bread, …
b. *Sally remembers what who bought, John remembers what who bought, …

(78) a. Who$_1$ *who$_2$* [t$_1$ remembers [what$_3$ t$_2$ bought t$_3$]] (subject wide scope)
b. *Who$_1$ [t$_1$ remembers [what$_3$ *who$_2$* t$_2$ bought t$_3$]] (subject narrow scope)

Golan (1993) suggests that this observation receives a natural explanation on the assumption that the economy conditions which regulate movement are calculated relative to a fixed interpretation. Economy excludes the narrow scope, single question construal

(78b), because the competing surface representation (79) conforms better with Shortest and achieves with (79a) the same target interpretation that (77) does with (78b):

(79) *Who remembers who*$_1$ *t*$_1$ *bought what?*
  a. Who remembers [*who*$_1$ what$_2$ t$_1$ bought t$_2$] (subject narrow scope)
  b. *Who *who*$_1$ remembers [t$_1$ what$_2$ bought t$_2$] (subject wide scope)

There is, however, no alternative strategy for expressing the subject wide scope, multiple question reading (78a) apart from (77). This is so because in (79), the lower subject *who*$_1$ marks the complement as an interrogative complement and therefore must be interpreted in the local SpecCP (*Wh-Criterion*; Rizzi 1996), excluding the subject wide scope reading (79b). As a result, economy legitimizes (77) as the optimal form for the target interpretation (77a), despite the fact that strictly speaking, (77) fails to abide by Shortest.

To summarize, the economy metric which regulates the information flow between syntax and semantics treats QR and certain types of *wh-in-situ* alike. In both cases, Shortest selects the most parsimonious derivation relative to a given interpretation. That is, if two derivations based on the same numeration yield the same interpretation and differ only in the length of their respective movement paths, the grammar prefers the one with the least amount of movement. For covert movement, this translates into the generalization that QR is banned unless it generate new scope orders. And in environments of wh-movement, the costlier derivation is sanctioned only if it places the *wh-in-situ* into a scope position that would be unaccessible otherwise. Since the emergence of economy effects is generally held to be symptomatic of syntactic operations, the fact that certain properties of scope fixing fall under the reign of economy provides further evidence for the claim that aspects of interpretation are determined by syntactic principles, as expressed by the Abstractness Hypothesis. For further applications of Scope Economy see Fox (2000); Meyer and Spector (2009) and Reinhart (2006), among others.

4.5. Cross-categorial QR

Movement that affects interpretation is not restricted to nominal generalized quantifiers of individuals, but is also attested with other syntactic categories and second-order properties in other ontological domains, further substantiating the claim that inverse scope phenomena have a structural basis. The present section briefly reviews two such cases: silent movement of the degree head in comparatives, and semantically detectable, overt head movement.

Heim (2000) designs a semantics for comparatives, exemplified by (80a), which treats the degree head *-er* as the degree counterpart of determiners quantifying over individuals, with the meaning given in (80b). The second order property of degrees *-er* combines with the *than*-XP first and takes a derived degree predicate as its second argument. In order to generate such a derived degree predicate, the string *-er taller than Bill* needs to raise, targeting a propositional node, as shown in (80c).

(80) a. *Ann is taller* [$_{than\text{-}XP}$ *than Bill].*
  b. ⟦-er⟧ = $\lambda P_{<d,t>}\ \lambda Q_{<d,t>}.\ P \subset Q$
  (adapted from Bhatt and Pancheva 2004, [84])
  c. [[-er than Bill]$_{2,\ <<d,t>,t>}$ [$_{<d,t>}$ λ_2 [$_{<t>}$ Ann is tall-t$_2$]]]

The hypothesis that degree heads are not interpreted in their base position has received additional support from two directions: *-er* movement generates new readings (Heim 2002; Beck 2011) and creates previously unavailable binding options for categories inside the *than*-XP (Bhatt and Pancheva 2004). Bhatt and Pancheva (2004) demonstrate that these observations are best accounted for by an analysis that moves *-er* on its own, followed by post-cyclic attachment of *than Bill* (see [117] for details). On this view, comparatives implicate instances of covert, scope shifting head movement.

A second instance of semantically detectable X°-movement has been argued to affect certain modal heads (Lechner 2007). In (81), the subject can be assigned split scope, such that the negation takes scope above, and *every boy* is interpreted below the modal:

(81) *Not every boy can make the team.* $(\neg \Diamond \succ \forall)$

Both the subject and the modal reach their respective surface positions by movement. That modals move is confirmed by the observation that they usually scope below of adverbs to their right:

(82) *He can$_2$ always t$_2$ count on me.* (*always* $\succ \Diamond$ /*$\Diamond \succ$ *always*)

Hence, the split reading of (81) can in principle be derived by reconstructing *every boy* below the derived position of the modal, as detailed by (83) (denotation brackets mark interpreted positions):

(83) $[[\![\textbf{not}]\!]$ every boy$_1$ $[[\![\text{can}]\!]_2$ $[[\![\textbf{every boy}]\!]_1$ $[t_2 \ldots [t_1 \ldots]]]]]$ $(\neg \Diamond \succ \forall)$

Crucially, if the parse in (83) turns out to be correct, it follows that *can* is interpreted in a derived position, since on the intended reading, the modal scopes over the subject.

Evidence for the assumption that *every boy* indeed reconstructs into a position above the base position of the modal comes from the interaction of scope-splitting with negative polarity items (NPIs). Linebarger (1980) reports that an NPI must not be separated from its licensing negation by another quantifier at LF. Among others, the *Immediate Scope Constraint* excludes (84b) by imposing a locality requirement that is not met by the post-QR configuration (84c):

(84) a. *She doesn't budge$_{NPI}$ for me.*
b. **She doesn't budge$_{NPI}$ for everybody*
c. not [everybody$_1$[$_{vP}$ budge$_{NPI}$ for t$_1$ …

Turning to scope splitting, (85) demonstrates that negative universals are generally compatible with NPIs (Horn 2000). Embedding an NPI into configurations of scope splitting produces sharply degraded result, though, as seen in (86):

(85) *Not everyone has ever read any Jespersen.*

(86) **Not everyone can ever be on the team.* $(*\neg \succ \Diamond \succ \forall \succ \text{NPI})$

If it is assumed that the subject is located above the base position of the modal, as hypothesized in (83), the Immediate Scope Constraint offers a plausible explanation for the contrast above: is ill-formed because *everyone* intervenes between the negation and the NPI:

(87) [**not** everyone$_1$ [can$_2$ [$[\![$everyone$]\!]_1$ t$_{can}$ [**ever**$_{\mathbf{NPI}}$ … t$_2$ … t$_1$ …]]]]

Everything being equal, this entails for the well-formed case of scope splitting in (81) that the scope order between the subject and the modal also has to be computed in derived positions, just as in (83). But then, the modal scopes above its base position, indicating that certain instances of head movement have semantic effects. This is not unexpected if raising modals are taken to denote generalized quantifiers of situations (<<s,t>,t>). Thus, scope extension by head movement fits naturally into the typology of other scope shifting operations.

Apart from scope splitting, there is a second context where verb movement appears to induce semantic effects. As illustrated by the contrasts in (84)−(90) below, subject NPIs (in English) are licensed if negation cliticizes on a finite auxiliary in C°, but not by regular sentential negation ([88] attributed to Jim McCloskey by Jason Merchant; [89] attributed by Ian Roberts to Richard Kayne; [90] is from Szabolzci 2010):

(88) a. *Why isn't a single chair set up n here?*
b. **Why is a single chair not set up in here*?

(89) a. *Which sandwiches didn't anybody eat?*
b. **Anybody didn't eat the tuna sandwiches?*

(90) a. *Don't anyone/even one of you touch my arm!*
b. **Anyone/even one of you touch my arm!*

To summarize, scope shifting movement operations are not restricted to generalized quantifiers over individuals that surface as DPs, but are also attested with operators in different ontological domains (degrees and situations) that fall in the class of other syntactic categories (degree expressions, modals). Finding such correlations further solidifies the evidence for the transparent LF-model, which postulates a close relation between the logical type of an expression and its ability to affect interpretation by movement. Finally, the addition of semantically detectable overt head movement (modals) and covert head raising operations (*-er*) results in a typology that exhausts the full logical space created by the two parameters overt vs. covert and XP vs. X°-movement, respectively. This increase in system internal harmony can be taken as a further indicator that the Abstractness Hypothesis provides an adequate model of the interaction between surface syntax and interpretation.

5. Opacity and hidden structure

In current derivational models, the combinatory syntactic system CS employs a single structure building operation (Merge), which comes in three flavors:

(91) a. External Merge/First Merge: introduces new nodes at the root of the tree.
b. Internal Merge/Remerge: corresponds to movement in older terminologies.
c. Late Merge/Countercyclic Merge: targets positions created by movement and expands these positions by inserting nodes in non-root positions.

The guises of Merge correspond to three sources of abstractness that one typically expects to find in models of the grammar which espouse the Abstractness Hypothesis. First, External Merge may lead to the presence of unpronounced, yet interpreted terminals, in contexts involving ellipsis, copy traces or silent operators ([92a]). Next, Internal Merge can manifest itself in form of invisible, covert movement such as QR ([92b]). Finally, Late Merge is (by definition) responsible for the emergence of structure at an unexpected, delayed point in the derivation ([92c]):

(92) Sources of Abstractness
  a. External Merge: ellipsis, copy traces, silent operators
  b. Internal Merge: covert movement (e.g. QR)
  c. Late Merge: delayed emergence of structure

Furthermore, there is a natural divide that singles out (92b) and (92c) to the exclusion of (92a), in that the former presuppose the existence of movement as well as a sequential ordering of representations. Apart from vindicating the Abstractness Hypothesis, the two exponents of abstractness (92b) and (92c) accordingly will be seen to supply an important tool for detecting derivations. The heuristic underlying these diagnostics is based on the concept of opacity and can − to the extent that the results are associated with interpretive effects − also be used to probe for design features of the interface between syntax and semantic. Following some introductory remarks on opacity, the sections to follow will discuss manifestations of all three types of abstractness (92) that have been identified in the recent literature.

One of the strongest arguments for modeling natural language by means of derivations comes from rule opacity, a group of phenomena that plays a particularly prominent role in phonology (Kiparsky 1973). Opacity arises whenever "a rule is contradicted on the surface" (David Stampe, cited in Pullum 1976), or more generally, when properties of an expression cannot be solely attributed to surface appearance. The study of opacity also has important consequences for the theory of the syntax-semantics interface. If a category is spelled out in a derived position, and if it is possible to isolate aspects of interpretation that are not only determined by surface representations, it can be concluded that the dislocated category has retained properties of its derivational history. Opacity effects of this sort require the assumption of abstractness in syntax, and therefore demonstrate that the information flow from syntax to the semantic component is mediated by abstract representations such as LFs or enriched surface structures. Moreover, a particular subtype of opacity will be seen to furnish support for the even stronger hypothesis that at least some abstract expressions inside the syntactic tree are linked by movement.

Opacity effects come in three varieties: *counterbleeding*, *counterfeeding* and combinations of *feeding* and *bleeding* (the latter will be addressed in section 5.3). Assume that a principle or rule of grammar R licenses a property P in context C. In counterbleeding opacity, instances of P show up outside C, resulting in what is also referred to as *overapplication*. The rule R is opaque in that the context C that determined R has been destroyed by an independent operation and C is therefore not visible in the surface form. Thus, the fact that R has applied can be inferred only by inspecting earlier stages of the derivation. To illustrate, in (93), Principle A of Binding Theory, which demands that anaphors have a local c-commanding antecedent, applies in an opaque environment, because the context of application for Principle A (c-command) has been destroyed by movement.

(93) *Which picture of each other$_1$ do they$_1$ like best?*

In counterfeeding opacity (manifestations of which will be encountered in 5.1), P is absent from an environment in which it is expected to emerge (*underapplication*). Rule R is opaque because the fact that R applied is not visible in the surface form. Again, reference to derivations is crucial, in this case in order to enable P to escape the triggering context of R. As will be explicated in the next subsection, the analytical tools to model binding opacity effects are already an integral component of the derivational model, supporting the specific design adopted in recent versions of minimalist grammars.

5.1. Binding theory and leftward movement

The contrast in (94) shows that overt movement extends the binding domain of an anaphor across a potential antecedent, indicating that fronting feeds Principle A (Chomsky 1993).

(94) a. *I asked the boys$_1$ [which picture of each other$_1$]$_2$ I should buy t$_2$.*
b. **I asked the boys$_1$ which girl will buy [which picture of each other$_1$].*

Similar observations have been made for covert movement and Principle A in Fox (2003: [28]):

(95) a. *??The two rivals$_1$ hoped that Bill would hurt [every one of each other$_1$'s operations].*
b. *The two rivals$_1$ hoped that someone would hurt [every one of each other$_1$'s operations].* ($*\exists > \forall$ / $\forall > \exists$)

This parallelism between overt and covert displacement not only strengthens the view that scope shift is the product of a movement rule ([23a]), but also signals that Principle A does not act on surface representations, but is evaluated at LF, after the application of QR ([23c]).

In (96a), the context for application of principle A is restored subsequent to movement. On a prominent interpretation of this fact, the fronted node has been reconstructed into a position below the antecedent of the anaphor, as documented by (96b) (Barss 1986; Chomsky 1993; for surveys of reconstruction see Barss 2001 and Sportiche 2006):

(96) a. *[Which pictures of each other$_1$]$_2$ do you think that they$_1$ like best t$_2$?*
b. *[Which pictures of each other$_1$]$_2$ do you think that they$_1$ like best [which pictures of each other$_1$]?*

The standard explanation for (syntactic) binding reconstruction is provided by the Copy Theory of movement, which posits that movement does not strand simple traces, but leaves behind copies of the fronted category (Chomsky 1993). One of these copies can then be recycled for the computation of Principle A ([96b]). Note that such an analysis of reconstruction effects presupposes the assumption of hidden structure, as expressed by (92a).

Principle C is also affected by movement, yet in a slightly more complex way (Freidin 1986; Johnson 1987; Lebeaux 1990; van Riemsdijk and Williams 1981). With Ā-movement, overt dislocation obviates (bleeds) disjoint reference effects, but only if the name is located inside an adjunct to the fronted category, as in (97a, b) and (98a). R-expressions that are contained inside argument-like phrases ([97c] and [98b]) reconstruct for Principle C:

(97) a. *[Which picture [near John$_1$]]$_2$ did he$_1$ like t$_2$ best?*
b. *[Which picture [that John$_1$ made]]$_2$ did he$_1$ like t$_2$ best?*
c. **[Which picture [of John$_1$]]$_2$ did he$_1$ like t$_2$ best?*

(98) a. *[Which claim [that offended Bill$_1$]]$_2$ did he$_1$ repeat t$_2$?*
b. **[Which claim [that Mary offended Bill$_1$]]$_2$ did he$_1$ repeat t$_2$?*

Assuming the Copy Theory, (97a) should be parsed into the representation (99).

(99) *[Which picture [near John$_1$]]$_2$ did he$_1$ like [which picture [near John$_1$]] best?*

But in (99), the name is c-commanded by the coindexed pronoun, and the theory therefore wrongly predicts a disjoint reference effect. Thus, cases such as (97a, b) and (98a) represent instances of counterfeeding opacity or underapplication, because even though the context of Condition C is met, the rule does not apply, as witnessed by the well-formedness of the output.

Lebeaux (1990) presents a solution for modeling counterfeeding opacity which operates on the assumption that insertion of adjuncts can be delayed, applying subsequent to movement of the host. This strategy is known as *Late Merge* (LM) or *countercyclic merge*. As exemplified by (100), which tracks the derivation of (97a), LM has the effect that the names inside the adjuncts are added at a time when the hosting category has already escaped the c-command domain of the coreferential term.

(100) a. Move host: [Which picture] did he$_1$ like [which picture] best?
b. Late Merge of adjunct: [Which picture [near John$_1$]]$_2$ did he$_1$ like t$_2$ best?

Moreover, by restricting LM to adjuncts, corresponding countercyclic derivations are blocked for (97c) and (98b), where the names are contained inside arguments.

At this point, exponents of all three types of abstractness admitted by the structure building system of derivational models ([92]) have been incorporated into the discussion: silent movement (QR), silent base generated structure (copies) and the delayed emergence of structure with LM.

Two remarks are in order here. First, Lebeaux' analysis, just like the analysis of Principle C obviation ([94]) and bleeding of Principle A ([95]), relies on a sequential ordering of representations, and therefore is compatible with a derivational model only. Second, binding reconstruction is subject to different conditions if the r-expression or anaphor resides inside a fronted predicate. As illustrated by (101), predicate movement does not extend the binding domain for anaphors ([94]). Moreover, unlike reflexives within DPs ([102a]), anaphors that are contained inside predicates cannot choose their antecedent freely from potential binders they have passed ([102b]), suggesting that Principle A is invariable evaluated in the base position of the predicate (Barss 1986; Cinque 1984). This has been taken as an indication that the fronted category includes a trace of the antecedent (Huang 1993).

(101) *John wonders [*t_1 *how proud of herself*$_1$*/*himself] Jill*$_3$ *said that Mary*$_1$ *certainly is.*

(102) a. *I wonder [*t_1 *how many pictures of herself*$_1$*/himself*$_2$*] John*$_2$ *said that Mary*$_1$ *liked.*
b. *I wonder [*t_1 *how proud of herself*$_1$*/*himself*$_2$*] John*$_2$ *said that Mary*$_1$ *certainly is.*

Huang's analysis turns out to be incomplete, though, as shown by the distribution of disjoint reference effects (Heycock 1995; Takano 1995). In (103), the higher subject *he*$_2$ does not bind a trace inside the predicate. Still, the pronoun cannot be construed coreferentially with the fronted name. Thus, there must be some independent reason that forces predicates to reconstruct in syntax. See Takano (1995) for further discussion.

(103) **[How *t_2 *proud of John*$_1$*] do you think he*$_2$ *said Mary*$_3$ *is?*

Returning at this point to countercyclic Merger, recall that the combination of Copy Theory and LM was seen to deliver accurate results for Ā-movement above. But the analysis fails to account for a curious property of A-movement (Chomsky 1993; Lebeaux 1990). To begin with, A-movement reconstructs for the evaluation for the principles of Binding Theory, as can be inferred from (104). In this respect, raising patterns along with wh-movement.

(104) *Pictures of himself*$_1$ *seem to nobody*$_1$ *to be ugly.*

But unlike wh-movement, subject raising obviates Principle C violations, irrespective whether the name is contained in an adjunct or an argument (Lebeaux 1990; [106] from Takahashi 2006: 72, [15]; see also Takahashi and Hulsey 2009 and references therein).

(105) *Every picture of John*$_1$ *seems to him*$_1$ *to be great.*

(106) a. *The claim that John*$_1$ *was asleep seems to him*$_1$ *to be correct.*
(Chomsky 1993: 37)
b. *Every argument that John*$_1$ *is a genius seems to him*$_1$ *to be flawless.*
(Fox 1999a: 192)
c. *John*$_1$*'s mother seems to him*$_1$ *to be wonderful.*
e. *Pictures of John*$_1$ *seem to him*$_1$ *to be great.*
(Lebeaux 1998: 23−24)

In Takahashi (2006), the exceptional behavior of A-movement is taken to signal that it is not the argument vs. adjunct distinction that regulates LM. Instead, following Bhatt and Pancheva (2004), Takahashi adopts the assumption that LM applies unrestricted, subject only to the requirement that the resulting structures be interpretable (Fox 1999). On this *Wholesale Late Merge* (WSLM) analysis, even countercyclic insertion of arguments becomes possible under certain conditions. Concretely, Takahashi suggests that in the derivation of (105), relevant parts of which are provided by (107), the determiner *every* moves up to matrix T on its own ([107a]), followed by insertion of the NP-restrictor ([107b]). Since no occurrence of *John* resides inside the c-command domain of *he* in the representation to be submitted to interpretation, the WSLM account successfully avoids a disjoint reference effect:

(107) a. [$_{\text{TP}}$ Every$_2$ seems to him$_1$ [every$_2$ to be great]]
b. [$_{\text{TP}}$ [Every picture of John$_1$]$_2$ seems to him$_1$ [every$_2$ to be great]]

Furthermore, the fragmentary LF representation (107b) can be assigned a compositional interpretation by the same, independently motivated mechanism that converts lower movement copies into legitimate interface objects (Sauerland 2004; Fox 1999). The two rules of *Trace Conversion* responsible for interpreting copies are given in (108) (adapted from Fox 1999, 2003; n is valued by the index on the copy):

(108) Trace Conversion
a. Variable Insertion: (Det) (Pred)$_n$ ~> (Det) [(Pred) $\lambda x.x = n$]
b. Determiner Replacement: (Det) [(Pred) $\lambda x.x = n$] ~> the [(Pred) $\lambda x.x = n$]

In a first step, licensed by (108a), a variable is inserted into the position that is normally occupied by the NP-restrictor in the lower copy. For (105), *Variable Insertion* together with index reanalysis ([15]) yields (109b).

(109) a. [Every picture of John]$_1$ λ_2 seems to him$_1$ every$_2$ to be great

b. [Every picture of John]$_1$ λ_2 seems to him$_1$ [every $\lambda x.x = 2$] to be great (by [108a])

c. [Every picture of John]$_1$ λ_2 seems to him$_1$ [the $\lambda x.x = 2$] to be great (by [108b])

d. "Every z such that z is a picture of John seems to John to be such that the x which is identical to z is great"

The second rule (*Determiner Replacement*) substitutes a definite determiner for the original one, as shown by (109c). Semantically, the combination of these two operations amounts to treating the lower movement copy as an individual variable bound by the fronted category ([109d]; for more complex cases, in which the reconstructed DP contains a bound variable, see Sauerland 2004). Thus, the criterion that LM-derivations be interpretable is met, which in turn sanctions WSLM of the restrictor. Takahashi's account therefore correctly predicts that names embedded inside raising subjects can escape the verdict of Principle C even if they are contained in an argument.

But, as was noted above, disjoint reference effects persist with argument contained names that have undergone Ā-movement (s. [97c], repeated below as [110]):

(110) *_[Which picture of John$_1$]$_2$ did he$_1$ like t$_2$ best?_

Takahashi suggests to relate this contrast to a Case requirement on LM. This condition mandates that the NP-argument of the determiner has to be present by the point in the derivation at which the category is assigned Case. Thus, Case defines the upper limit for LM: Since Ā-moved objects are Case marked in the positions they originate in (by Agree), it follows that (110) cannot be produced by the same strategy as (105), blocking derivation (111) in which the determiner moves ([111a]) and the NP-restrictor is merged countercyclically later on ([111b]):

(111) a. Which$_2$ did he$_1$ like which$_2$ best?
b. [Which picture of John$_1$]$_2$ did he$_1$ like which$_2$ best

More specifically, WSLM of the restrictor *picture* is illegitimate for the reason that the head noun *picture* agrees with the determiner, and (by assumption) must be inserted prior to Case feature checking applies. At this point, the question arises, though, why not at least the complement PP *of John*, which is not subject to the case condition, could be merged late.

The explanation for why such a derivation of (110), which would avoid a disjoint reference effect, is unavailable follows from the interpretability requirement on the output of WSLM. Suppose that the argumenthood of nominal complements is also reflected in the arity of the predicates and that the relational head noun *picture* accordingly denotes a relation between individuals. Then, the determiner and the head noun therefore a type clash in the lower copy subsequent to Determiner Replacement, as detailed in (112). Note incidentally that Variable Insertion provides silent predicates, but not silent individual arguments.

(112) *[Which picture of John$_1$]$_2$ did he$_1$ like the$_{<<et>,e>}$ picture$_{<e,<et>>}$ best

As a result, the complement of the relational noun has to be inserted cyclically in its base position, accounting for the inability of Ā-moved arguments to escape Principle C.

The next section will follow up on consequences that the LM-analysis entails for categories that do have not reached their surface by overt leftward displacement, but by (covert) movement to the right.

5.2. Binding Theory and rightward movement

The LM analysis of complements receives further, independent support from its ability to contribute to a better understanding of how Principle C interacts with rightward extraposition, rightward shift of comparative complements, and movement that resolves VP-ellipsis. The presentation below is restricted to a synopsis of some recent results; further details can be found in Bhatt and Pancheva (2004), Fox (2003), and Hulsey and Takahashi (2009), among others.

Taraldsen (1981) observed that extraposition restores Principle C violations (for similar effects of extraposition on scope see Williams 1974):

(113) a. **I showed him$_3$ a book [that Sam$_3$ wanted to read] yesterday.*
b. *I showed him$_3$ a book t yesterday [that Sam$_3$ wanted to read].*

Movement to the right behaves in this respect just like leftward A'-movement in that both admit LM of relative clauses and other adjuncts. But there is also a crucial disparity that separates extraposition to the right from leftward movement. Unlike what was seen to be characteristic of leftward LM ([100]), where the hosting category and the adjunct end up in a contiguous string, rightward movement in (113b) severs the common noun and its determiner (*a book*) from the relative clause. This property is of course the hallmark of non-string-vacuous extraposition.

As shown in Fox and Nissenbaum (1999), word order contrasts between wh-movement and extraposition become inessential, if the standard Y- or inverted T-architecture is substituted by a single output model in which all movements apply overtly (Bobaljik 1995; Groat and O'Neil 1996; Pesetsky 2000). In such theories, extraposition is derived by the two step procedure in (114). First, the host noun (*a book*) undergoes silent rightward shift by *Overt Covert Movement* (OCM; [114a]). Second, LM attaches the relative clause to the moved node, yielding a configuration that abides by the principles regulating licit coreference relations ([114b]):

(114) a. I [$_{VP}$ showed him$_3$ a book] yesterday [~~a book~~]
b. I [$_{VP}$ showed him$_3$ a book] yesterday [~~a~~ [~~book~~][that Sam$_3$ wanted to read]]

LM in contexts involving extraposition now shares all relevant properties of LM with leftward movement. In a single output model, apparent differences between these two operations therefore no longer pose an obstacle to a unified analysis of Principle C obviation.

One important result of Fox and Nissenbaum's (1999) account of the interaction between syntactic movement and interpretation has been that the empirical scope of LM analyses can be considerably extended once they are embedded into less restrictive theories of movement, and thereby less complex models of the grammar. That expansion in this direction points in the right direction is further corroborated by findings from two other empirical domains: *Antecedent Contained Deletion* (ACD; Fox 1999) and comparatives (Bhatt and Pancheva 2004).

To begin with, the theory offers an account for a contrast that characterizes the difference between overt VPs ([115a]) and elliptical VPs in contexts of ACD ([115b]), first reported in Fiengo and May (1994: 274):

(115) a. **I showed him$_3$ every book [$_{CP}$ that Sam$_3$ wanted me to show him].*
b. *I showed him$_3$ every book [$_{CP}$ that Sam$_3$ wanted me to ⌂].*
⌂ = [$_{VP}$ show him]
c. I [$_{VP}$ showed him$_3$ every book$_{\text{pronounced}}$] [every book$_{\text{silent}}$ [$_{CP}$ that Sam$_3$ wanted me to ⌂]]

Fox and Nissenbaum (1999) argue that a Principle C violation in the ACD example (115b) can be averted on the assumption that QR is a special case of extraposition, the only difference being that in the case of genuine extraposition, the host categories move overtly, while ACD involves silent displacement. On this analysis, which has *every book* undergo silent rightward movement (OCM), followed by LM of the relative clause ([115c]), the derivation of ACD exactly mirrors that of extraposition:

(116) a. Extraposition: [$_{\text{VP}}$ … DP$_{\text{silent}}$ …] [DP$_{\text{pronounced}}$ [$_{\text{CP}}$ …]$_{\text{Late merged}}$]
b. ACD: [$_{\text{VP}}$ … DP$_{\text{pronounced}}$ …] [DP$_{\text{silent}}$ [$_{\text{CP}}$ …]$_{\text{Late merged}}$]

Another configuration involving LM and OCM was identified by Bhatt and Pancheva (2004). Bhatt and Pancheva note that overt extraposition of comparative complements has the same effect on Principle C as extraposition of relative clauses, as the contrast (117a/b) confirms.

In both cases, movement legitimizes previously unavailable coreference relations:

(117) a. *??I will tell him$_2$ a sillier rumor (about Ann) [$_{than\text{-}XP}$ than Mary told John$_2$].*
b. *I will tell him$_2$ a sillier rumor (about Ann) tomorrow [$_{than\text{-}XP}$ than Mary told John$_2$].*
c. I [will tell him$_2$ a silly-t$_1$ rumor (about Ann) tomorrow]
[-er$_{\text{silent}}$ [$_{than\text{-XP}}$ than Mary told John$_2$]]

The analysis is sketched in (117c): the degree head *-er* moves by OCM to its scope position (section 4.5; Heim 2000), followed by countercyclic attachment of the *than*-XP, in a way similar to how extraposed relative clauses are late merged with their head noun. However, unlike relative clauses, the extraposed constituent in (117) serves as an argument, and not as an adjunct. It follows that *-er* and the *than*-XP combine by WSLM. Bhatt and Pancheva also demonstrate that this operation is − just like WSLM inside DPs − regulated by interpretive considerations (see Bhatt and Pancheva 2004 for details and Grosu and Horvath 2006 for complications).

In sum, there is accumulating evidence that LM is not restricted to adjuncts, but may also apply to arguments, given that the operation yields interpretable output representations.

5.3. Feeding – Bleeding opacity (Duke of York)

The line between derivational and representational theories of natural language syntax is notoriously hard to draw on empirical grounds. Partially, this is so as syntactic representations can be enriched with markers such as copies or traces that keep track of the evolution of an expression, rendering even opacity effects amenable to representational analyses. The current section adds a (third) type of opacity, known since Pullum (1975) as *Duke of York*, which differs from counterfeeding and counterbleeding in that it combines properties in a way that renders a representational analysis impossible. At the same time, the current section introduces evidence for two further types of silent movement operations that affect *wh*-phrases in pied-piping constructions.

Contrasts such as (118) indicate that quantifiers induce barriers for operations that connect *wh-in-situ* phrases with their scope positions (Beck 1996; intervener bold; see also Pesetsky 2000).

(118) a. *Sie fragte, was wer wann verstanden hat.* [German]
She asked what who when understood has
'She asked, who understood what when.'

b. **Sie fragte, was* ***niemand*** *wann verstanden hat.*
She asked what nobody when understood has

The group of interveners restricting the distribution of *wh-in-situ* also includes degree particles such as *genau* ('exactly') :

(119) a. **?Sie fragte, wer gestern* ***genau*** *wann angekommen ist.* [German]
She asked who yesterday exactly when arrived is
(Sauerland and Heck 2003)

b. *Sie fragte, wer gestern wann* ***genau*** *angekommen ist*
She asked who yesterday when exactly arrived is
'She asked, who arrived yesterday when exactly.'
(adapted from Sauerland and Heck 2003)

(120) a. **Sie fragte, wer gestern* ***genau*** *mit wem gesprochen hat.* [German]
She asked who yesterday exactly with whom spoken has

b. **?Sie fragte, wer gestern mit* ***genau*** *wem gesprochen hat.*
She asked who yesterday with exactly whom spoken has

c. *(?)Sie fragte, wer gestern mit wem* ***genau*** *gesprochen hat.*
She asked who yesterday with whom exactly spoken has
'She asked, who yesterday with exactly whom spoken has.'

Moreover, Sauerland and Heck notice that intervention effects are not restricted to *wh-in-situ* contexts, but are also attested with relative pronouns that pied-pipe PPs (cf. [121b] vs. [121c]).

(121) a. *Maria sprach [$_{PP}$ über* ***genau*** *zwei Freunde].* [German]
Mary talked about exactly two friends

b. *die Freunde, [$_{PP}$ über die] Maria sprach*
the friends about who Mary talked

c. **die Freunde, [$_{PP}$ über* ***genau*** *die] Maria sprach*
the friends, about exactly who Mary talked
'the friends (*exactly) who Mary talked about'

A unified explanation for these observations is provided by the analysis of pied-piping by von Stechow (1996), schematized in (122a), on which the pied-piper undergoes LF-movement to its scope position (or, to be precise, to the scope position of the λ-binder that translates as the index on the pied-piper). On this view, (121c) fails to satisfy the same principle that is responsible for generating intervention effects in contexts involving *wh-in-situ*:

(122) a. LF: the friends [*who* $\boldsymbol{\lambda}_1$ [$_{PP}$ about t_1] Mary talked
└────────────┘

b. LF: the friends [*who* $\boldsymbol{\lambda}_1$ [$_{PP}$ **exactly** about t_1] Mary talked
└──────*──────┘

Taken together, pied-piping and the recognition of a novel class of interveners provide the basis for a *Duke of York* argument in support of derivations. The evidence comes from German example such as (123). The scheme in (124) tracks how the relevant steps of the derivation, to be explicated below, unfold (PRT in the gloss stands for particle):

(123) *etwas [[$_{CP}$ [$_{PP}$ über* ***(*genau)*** *das$_3$] auch nur mit einem seiner$_1$* [German]
something about exactly which even only with a of.his
Freunde zu sprechen]]$_2$ wohl ***keiner$_1$*** *$t_{CP, 2}$ wagen würde*
friends to speak PRT nobody dare would
'something OP$_3$ that nobody$_1$ would dare to talk about t_3
[to even a single one of his$_1$ friends]$_{NPI}$'

(124) a. [**intervener$_1$** [[$_{CP}$ r-pron$_3$ pron$_1$]]]
b. [[$_{CP}$ r-pron$_3$ pron$_1$] [**intervener$_1$** [....]]]
c. r-pron λ_3 [[$_{CP}$ t_3 pron$_1$] [**intervener$_1$** [....]]]
└─────┘
d. *r-pron λ_3 [[**intervener$_1$** [[$_{CP}$ t_3 pron$_1$]]]
└──────────*──────────┘
e. r-pron λ_3 [[$_{CP}$ t_3 pron$_1$] [**intervener$_1$** [[$_{CP}$ t_3 pron$_1$]]]
└─────┘

The *Duke of York* argument for derivations proceeds in two steps. First, as seen in the transition from (124a) to (124c), transporting the relative pronoun (*r-pron$_3$*) inside a larger, containing CP across an intervener puts the pronoun into a position from where it can be silently moved without inducing an intervention effect (cf. *smuggling* in Collins 2005). This indicates that the relative pronoun (*r-pron$_3$*) reaches its final location at LF by moving out of the fronted CP, as in (124c), and not from the reconstructed CP, as in (124d). If the latter would have been the case, one would expect the signature of an intervention effect − which is absent in (123). The second ingredient for the *Duke of York* argument is provided by the fact that the fronted CP contains a pronominal variable (*pron$_1$* in [124]) that is bound by the intervener. Hence, CP must reconstruct into a position below the intervener at LF ([124e]), in order to license variable binding. It follows that CP needs to be evaluated in a position below the intervener. (In addition, [123] includes an additional safe guard that secures reconstruction of CP in form of the NPI *even a single*.)

Given the deliberations above, it appears as if the derivation (124) imposes two contradictory requirements on CP: reconstruction is obligatory for the computation of binding relations, but prohibited for purposes of relative pronoun movement. The conflict can be resolved, though, if one assumes that intervention effects are evaluated derivationally, and if the derivation proceeds by the following three step procedure. CP is pied-piped first ([124b]), followed by silent relative pronoun movement which targets the CP in its derived position ([124c]). Finally, CP reconstructs, such that pronominal variable binding and NPI licensing can be read off the lower copy of CP ([124e]). It is exactly this type of conspiracy of upward movement, application of an operation in the upper position, followed by recycling of a lower copy which is characteristic of *Duke of York* derivations. To summarize, the discussion above revealed that relative pronouns that do not surface right-adjacent to their head noun covertly move to their scope positions. This movement is subject to intervention effects, hence must not cross quantifiers or particles such as *exactly.* If the relative clause is contained inside a larger node that moves, pied-piping can furthermore be shown to elicit evidence for a *Duke of York* configuration, which provides one of the strongest known arguments in support of a derivational model of the grammar. This is so as representations are unable to account for *Duke of York* effects even if they are enriched by standardly sanctioned abstract components such as copies.

6. Reconstruction

As was seen in section 5 above, the principles of grammar do not only expand the interpretive domain of expressions upwards, but movement has also been observed to reconstruct. The final section of this article reviews a selection of such phenomena. Also, it will be seen that while movement is in most cases simultaneously undone for all reconstructible properties, there are also constellations that suggest a more complex typology. These findings support the assumption of two distinct strategies for restoring expressions into positions below the ones they surface in.

6.1. Reconstruction across three dimensions

Reconstruction is attested in at least three interpretive domains (von Fintel and Heim 2011, chapter 7, among others). First, c-command sensitive relations such as disjoint reference effects, variable binding or NPI licensing can be computed in configurations that retain (some) pre-movement properties. Ample evidence of this process has been given in section 5.

Second, there are contexts in which reconstruction results in *scope diminishment* of quantificational expressions (borrowing a term of von Fintel and Iatridou 2004). Pairs such as (125) (adapted from Lebeaux 1995; Hornstein 1996) render visible the interpretive effects of scope reconstruction with A-moved subjects. (125a) demonstrates that raising complements (marked α) are scope islands for embedded objects. Thus, the distributive, wide scope reading for *every senator* in (125b) cannot be derived by scope inversion in the higher clause, but must be the product of reconstructing the subject into a position inside the raising complement α. This is standardly done by assuming that t_1 holds a copy of *two women*:

(125) a. *Mary seems to two women [$_\alpha$ to have danced with every senator].*
($\exists_2 \succ \forall$ / *$\forall \succ \exists_2$)

b. *Two women$_1$ seem [$_\alpha$ t_1 to dance with every senator].* ($\exists_2 \succ \forall$ / $\forall \succ \exists_2$)
(adapted from Lebeaux 1995)

Not all quantifiers partake in scope reduction to the same extent, and there is some debate as to the correct empirical generalization underlying these phenomena. Negative quantifiers, for one, have been recognized to resist narrow scope readings below raising predicates, (126a) cannot be paraphrased by (126b) (Partee 1971; Lasnik 1972, 1999; Penka 2002):

(126) a. *Nobody is (absolutely) certain to pass the test.*
  b. *It is (absolutely) certain that nobody will pass the test.*

So far, reconstruction was seen to affect either elements contained inside the restrictor of a moved category or the scope of the category itself. But there is also a third meaning related property systematically correlating with the position of a node in the tree, which manifests itself in *referential opacity* and *de dicto* vs. *de re* ambiguities.

Referentially opaque or *de dicto* interpretations arise whenever the extension of an expression is not functionally determined by the speaker's knowledge, but varies according to the way alternative worlds or situations are structured which are accessible to the subject of a higher intensional predicate (modals, propositional attitude predicates like *believe*, *know* or *hope*). To exemplify, assume that John, otherwise an entirely sane and consistent person, entertains the firm belief that all planetary systems include an uneven number of planets. Suppose moreover that the actual number of planets in the solar system is eight (which is the case as of 2014). Intuitively, sentence (127) can be used to report such a scenario because of John's non-standard, notional belief (Quine 1956). Understood *de dicto*, the meaning of the predicate *number of planets in the solar system* is not calculated on the basis of the speaker's knowledge about the world, but by taking into account only those situations that are compatible with John's beliefs.

(127) *John believes that [$_{DP}$ the number of planets in the solar system] is uneven.*
  a. *de dicto:* True, because of John's non-standard beliefs about planetary systems.
  b. *de re:* False, because John does not believe that 8 is uneven.

Sentence (127) also has a second meaning ([127b]), which is falsified by the scenario above. On this alternative, objectual, referentially transparent or *de re* reading of the common noun, the subject *the number of planets* is interpreted with respect to the speaker's evaluation situation and denotes the even number 8 (assuming that the speaker is aware of current trends in astronomy).

On a popular view, this ambiguity has its roots in the three assumptions (i) that situation variables are part of the object language (Ty2; Gallin 1975; Cresswell 1990); (ii) that predicates contain silent situation variables, and (iii) that these situation variables need to be captured by c-commanding λ-binders (Percus 2000; Keshet 2010). From this, it follows that the two interpretations of (127) are mapped unto two distinct LF-representations, schematically rendered in (128), which minimally differ in whether the situation variable is bound by the λ-operator below *believe*, resulting in the *de dicto* reading, or a λ-binder outside the scope of the intensional verb, yielding the transparent *de re* construal:

(128) a. *de dicto*: λ_1 … [believe [$\underline{\lambda_2}$ … [$_{DP}$ the number of planets in the solar system($\underline{s_2}$)]]]

b. *de re:* $\underline{\lambda_1}$ … [believe [λ_2 … [$_{DP}$ the number of planets in the solar system($\underline{s_1}$)]]]

Crucially, configurations that involve referential opacity effects can also be used as a probe for the LF-position of dislocated predicates that contain bound situation variables.

With this in the background, observe that sentence (129a) can be understood as true in the scenario above, indicating that it is possible to interpret the subject *de dicto*, that is within the scope of the situation variable binder below *seems*. Given that variable binding is contingent upon c-command at LF, availability of a *de dicto* reading therefore constitutes a diagnostic for reconstruction of the raised subject to a position below *seem* ([129b]):

(129) a. *[The number of planets in the solar system] seems to John to be even.* (*de dicto*/*de re*)

b. λ_1 … [seems [$\underline{\lambda_2}$ [$_{\alpha}$ … [$_{DP}$ the number of planets in the solar system($\underline{s_2}$)]]]]

Finally, the examples in (130a) combine the effects of scope diminishment and reconstruction for referential opacity. (130a), for one, is verified by models in which the individuals the speaker mistakenly identifies as unicorns vary from accessible situation to situation. Thus, the existential of *a unicorn* resides within the scope of the universal of *seem* quantifying over accessible situations. (130c) furthermore provides a clear illustration of A-reconstruction (Fox 1999). On its sensible, pragmatically plausible reading, (130c) expresses the proposition that it is likely that with every battle, a different soldier is losing his life:

(130) a. *A unicorn seems to be in the garden.*
b. *Someone from NY is likely to win the lottery.*
c. *At least one soldier seems (to Napoleon) to be likely to die in every battle.*

To recapitulate, DP-reconstruction potentially restores the configuration for three interpretive properties: (i) the scope of the quantificational determiner heading the fronted DP; (ii) evaluation of the principles of Binding Theory and other c-command sensitive phenomena which involve individual variables; and (iii) referential opacity, expressed in terms of situation variable binding. For ease of further reference, these properties will also be referred to as *scope, binding,* and *opacity*, respectively.

On the standard analysis of reconstruction in terms of the Copy Theory of movement, one is, at least at first sight, led to expect that all three properties are evaluated together, in the same position of the tree. Thus, reconstruction for any of the three properties should entail reconstruction for the remaining two ones. Interestingly, this does not always seem to be the case. The closing part of this section will consider the nature of the correlation between scope, binding and opacity, reporting findings that pose complications for the view that all reconstruction is reducible to the Copy Theory of movement.

6.2. Scope trapping

Scope Trapping denotes a family of phenomena which have in common that reconstruction for the evaluation of one principle of the grammar forces other properties to be inspected from that reconstructed position, too (see Fox 1999; Hicks 2008; Hornstein 1995; Lasnik 1998; Romero 1998; Wurmbrand and Bobaljik 1999, among others).

A first manifestation of Scope Trapping (Lebeaux 1995) is attested with quantifiers that have A-moved across pronouns they bind. In principle, raising subjects may reconstruct into their local clause, resulting in a narrow, inverse scope, distributive reading for (131a). The reconstructed, narrow scope reading is lost, though, if the subject binds a reciprocal in the higher clause, as in (131b). This follows from the assumption that Principle A demands anaphors to be c-commanded by their antecedents at LF.

(131) a. *Two women seem to me t_1 to have talked with every senator.* $(\forall > \exists_2)$
b. *Two women$_1$ seem to each other$_1$ t_1 to have talked with every senator.* $(^*\forall > \exists_2)$
(adapted from Lebeaux 1995)

The same point is reinforced by the infelicity of (132b), in which anaphor licensing conflicts with the (pragmatically induced) narrow scope requirement for the raised subject (Fox 1999):

(132) a. *One soldier$_1$ seems (to Napoleon) t_1 to be likely to die in every battle.*
b. *#One soldier$_1$ seems to himself$_1$ t_1 to be likely to die in every battle.*

These findings demonstrate that the computation of Principle A and scope cannot be distributed across different copies, as expressed by the *Coherence Hypothesis* in (133) (Fox 1999; Hornstein 1995; Lebeaux 2009).

(133) Coherence hypothesis
If α moves and reconstructs into β for the evaluation of one of the three properties scope, binding and opacity, then all three of these properties are evaluated in β.

Independent, additional support for the Coherence Hypothesis is provided by a strong correlation between Principle C reconstruction and the emergence of opaque readings for the host containing the R-expression (Romero 1997: 363). The name in (134) can be construed coreferentially with the pronoun to its right only if the subject is interpreted transparently *de re* (i.e. the speaker considers the subject denotation to consist of nudes of Marilyn):

(134) *A nude of Marilyn$_1$ seems to her$_1$ to be a good emblem of the exhibit.*
$(\exists > seem\ /\ ^*seem > \exists)$

This demonstrates that generating opaque *de dicto* readings by lowering a DP into the scope of an intensional operator entails binding reconstruction of material inside that DP.

To summarize, the Coherence Hypothesis finds support from two generalizations. First, the binding domain of quantifiers shrinks in accordance with their scope domain

([131/132]). And second, referential opacity correlates with binding reconstruction. Trapping Effects of this sort receive a straightforward explanation on the assumption that all reconstruction has its origins in the copy theory of movement. But there are also selected contexts in which reconstruction does not affect all three principles alike, to be followed up in section 6.3.

6.3. Syntactic vs. semantic reconstruction

The analysis of reconstruction in terms of the Copy Theory is challenged by two paradigms indicating that the Coherence Hypothesis does not survive exposure to the full range of data. More precisely, the behavior of (short) scrambling and amount questions reveal that coherence strictly holds for binding and opacity only, allowing scope and binding to be computed in different positions. These findings are of particular theoretical significance, because they necessitate the introduction of an additional mechanism for scope diminishment apart from syntactic reconstruction by movement copies, as well as suitable conditions on this mechanism. I will discuss scrambling first, proceeding from there to more complex cases of amount questions, which involve intensional contexts.

In German, reciprocals embedded inside direct objects can be bound either by the indirect object or the subject ([135a]; Grewendorf 1984):

(135) a. *weil wir*$_3$ *den* ***Gästen***$_{2, IO}$ *[einige Freunde von* [German]
since we the.DAT guests.DAT some.ACC friends.ACC of
einander$_{2/3}$*]*$_{, DO}$ *vorstellen wollten*
each.other introduce wanted
'since we wanted to introduce some friends of each other to the guests'

b. **weil ich [einige Freunde von* ***einander***$_2$*]*$_{1, DO}$ ***den Gästen***$_{2, IO}$ t_1
since I some.ACC friends.ACC of each.other the.DAT guests.DAT
vorstellen wollte
introduce wanted
'since I wanted to introduce some friends of each other to the guests'

The former option is lost once the direct objects has been shifted to the left of the dative, as in (135b), indicating that short scrambling across datives does not reconstruct for the evaluation of anaphoric binding (Frey 1993; Haider 1993). (136) furthermore documents that short scrambling feeds scope ambiguity. At the same time, (136) patterns along with the scopally uninformative example (135) in that scrambling is not undone for variable binding (Lechner 1996):

(136) *weil wir*$_3$ *[einige Freunde von* ***einander***$_{*2/3}$*]*$_{1, DO}$ t_1 [German]
since we some.ACC friends.ACC of each.other $(\exists > \forall\ /\ \forall > \exists)$
allen Gästen$_{2, IO}$ *vorstellen wollten*
all.DAT guests.DAT introduce wanted
'since we wanted to introduced some friends of each other to all the guests'

From this, it can be concluded that the lowest copy accessible for syntactic reconstruction must be located above the indirect object, where it resides in a position too high for sponsoring the narrow scope reading. Thus, there must be an alternative strategy for licensing scope diminishment in the absence of syntactic reconstruction.

Such a device is provided by *Semantic Reconstruction* (SemR; von Stechow 1991: 133), a class of operations that make it possible to delay scope diminishment to the semantic component (Cresti 1995; Rullmann 1995; Sternefeld 2001). SemR, schematically depicted in (137), applies whenever the logical type of a movement trace matches the type of its antecedent. In (137a), a category α of logical type ε − typically <et,t> − has crossed over another scope sensitive operator β, stranding an ε-type trace. In course of the semantic computation, α is then λ-converted into its trace position t_1, resulting in narrow scope for α with respect to β ([137b]):

(137) a. Movement $\alpha\ [\lambda_{1,\,\varepsilon} \ldots [\beta \ldots\ [t_{1,\,\varepsilon} \ldots$ (Surface order: $\alpha \succ \beta$)
b. Semantic reconstruction: $[\beta \ldots\ [\alpha_{,\,\varepsilon} \ldots$ (Scope order: $\beta \succ \alpha$)

What is of particular significance for present purposes is the fact that SemR does not restore the binding relations early enough for them to be visible by LF. Applied to (136), this has the consequence that the direct object can be interpreted with narrow scope, while binding relations are left unchanged at LF (Lechner 1996).

Sharvit (1998) brings to attention a second dissociation between scope and binding which further endorses the view that reconstruction can be postponed by SemR. In the amount question (138), the degree predicate *n-many* is most naturally interpreted with scope inside *hope.*

(138) *How many students who hate Anton$_1$ does he$_1$ hope will buy him$_1$ a beer?*
a. Narrow *n-many*, transparent restrictor: (**de dicto/√de re*)
“For what number n: in all bouletic situation alternatives of Anton s’: there are n-many students who hate Anton in the actual situation and that will buy him a beer in s’.”

b. *Narrow n-many, opaque restrictor:
“For what number n: in all bouletic situation alternatives of Anton s’: there are n-many students who hate Anton in s’ and that will buy him a beer in s’.”

Moreover, the restrictor of the *wh*-phrase (*students who hate Anton$_1$*) can be construed *de dicto*, or *de re.* Interestingly, the *de re* interpretation appears to put the restrictor outside the binding domain of the higher pronoun *he* ([138a]) while the *de dicto* reading systematically correlates with the emergence of a disjoint reference effect ([138b]). This particular combination of properties in (138a) suggests that scope diminishment has been produced by SemR, and not by reconstruction in the syntactic component (see also Romero 1997).

To recapitulate, the principles that determine scope diminishment appear to operate at least partially independently from those which regulate reconstruction of restrictors. Certain environments which do not license binding reconstruction, but still permit narrow scope readings (short scrambling chains [136]), attest to the fact that not all scope reconstruction is the product of interpreting lower movement copies. Furthermore, Sharvit’s paradigm (138) demonstrates that scope reconstruction entails binding reconstruction only if the fronted node also reconstructs for the evaluation of opacity, i.e. if the restrictor is interpreted *de dicto*. Again, this indicates that scope reconstruction is independent of binding reconstruction, endorsing the view that the Coherence Hypothesis ([133]) is too strong. Evidently, these results conflict with the verdict reached in the discussion of Scope Trapping in section 6.2. Although the present survey is not the appropriate place for a synthesis, it is possible to isolate some systematic correlations one might further pursue in the search for a common analysis.

The three binary choices for whether a DP reconstructs for scope, binding and opacity generate a six cell matrix shown in table 35.1. Out of these six possible dissociations among the reconstructible properties, two (IV and V) are immediately excluded by the assumption that syntactic reconstruction (SynR) by copies entails scope reconstruction.

(139) Tab. 35.1: DP-reconstruction

Reconstruction of a moved DP for				
	Scope	B*inding*	*Opacity*	*Is the combination attested?*
I.	+	–	–	a. Yes (if α contains bound category; [136] and [138])
				b. No (if α is the binder; Scope Trapping [131/132])
II.	+	+	–	No (syntactic condition on s-variable binding)
III.	+	–	+	No (by condition on logical type of trace)
IV.	–	+	+	No (since SynR entails SemR)
V.	–	+	–	No (since SynR entails SemR)
VI.	–	–	+	No (by condition on logical type of trace)

Moreover, by restricting higher type traces to certain logical types it becomes possible to define SemR in such a way that it does not feed situation variable binding (von Fintel and Heim 2011; Lechner 2013). As a consequence, a fronted DP can be assigned an opaque, *de dicto* reading w.r.t. an intensional operator it has passed only in case the DP's descriptive content is restored within the scope of the operator at LF. On this conception, opaque readings require reconstruction in the syntactic component, which in turn renders ineligible cells III and VI of table 35.1.

At this point, two illegitimate cases of the matrix remain to be accounted for. First, Scope Trapping of the type seen in (131) and (132) (cell I/b in table 35.1) signals that a DP which semantically reconstructs cannot serve as an antecedent for an anaphor it has crossed over. This restriction arguably falls out from the fact that such constellations, schematized in (140), impose two conflicting binding requirements on the moved DPs. While SemR demands that the DP binds objects in the generalized quantifier type domain, anaphors are arguably individual variables (or contain e-type variables) and therefore require an e-type binder.

(140) $*[\mathrm{DP}_{<et,t>}\ [\lambda_1 \ldots [\mathit{anaphor}_e \ldots [t_{1,\ <et,t>} \ldots]]]]$

Thus, scope reconstruction cannot be delayed to semantics, which in turn entails that scope and binding must be evaluated in a single position, as expressed by the Scope Trapping generalization.

Finally, cell II of table 35.1 can be excluded by syntactic considerations. More specifically, the reconstructed *de re* reading of (134), repeated below, is blocked by the descriptive principle (70), which mandates that movement out of movement be local. This bars long s-variable binding as in (141b). It follows that syntactic reconstruction invariably produces opaque *de dicto* readings.

(141) a. *A nude of Marilyn$_1$ seems to her$_1$ to be a good emblem of the exhibit.*
(∃ > *seem* / **seem* > ∃)

b. *de re:* *$\underline{\lambda}_1$ … [seems to her$_1$ [λ_2 … [[$_{DP}$ a nude of Marilyn$_1$]…

Thus, along these lines it becomes possible to envision a system that eliminates all dissociations among scope, opacity and binding but the single attested one (cell I/a in table 35.1). Naturally, the remarks above do not substitute for an explicit and more complete theory of reconstruction. Still, the systematicity of the phenomena involved, to the extent that they are understood, foster the hope that such a theory is not beyond reach.

7. Two recent developments

This final section sketches two trends in current research on the syntax-semantics interface. First, current LF-based theories show a tendency to postulate an increasing amount of hidden structure in syntax. In sections 5 and 6, this trend was seen to underlie the standard account of reconstruction phenomena in terms of movement copies. But enriched object language representations have also been identified in other domains, and are, among others, manifest in analyses that treat third person pronouns as hidden definite descriptions (Elbourne 2005; Sauerland 2007; for resumptive pronouns see Guilliot 2008), or in the resurrected interest in raising analyses of relative clauses (Hulsey and Sauerland 2006) and related constructions such as comparatives (Lechner 2004).

Interestingly, the general willingness of research in the LF-tradition to adopt more structure than meets the eye co-exists with a second tendency, which appears to point into the diametrically opposite direction. Various authors have observed that the grammaticality status of certain constructions is not determined by all terminals that can be assigned a model theoretic interpretation, but seems to be sensitive only to properties of the logical constants, or the *logical skeleton* (Gajewski 2002) of the expressions involved. Prominently among these phenomena are the definiteness effect in the existential construction ([142]; Barwise and Cooper 1981), and quantifier restrictions in exceptives ([143], von Fintel 1994).

(142) a. *There is no man/a man (in the garden).*
b. **There is/are every man/most men (in the garden)*

(143) *every man/no man/*a man/*many men/*most men except Bill*

For both cases, the logical skeleton can be obtained by replacing each non-logical constant (*man/men* and *is/are* in [142], and *man/men* and *Bill* in [143]) by a variables of corresponding type. It then becomes possible to define a calculus which derives well-formedness of an expression from the logical syntax of the components involved (Gajewski 2002). On this conception, triviality in truth conditions translates into ungrammaticality.

Reflexes of the logical skeleton can also be detected in other areas. For instance, on the theory of Scope Economy (Fox 2000; see section 4.4), scope shifting operations are licensed only if they result in truth-conditionally distinct and logically independent readings. Since the contribution of non-logical constants is generally irrelevant for the calculation of entailments and other logical relations, it is possible to decide whether an operation is legitimized by inspecting the logical skeleton, which contains the logical constants (Boolean operators, quantifiers, …) only. Fox moreover proposes that the scope relations among the operators are computed in a language specific deductive component, the Deductive System (DS), which calculates entailments among competing interpretations. In this manner, DS determines whether a syntactic scope shifting operation is licensed by Scope Economy or not, rendering legitimate certain instances of non-local, scope shifting QR.

This conception has an important further consequence for the architecture of the grammar, as it entails that some aspects of natural language syntax are conditioned by the extra-syntactic DS module. Thus, the syntactic autonomy hypothesis, on which syntactic operations can only be motivated by properties of the syntactic component must be weakened, granting DS privileged access to the syntactic component.

That purely logical properties have the ability to trigger syntactic operations is also reflected in the widely held view that (certain) type mismatches are resolved by silent movement (Heim and Kratzer 1998). If the type of each atomic expression is fully specified in the logical skeleton, the recursive type assignment rules can also be computed in DS, from where they are subsequently passed on to the syntactic derivation, triggering QR if need arises. Thus, the hypothesis that type mismatches can be repaired by syntactic movement operations provides further corroborating evidence for a model of the grammar in which the syntactic component is not entirely informationally encapsulated, but accepts instructions from a language specific logical subsystem.

In sum, recent studies on the syntax-semantics interface have identified two architectural features that correlate with an orientation of the grammar into two opposite directions. On the one hand, some natural language properties are determined by the logical constants of the expressions involved, suggesting that syntax corresponds with a designated deductive system DS via impoverished representations that ignore non-logical constants (logical skeleton). By contrast, various tests that diagnose the presence of descriptive, lexical content indicate that object language representations are enriched by copies and silent definite descriptions in the position of pronouns.

Acknowledgements

I would like to thank Elena Anagnostoulou, Friedrich Neubarth and Viola Schmitt for detailed comments on an earlier version which led to numerous improvements. Also, I am grateful to Kyle Johnson for helpful suggestions. All errors and misrepresentations are my own. Parts of this research was supported by an Alexander von Humboldt fellowship.

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