J. Linguistics **41** (2005), 465–511. © 2005 Cambridge University Press
doi:10.1017/S0022226705003427 Printed in the United Kingdom

Control and semantic resource sensitivity[1]

ASH ASUDEH

University of Canterbury

(Received 9 September 2003; revised 22 February 2005)

This paper examines tensions between the syntax of control and semantic resource sensitivity. Structure sharing of controller and control target leads to apparent RESOURCE DEFICIT under certain circumstances. An analysis is presented using Glue Semantics for Lexical Functional Grammar. It demonstrates that structure sharing and resource sensitivity can be reconciled without giving up or relaxing either notion. It is shown that the analysis can handle either property or propositional denotations for controlled complements. The analysis is extended to finite controlled complements, which raise the opposing problem of RESOURCE SURPLUS. A solution is proposed and its typological implications discussed. The syntax and semantics of control as structure sharing is compared to a recent anaphoric control analysis by Dalrymple (2001). Based on facts of exhaustive and partial control, the present analysis is argued to be superior.

1. INTRODUCTION

Control and raising have been central concerns of generative grammar since the pioneering work of Rosenbaum (1967). Generative theories have dealt with the phenomena in a variety of ways. Transformational theories have traditionally treated the two using distinct mechanisms: raising has involved a local movement transformation (NP movement in Government and Binding theory (GB); Chomsky 1981, 1986) and control has involved binding or deletion of a distinguished base-generated pronominal ('PRO' in GB; Chomsky 1981, 1986). A recent transformational analysis of control within the Minimalist Program (Chomsky 1995) has sought to instead treat control in terms of movement (Hornstein 1999) – like raising.[2] Monostratal,

[1] I would like to thank the following people for their assistance and for helpful discussions: Joan Bresnan, Daniel Büring, Gennaro Chierchia, Dick Crouch, Mary Dalrymple, Ron Kaplan, Tracy Holloway King, Paul Kiparsky, Hanjung Lee, John Maxwell, Jim McCloskey, Dave McKercher, Line Mikkelsen, Yukiko Morimoto, David Pesetsky, Chris Potts, Ivan Sag, Peter Sells, Ida Toivonen, Nigel Vincent, Draga Zec, and audiences at Stanford's Semantics Fest 1 and LFG 2000. Thanks also to the anonymous *JL* referees and to Bob Borsley and Ewa Jaworska at *JL*. I accept full responsibility for any errors. This work was supported in part by SSHRC Doctoral Fellowship 752-98-0424.

[2] This approach is by no means uncontroversial. For criticisms, see Culicover & Jackendoff (2001) and Landau (2003). Boeckx & Hornstein (2003, 2004) provide replies.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

non-transformational theories, such as Lexical Functional Grammar (LFG; Kaplan & Bresnan 1982, Bresnan 2001, Dalrymple 2001) and Head-Driven Phrase Structure Grammar (HPSG; Pollard & Sag 1994), have since the initial work of Bresnan (1982a) treated raising and at least some instances of control in terms of STRUCTURE SHARING, i.e. total or partial equality of the controller/raiser and the control/raising target. The difference between raising and the relevant kind of control in these theories has rested solely on the independently necessary distinction of whether the target is a semantic argument of the verb that lexically determines the identity: the target of raising is only a subordinate argument and not a matrix argument, whereas the target of control is both a matrix and a subordinate argument. Structure sharing results in a single element occupying multiple syntactic positions. In terms of LFG's f(unctional)-structures, this is realised as multiple f-structure attributes with a token-identical value. In terms of HPSG's directed graphs, it is multiple entrancy into a single node. Both LFG and HPSG treat raising as structure sharing of two grammatical functions. LFG also equates entire grammatical functions in instances of control that are modelled using the mechanism of functional control. Control in HPSG involves structure sharing only of indices, which are parts of the syntactic elements involved in the control relation. Indices in HPSG possess internal structure – unlike the indices used to represent coindexation in transformational theories. HPSG's *referential* indices house the PERSON, NUMBER and GENDER features relevant to agreement and constitute the interface to semantics, since they simultaneously serve as values of semantic features in CONTENT.

Structure sharing, as exemplified by control and raising, is apparently at odds with resource-logic approaches to the syntax–semantics mapping and semantic composition, such as Glue Semantics (Glue; Dalrymple 1999, 2001) and the Lambek Calculus tradition of Categorial Grammar, often called Type-Logical Grammar (TLG; Morrill 1994, Carpenter 1997, Moortgat 1997). In these theories, lexically and constructionally contributed meanings are resources that cannot be freely reused or discarded. This precisely models the resource sensitivity of natural languages whereby the meanings of subexpressions must be used EXACTLY ONCE in calculating the meaning of larger expressions in which they occur. For example, given the sentence *Kim fooled Sandy* each lexical meaning is used exactly once to derive *fool*(k, s), but it is not possible to disregard the meaning of *Sandy* and use the meaning of *Kim* twice to derive *fool*(k, k) as the meaning of the sentence. The linguistics literature contains many implicit claims of resource sensitivity, such as Bounded Closure (Klein & Sag 1985), Completeness and Coherence (Kaplan & Bresnan 1982, Bresnan 2001), the Bijection Principle (Koopman & Sportiche 1982), the Theta Criterion (Chomsky 1986), and the Principle of Full Interpretation (Chomsky 1986), to name a few representative cases. The insights behind these claims are made explicit and formally captured in

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

resource-sensitive semantic theories like Glue and TLG, as discussed extensively in Asudeh (2004).[3]

1.1 *Resource deficit*

The potential conflict between structure sharing and resource sensitivity is illustrated by control. There is a single syntactic element shared as the controller and control target. This single syntactic element apparently realises two different semantic arguments, since it is an argument of both the matrix control verb and the subordinate predicate. In resource terms, this seems to be a case of RESOURCE DEFICIT. There is a single resource contributed by the structure-shared controller/control target, but there are two consumers of this resource: the control verb and the subordinate predicate. Things are not quite this straightforward, though. In particular, there have been two approaches to the semantics of controlled complements in the literature and the tension between structure sharing and resource sensitivity arises only on one approach.

The first approach treats the controlled complement as denoting a property (henceforth the PROPERTY THEORY). The property theory of control does not pose a problem for resource sensitivity in the case of infinitival control complements. The subordinate predicate does not get saturated, since it denotes a property, and therefore does not need to actually consume its argument; the single resource contributed by the structure-shared argument is consumed by the matrix control verb.

The second approach treats the controlled complement as denoting a proposition (henceforth the PROPOSITIONAL THEORY). The propositional theory challenges resource sensitivity, because in this case the single resource that corresponds to the structure-shared argument has to be consumed by both the matrix control verb and the controlled complement, since the latter must be saturated in order to denote a proposition. In this case, structure sharing is at odds with resource sensitivity because there is a single syntactic contribution of a resource for semantic composition and the resource has multiple semantic consumers that actually need to consume the resource. In particular, it is the assumption of a propositional denotation for the controlled complement that gives rise to this conflict.

Control also highlights a number of other issues central to an understanding of the interaction between structure sharing and resource-sensitive semantic composition. First, structure sharing per se is not sufficient for resource deficit. There must in fact be multiple consumers of the single semantic resource contributed by the structure-shared syntactic element. This issue was exemplified above, where it was noted that if the controlled

[3] Asudeh (2004: 72–82) also discusses resource sensitivity with respect to components of grammar other than semantics, in particular syntax and phonology.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

complement denotes a property then the complement does not consume the single resource and there is no conflict with resource sensitivity.

Similarly, raising does not result in a conflict between structure sharing and resource sensitivity: there is structure sharing in the syntax, but the resource corresponding to the single, structure-shared argument is only consumed by the subordinate predicate. Despite the compatibility of structure sharing and a resource-sensitive semantics for raising, it will prove useful to analyse raising in some detail. First, as mentioned above, there is a long-standing view in generative grammar that control and raising are intimately related. Second, presentation of an explicit analysis of raising facilitates discussion of certain key empirical differences between control and raising. Third, the analyses of control and raising together demonstrate the viability of maintaining unified syntactic analyses of raising and at least a subclass of control. Lastly, examination of raising as a case of unproblematic structure sharing and of control as a case of potentially problematic structure sharing permits a deeper understanding of the issues involved.

As a final example of structure sharing that is unproblematic from the perspective of resource sensitivity, consider filler–gap unbounded dependencies, which are also modelled using structure sharing in most versions of LFG and HPSG (see, e.g. Kaplan & Zaenen 1989 and Bouma et al. 2001). The single filler is structure-shared between the top of the unbounded dependency and the bottom (and intermediate positions in the case of the HPSG treatment of Bouma et al. 2001). However, the filler is semantically active only at the top of the dependency, where it functions like an operator, and the bottom of the dependency is interpreted like a variable bound by the operator.

A second, related issue arises, which is especially relevant to HPSG, since there is a great degree of structure sharing throughout HPSG's *sign* objects. The issue is that although only structure sharing of semantically relevant information potentially conflicts with semantic resource sensitivity, the problematic cases of structure sharing need not necessarily involve sharing of whole syntactic arguments and adjuncts. On the one hand, this means that much of the structure sharing in a typical HPSG sign does not give rise to conflicts with resource sensitivity. On the other hand, it means that even if only a subpart of a grammatical function is structure-shared, issues of resource accounting may still arise if it is the subpart that interfaces with the semantics. As mentioned above, indices are parts of grammatical functions that also serve as values in CONTENT, which represents semantics in HPSG. Thus, although control in HPSG involves only structure sharing of indices, this is sufficient to give rise to the resource deficit issue that stems from structure sharing of entire grammatical functions in LFG. In fact, in the resource-sensitive semantics for HPSG provided by Asudeh & Crouch (2002), the role of indices is taken over by the resources used for semantic composition.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

Lastly, although structure sharing is a mechanism used in monostratal theories like LFG and HPSG, the issues that have been discussed equally apply to transformational theories that assume a copy theory of movement. Although it may not be immediately apparent, movement in the copy theory potentially involves structure sharing, since a single element is realised as multiple terminal nodes, with the additional operation of an actual movement transformation. This means, for example, that filler–gap unbounded dependencies modelled as *wh*-movement are no more problematic than filler–gap dependencies modelled by structure sharing in monostratal theories, for the reasons discussed above. But it also means that control-as-movement (Hornstein 1999) is subject to the issues of resource deficit and surplus discussed with respect to structure sharing. Thus, the tension between structure sharing and resource sensitivity is not just relevant for monostratal, non-transformational theories, it is also quite relevant to recent transformational proposals.

1.2 *Resource surplus*

Structure-sharing analyses of control, which give rise to the problem of resource deficit, are appropriate for many cases of obligatory control into nonfinite complements. However, a number of languages have finite or otherwise syntactically saturated controlled complements. One example is Serbo-Croatian, in which controlled complements are finite clauses with null pronominal subjects (Zec 1987). Finite control has been analysed as obligatory anaphoric control, with the relationship between the controller and control target mediated by anaphoric binding, rather than structure sharing. This leads to the opposing problem of RESOURCE SURPLUS.

The problem of resource surplus is most clearly illustrated if finite control as obligatory anaphoric control is coupled to the property theory of control. I noted above that structure sharing in control together with a property denotation for the controlled complement is unproblematic, because the control target is not required for composition of the controlled complement's property. However, this equally means that the pronominal control target in obligatory anaphoric control is superfluous to composition of the property. Since pronouns are contentful expressions and therefore contribute semantic resources, this means that the pronominal resource would not be properly used and would be surplus to semantic composition. Thus, both proposals for the semantics of control lead to conflicts with resource sensitivity.

The issue of resource surplus is in fact even more general. The solution to the problem of structure sharing and resource sensitivity rests on the control verb handling composition in such a way that the controlled complement does not consume the shared resource. This is compatible with either a property or propositional denotation for the controlled complement. There are

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

empirical reasons to believe that finite control has comparable compositional semantics to nonfinite control, which means that the finite controlled complement does not consume its controlled pronominal subject's resource and, as a result, the pronominal's resource is surplus to composition. Thus, the more general problem is that a compositional semantics that avoids resource deficit for nonfinite control inevitably runs afoul of resource surplus in finite control. Given the arguments for parity of semantics between finite and nonfinite control, this is a fundamental problem in the syntax and semantics of control that extends beyond the debate about the correct denotation for the complement.

1.3 *Aims and outline*

The overarching aim of this paper is to consider tensions between the syntax and semantics of control, based on a monostratal theory of syntax (LFG) and a resource-sensitive theory of semantic composition (Glue Semantics), and to show that these tensions can be resolved without giving up resource sensitivity or standard analyses of control. Glue is well-suited to this task because, although it has been principally developed with an LFG syntax, it can be readily adapted to other syntactic theories (e.g. HPSG in Asudeh & Crouch 2002, Lexicalized Tree-Adjoining Grammar in Frank & van Genabith 2001).

The paper focuses principally on the apparent conflict between structure sharing in the syntax of control and resource-sensitive semantic composition. Both the property and propositional theories of control semantics are considered. When coupled to a structure-sharing analysis of control, the propositional theory poses a resource deficit problem for resource sensitivity, but the property theory does not. It is demonstrated that the same Glue composition scheme can derive either the property denotation or the propositional denotation. This has two implications. The first is that the propositional denotation is possible without abandoning structure sharing or resource sensitivity. The second is that the matter of the proper denotation for controlled complements is orthogonal to the Glue composition scheme for combining control verbs with their complements.

The focus then shifts to finite control, as exemplified by Serbo-Croatian, which involves obligatory anaphoric control of the controlled complement's null pronominal subject. Despite the differing syntactic mechanisms of obligatory anaphoric control and functional control, finite and nonfinite control arguably have the same compositional semantics. This means that the analysis of control semantics developed for nonfinite control should be extended to finite control. The result is a problem of resource surplus that can be traced to the pronominal control target in finite control. The paper shows how this problem can be solved, based on a theory of resource management (Asudeh 2004), which was initially developed in a theory of resumptive pronouns and copy raising. This results in a new typological

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

perspective on control which relates finite control to copy raising, thus further strengthening the theoretical ties between control and raising.

A subsidiary goal of the paper is to demonstrate that basic empirical desiderata of a theory of raising and control are met by the Glue theory. In particular, it follows that raising verbs can have expletive arguments and that scopal elements can take both wide and narrow scope with respect to raising verbs but can only take wide scope with respect to control verbs.[4]

Lastly, I consider an alternative proposal for the syntax of English nonfinite control by Dalrymple (2001), who posits that the syntactic mechanism involved is not functional control, but rather obligatory anaphoric control. I argue against this analysis and for the functional control analysis based on Landau's (2000) work on exhaustive and partial control. I also argue that there is no independent evidence for assuming that nonfinite controlled complements in English are closed complements with pronominal subjects. In light of this absence of evidence and the fact that functional control better accounts for exhaustive and partial control, I conclude that nonfinite control in English does indeed involve functional control.

The paper is organised as follows. In the next section, I focus on syntactic structure sharing by presenting a standard syntax for raising and control in LFG. In section 3, I present Glue Semantics within an LFG grammatical architecture and illustrate the semantic resource sensitivity of Glue that arises from its underlying logic, LINEAR LOGIC (Girard 1987). This sets up the tension between syntactic structure sharing and semantic resource sensitivity, which is discussed in section 4. Section 5 presents the two views of the denotation of controlled complements, without attempting to argue for one versus the other. Section 6 presents the Glue analyses of control and raising; special attention is paid to issues of structure sharing and resource sensitivity. Section 7 presents some empirical results of the analysis and shows that it generalises properly to multiple structure sharing. Section 8 considers the question of resource surplus that arises from assigning finite controlled complements a property denotation. Before turning to the resource surplus issue, the section first considers arguments for the property theory from English, a nonfinite control language, that carry over to Serbo-Croatian, a finite control language. Finally, section 9 critically discusses the alternative view of control set forth in Dalrymple (2001).

[4] The fact that I do not compare in any detail the Glue/LFG analyses to analyses in other theories, even closely related ones such as Categorial Grammar and HPSG, should not be taken as a slight to work in those theories, but rather reflects the fact that the main goal of the paper is to examine a broader theoretical issue, the tension between syntactic structure sharing and semantic resource sensitivity and issues of resource deficit and resource surplus. The empirical results are thus mainly presented to establish that the resulting theory which resolves this tension also gets the basic facts right, not to advocate its merits relative to other theories.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

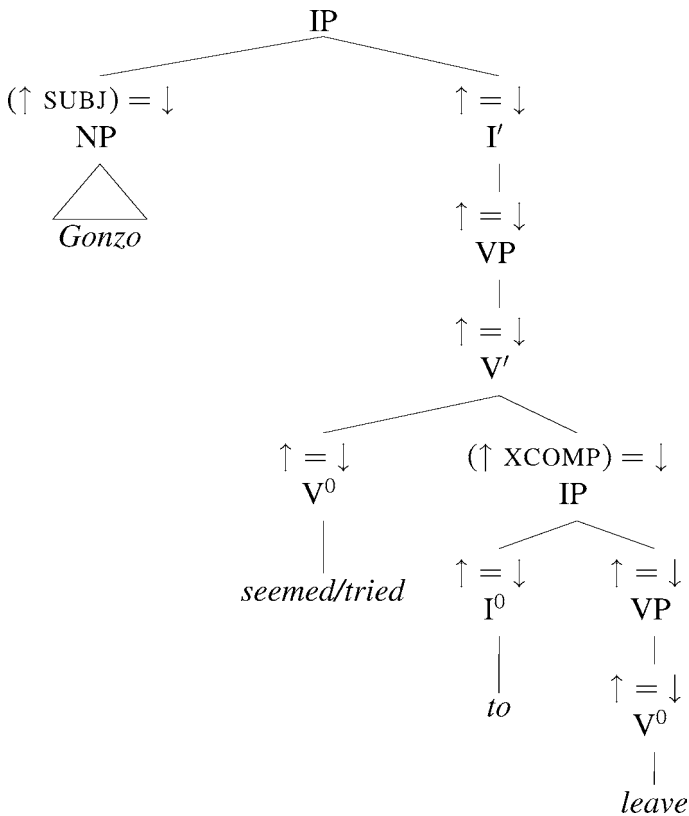
2. Structure sharing in the syntax of control and raising

In this section I will present LFG analyses of raising verbs and the subclass of control verbs that involve structure sharing. For purposes of illustration, I will focus here on the very basic sentences (1) and (2).

(1) Gonzo seemed to leave.
(2) Gonzo tried to leave.

The c(onstituent)-structures for these two sentences are identical (save for the terminal nodes):[5]

(3)



[5] I tacitly assume in this analysis, as evident from the c-structure (3), that *to* is simply a co-head with the embedded verb, and it does not make a semantic contribution here (reflected by its lack of a PRED), much like an expletive argument of a raising verb. This analysis is a long-standing one in LFG (Kaplan & Bresnan 1982, Bresnan 2001). However, should one wish to treat *to* as a raising/auxiliary verb (Pullum 1982), the Glue Semantics analysis presented here does not need to change. The sentence then is just a case of a raising verb embedded under a raising verb or a control verb.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

In either case, the matrix verb takes an IP complement that serves as an open XCOMP complement in f(unctional)-structure.

The differences between a subject raising verb, like *seem*, and a subject control verb, like *try*, are semantic in nature and are represented in the f-structure equations in their lexical entries and in their semantics. I will return to the difference in the semantics in section 6 below. Leaving that aside, the lexical entries for *seem* and *try* would be as follows:

(4) seem V (↑ PRED) = 'seem⟨(↑ XCOMP)⟩ (↑ SUBJ)'
(↑ SUBJ) = (↑ XCOMP SUBJ)

(5) try V (↑ PRED) = 'try⟨(↑ SUBJ), (↑ XCOMP)⟩'
(↑ SUBJ) = (↑ XCOMP SUBJ)

The only syntactic difference between the lexical entries, aside from the name of the PRED relation, is that the control verb *try* selects for a thematic subject, while the raising verb *seem* does not. This difference is represented by having the thematic subject inside the angle brackets of the PRED, while the non-thematic subject is outside these brackets.

This difference in argument structure possibilities is reflected in the fact that the raised argument can be replaced by an expletive or idiom chunk, but the controller cannot (Bresnan 1982a):

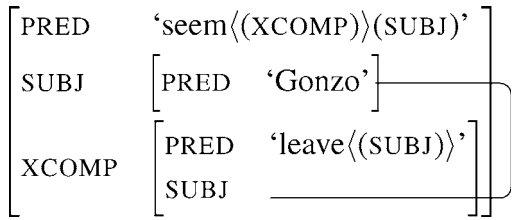
(6) (a) It seemed to rain.
(b) *It tried to rain.
(c) Tabs seemed to be kept on Gonzo.
(d) *Tabs tried to be kept on Gonzo.

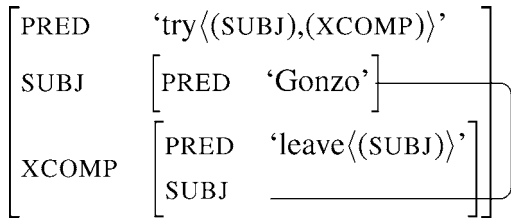
In LFG-theoretic terms, a non-thematic subject can be realised with no PRED of its own, whereas a thematic subject must have a PRED (Kaplan & Bresnan 1982, Zaenen & Engdahl 1994).

Despite this difference, in both cases there is a functional control equation, (↑ SUBJ) = (↑ XCOMP SUBJ), that identifies the matrix subject with the subject of the complement,[6] resulting in the following f-structures for (1) and (2):

[6] The technical term FUNCTIONAL CONTROL should not be confused with the term CONTROL, which seems to be the currently preferred term for the empirical phenomenon also known as EQUI (Postal 1970). Functional control is a general mechanism for structure sharing syntactic information via f-structure equality. The terminology will be easily distinguishable, though. I always refer to the structure sharing mechanism as FUNCTIONAL CONTROL; any use of CONTROL on its own refers to the phenomenon.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

(7)


(8)


In summary, the only syntactic difference between a control verb and a raising verb on this theory is that the former takes a thematic subject (i.e. non-expletive subject), while the latter takes a non-thematic subject (i.e. raised or expletive subject). Dalrymple (2001) has recently proposed that obligatory control in English should be modelled with anaphoric control rather than with functional control. I will assume the standard functional-control treatment of obligatory control and return to a discussion of Dalrymple (2001) in section 9.

3. Glue Semantics

3.1 *Glue and the parallel projection architecture of LFG*

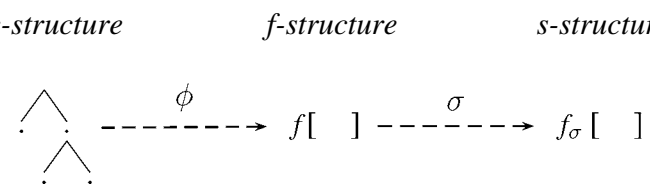
Although Glue does not necessarily have to be coupled with LFG, most work in Glue Semantics has been done with an LFG syntax (Dalrymple et al. 1993; Dalrymple 1999, 2001; Asudeh 2004). The more important architectural point is that Glue is coupled to an independent level of syntax, unlike Categorial Grammar, which makes no distinction between syntax proper and the syntax of semantic composition. Glue Semantics is thus a general theory of the syntax–semantics interface and semantic composition that assumes a separate level of syntax in which lexically contributed Glue premises are instantiated.

LFG has a parallel-projection architecture. This means that there are various levels of linguistic representation, called PROJECTIONS, which are present in PARALLEL, and these projections are related by functional correspondences (also known as projection functions) which map elements of one projection onto elements of another (Kaplan 1987, 1989; Halvorsen & Kaplan 1988). This is a generalisation of the original notion of functional correspondence in which the ϕ-function maps c(onstituent)-structures onto

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

f(unctional)-structures (Kaplan & Bresnan 1982). As a result of this generalisation, f-structures are mapped onto s(emantic)-structures by the σ-function (Dalrymple et al. 1999b, Dalrymple 2001). This results in an architecture like the following:

(9)



In terms of this architecture, Glue Semantics is a theory of the syntax–semantics interface (the σ-function), semantic representation and interpretation (s-structure), and semantic composition (the Glue proofs).

The various levels of grammatical representation are simultaneously present, but each level is governed by its own rules and representations. This separation of levels allows one to make simple theoretical statements about the aspects of grammar that the level in question models. Phrase structure, constituency, dominance, and precedence are represented at c-structure using trees, while grammatical functions, subcategorisation, binding, raising, control, and various other aspects of syntax are represented at or mediated by f-structure using attribute-value matrices. Semantics and the relationship between syntax and meaning are represented at s-structure using Glue Semantics: linear logic associated with a chosen meaning language.

An important feature of this architecture is that there can be systematic mismatches between grammatical levels. For example, null pronoun subjects in pro-drop languages are not present at c-structure, because they are unmotivated by the syntactic phenomena represented at that level. Rather, null pronouns are present at f-structure, where they can participate in agreement, binding, and other syntactic processes best represented at that level. Similarly, there can be systematic mismatches between f-structure and s-structure, and it is this aspect of the architecture that allows for an adequate semantics of control that nevertheless does not conflict with structure sharing in the syntax and in fact uses the syntax to provide solutions to problems that arise from finite control for the property analysis of control semantics.

3.2 *Overview of Glue Semantics*

Glue uses two logics: a meaning logic for representing meaning terms, and linear logic (Girard 1987) for assembling meanings (Dalrymple et al. 1999a, b, c). Recent work in Glue Semantics has used the Curry-Howard isomorphism (Curry & Feys 1958, Howard 1980) to directly relate the Glue and meaning

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

languages (Dalrymple et al. 1999a). According to the Curry-Howard isomorphism (CHI), implication introduction corresponds to abstraction and implication elimination corresponds to functional application. I will primarily use the implicational fragment of linear logic in my analysis, and will present Glue proofs in the natural deduction style. The natural deduction proof rules with Curry-Howard term assignments for implication are as follows:

(10) *Implication elimination* *Implication introduction*

$$\frac{f : A \multimap B \qquad a : A}{f(a) : B} \multimap\mathcal{E} \qquad \frac{\begin{array}{c}[x : A]^1 \\ \vdots \\ f : B\end{array}}{\lambda x.f : A \multimap B} \multimap\mathcal{I}, 1$$

The elimination rule is just MODUS PONENS: the implication $A \multimap B$, which corresponds to a function f, is combined with A, a premise that matches the implication's antecedent and which is coupled with a meaning term a (where a can be a constant or a variable). The result of elimination is the consequent of the implication, B. The corresponding result in the meaning language is functional application of f to a. The introduction rule is HYPOTHETICAL REASONING. It involves flagging an assumption in square brackets and assigning the assumption a variable in the meaning language. The assumption is subsequently discharged once it has been used to prove another premise. The Curry-Howard correspondent of implication introduction is abstraction over the variable introduced in the assumption.

The following simple example shows the natural deduction rules and the CHI working together to prove that $a \multimap b \vdash a \multimap b$.

(11)
$$\dfrac{\dfrac{[x : a]^1 \qquad f : a \multimap b}{f(x) : b}\, functional\ application : \multimap\mathcal{E}}{\lambda x.f(x) : a \multimap b}\, abstraction : \multimap_{\mathcal{I},1}$$

In the first step, $x : a$ is assumed (indicated by square brackets) and the assumption is flagged with the superscripted numeral. We take this assumption and combine it with our one premise $a \multimap b$ by elimination, which corresponds to functional application in the meaning language. The assumption is discharged in the second step, reintroducing the assumed linear logic atom a. On the meaning language side this corresponds to abstracting over the associated variable, x.

Semantic composition in Glue is driven by linear logic deduction (i.e. proofs) on lexically contributed MEANING CONSTRUCTORS. Each meaning constructor has the following form:

(12) $\mathcal{M} : \mathcal{G}$

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

$\mathcal{M}$ is a term from some representation of meaning, the meaning language, and $\mathcal{G}$ is a term of linear logic. As mentioned above, the fragment of linear logic is primarily the implicational fragment. Conjunction will be used in the representation of anaphora in section 8.1 below, but the proof rules for the connective will not be crucial to the discussion.[7] The meaning language in this paper is a basic fragment of intensional logic. I assume an intensional type theory without the type *s*. Instead the base type *t* stands for propositions rather than truth values (van Benthem 1988, 1991). In other words, the domain of *t* is not {0, 1}, but rather a set of sets of indices or possible worlds. If *W* is the set of possible worlds, then the domain of *t* is the power set of *W*.

Meaning constructors are instantiated by a syntactic parse, provided in this case by an LFG syntax. The linear logic resources used for semantic composition are node labels in semantic structure instantiated by the σ projection function from f-structures. This means that the meaning constructors contributed by lexical items are instantiated by σ-projections on f-structure equations. For example, the proper name *Iago* provides the meaning constructor in (13a) and the intransitive verb *sneered* the one in (13b).

(13) (a) $Iago: \uparrow_{\sigma_e}$
(b) $sneered: (\uparrow \text{SUBJ})_{\sigma_e} \multimap \uparrow_{\sigma_t}$

The $\uparrow$ meta-variable in the lexical entries refers to the f-structure that the entry contributes information to. The lexical item *Iago* contributes a resource that is the σ-projection of its f-structure; similarly, the lexical item *sneered* contributes a resource that is an implication from the σ-projection of its subject to the σ-projection of the verb. In parsing the sentence *Iago sneered*, the f-structure of *Iago* will be identified as the f-structure of the subject of *sneered*. The resources are typed with the standard types *e* and *t*. It is common practise in recent Glue work to name meaning constructors mnemonically and to suppress the σ-projection and type subscripts where convenient. Therefore, the normal abbreviation for the resources contributed by *Iago* and *sneered*, when the former is the subject of the latter, would be i and $i \multimap s$. This naming convention allows a schematic presentation of meaning constructors that abstracts away from how they are derived from the syntax, focusing instead on the compositional semantics. Let us call full meaning constructors, as in (13), GENERALISED MEANING CONSTRUCTORS and the abbreviated, mnemonic meaning constructors SCHEMATIC MEANING CONSTRUCTORS.

The meaning constructors for *Iago* and *sneered* yield the following proof:

(14) $$\frac{iago : i \qquad sneer : i \multimap s}{sneer(iago) : s} \multimap \varepsilon$$

[7] For further details of linear logic for linguistic applications see Dalrymple (1999, 2001), Crouch & van Genabith (2000), Asudeh (2004) and references therein.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

The linear logic rule that combines the two premises is implication elimination. As discussed above, this corresponds to functional application in the meaning language, via the Curry-Howard isomorphism. In the next section I present a slightly more complicated example of composition which illustrates how scope works.

An important consequence of the CHI is that Glue proofs cannot be constrained by operations in the meaning language (Dalrymple et al. 1999a). It therefore suffices to present the linear logic side alone in order to show that there exists a valid proof of a sentence's semantics. Composition in the meaning language can be indicated by showing the meaning language side of meaning constructors in proof trees, as in (14). However, proof trees for more complicated examples can become ungainly. Meaning composition for more complex proofs can alternatively be presented in a separate list-style proof. Not only is this useful from a presentational point of view, it also underscores that the linear logic terms are what drive composition and that proofs are abstract objects that can be written down in various ways.

3.3 *Scope in Glue Semantics*

The simple example in (15) further demonstrates Glue and also shows how scope works in this semantic theory.

(15) Something worries everyone.

I assume a theory of generalised quantifiers (Barwise & Cooper 1981): a noun serves as the restriction of a type $\langle\langle e, t\rangle, \langle\langle e, t\rangle, t\rangle\rangle$ determiner. There are a variety of ways to represent determiners on the left hand side of the meaning constructor; I opt for a three-place functional representation:

(16) $\lambda R \lambda S.\mathit{few}(x, R(x), S(x))$

Note that unlike *few* the quantified pronouns *something* and *everyone* have lexically specified restrictions.

The meaning constructors for *something* and *everyone* look for an $\langle e, t\rangle$ implication that depends on the resource of the quantified NP:

(17) (a) $\lambda S.\mathit{some}(x, \mathit{thing}(x), S(x)) : (\uparrow_{\sigma_e} \multimap X_t) \multimap X_t$
(b) $\lambda S.\mathit{every}(y, \mathit{person}(y), S(y)) : (\uparrow_{\sigma_e} \multimap Y_t) \multimap Y_t$

The fact that a variable X is used in forming the scope allows the quantifier to take higher scope by introducing a hypothesis on the resource instantiating $\uparrow_\sigma$, discharging the dependency on this resource locally, and then reintroducing it at a later point in the derivation.[8] This will become clear

[8] I have taken a shortcut here. There is actually universal quantification over the variables in the linear logic side of scope-taking items (Dalrymple et al. 1999a, c; Kokkonidis 2004). The

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

momentarily. The reader is referred to Dalrymple et al. (1999c), Crouch & van Genabith (1999), and Dalrymple (2001) for further details.

Using the mnemonic convention described above and suppressing σ and type subscripts, the lexically contributed schematic meaning constructors for sentence (15) are:

(18) 1. $\lambda S.some(x, thing(x), S(x)) : (s \multimap X) \multimap X$ Lex. **something**
2. $\lambda u \lambda v.worry(u, v) : s \multimap e \multimap w$ Lex. **worries**
3. $\lambda S.every(y, person(y), S(y)) : (e \multimap Y) \multimap Y$ Lex. **everyone**

From these premises we can construct either proof (19), the surface scope reading, or proof (20), the inverse scope reading. Notice that in (20) the meaning constructor for the verb has been curried (rewritten) to consume the object first.[9] Only the linear logic side of the meaning constructors are indicated. The premises contributed by the lexical items are indicated in bold for readability.

(19)
$$\dfrac{\dfrac{\dfrac{\mathbf{s} \multimap \mathbf{e} \multimap \mathbf{w} \qquad [s]^1}{e \multimap w}\multimap_{\mathcal{E}} \qquad (\mathbf{e} \multimap \mathbf{Y}) \multimap \mathbf{Y}}{w}\multimap_{\mathcal{E}}, [w/Y] \qquad (\mathbf{s} \multimap \mathbf{X}) \multimap \mathbf{X}}{w}\multimap_{\mathcal{I},1} \multimap_{\mathcal{E}}, [w/X]$$

(20)
$$\dfrac{\dfrac{\dfrac{\mathbf{e} \multimap \mathbf{s} \multimap \mathbf{w} \qquad [e]^1}{s \multimap w}\multimap_{\mathcal{E}} \qquad (\mathbf{s} \multimap \mathbf{X}) \multimap \mathbf{X}}{w}\multimap_{\mathcal{E}}, [w/X] \qquad (\mathbf{e} \multimap \mathbf{Y}) \multimap \mathbf{Y}}{w}\multimap_{\mathcal{I},1} \multimap_{\mathcal{E}}, [w/Y]$$

The quantifier takes its scope by finding an appropriate dependency and consuming it through implication elimination. The quantifier that enters the derivation last gets widest scope (for further discussion of the use of proof topology to express scope constraints, see Crouch & van Genabith 1999).

simplification I adopt has no real consequences for the analysis, though, because eliminating a universal is trivial.

[9] Note that $s \multimap e \multimap w \vdash e \multimap s \multimap w$. The proof simply involves assumption of s and then e and then discharging the assumptions in the opposite order. The corresponding meaning term is also curried via the CHI.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

The meaning terms are entirely determined by the Curry-Howard isomorphism, but for extra clarity here is a list-style proof with meaning terms for the surface scope reading ($\Rightarrow_\beta$ indicates beta-reduction):

(21)

1.	$\lambda S.some(x, thing(x), S(x)) : (s \multimap X) \multimap X$	Lex. **something**
2.	$\lambda u \lambda v.worry(u, v) : s \multimap e \multimap w$	Lex. **worries**
3.	$\lambda S.every(y, person(y), S(y)) : (e \multimap Y) \multimap Y$	Lex. **everyone**
4.	$z : s$	assumption
5.	$\lambda v.worry(z, v) : e \multimap w$	E $\multimap$ (2, 4), $\Rightarrow_\beta$
6.	$every(y, person(y), worry(z, y)) : w$	E $\multimap$ (3, 5), $[w/Y]$, $\Rightarrow_\beta$
7.	$\lambda z.every(y, person(y), worry(z, y)) : s \multimap w$	I $\multimap$
8.	$some(x, thing(x), every(y, person(y), worry(x, y))) : w$	E $\multimap$ (1, 7), $[w/X]$, $\Rightarrow_\beta$

The proof for the inverse scope meaning should be apparent from this proof and the proof tree (20).

3.4 *Linear logic is a resource logic*

As mentioned already, linear logic is a resource logic: all premises in a valid linear logic proof must be used exactly once. This can be seen by comparing classical logic to propositional linear logic and observing the differences in certain entailment patterns ($\otimes$ is multiplicative linear conjunction).

1. *A premise can only be used once*

(22) Classical implication ($\rightarrow$)

(a) $p, p \rightarrow q \vdash q$
(b) $p, p \rightarrow q \vdash p \wedge q$ p used to derive q and can be conjoined with q

(23) Linear implication ($\multimap$)

(a) $p, p \multimap q \vdash q$
(b) $p, p \multimap q \nvdash p \otimes q$ p was used up to derive q

2. *Each premise must be used*

(24) Classical conjunction ($\wedge$)

(a) $p \wedge q \vdash p$ q ignored

(25) Linear conjunction (multiplicative) ($\otimes$)

(a) $p \otimes q \nvdash p$ must use q

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

In principle, we can choose any logic for the meaning logic in Glue Semantics, so long as a systematic relationship can be established between operations in the meaning language and those in the linear logic. As discussed in the introduction, the resource sensitivity of linear logic is linguistically significant, because it models the resource sensitivity of natural languages.

4. Structure sharing and resource sensitivity

Let us now reconsider the problem of resource sensitivity and structure sharing. Consider again the two f-structures, (7) and (8), in section 2 above, repeated here as (26) and (27) with f-structure labels:

(26)
$$s\begin{bmatrix}\text{PRED} & \text{`seem}\langle(\text{XCOMP})\rangle(\text{SUBJ})\text{'} \\ \text{SUBJ} & g\begin{bmatrix}\text{PRED} & \text{`Gonzo'}\end{bmatrix} \\ \text{XCOMP} & l\begin{bmatrix}\text{PRED} & \text{`leave}\langle(\text{SUBJ})\rangle\text{'} \\ \text{SUBJ} & \end{bmatrix}\end{bmatrix}$$

(27)
$$t\begin{bmatrix}\text{PRED} & \text{`try}\langle(\text{SUBJ}),(\text{XCOMP})\rangle\text{'} \\ \text{SUBJ} & g\begin{bmatrix}\text{PRED} & \text{`Gonzo'}\end{bmatrix} \\ \text{XCOMP} & l\begin{bmatrix}\text{PRED} & \text{`leave}\langle(\text{SUBJ})\rangle\text{'} \\ \text{SUBJ} & \end{bmatrix}\end{bmatrix}$$

In each f-structure, the SUBJ and XCOMP SUBJ share as their value a single f-structure *g*. As we saw in section 3, f-structure nodes are mapped onto semantic resources at s(emantic)-structure, according to lexical specifications. The f-structure *g* contributes one semantic resource that must be used in the Glue proof of the sentence's meaning.

In the case of raising, (26), structure sharing does not conflict with resource sensitivity. The raised argument is only consumed in the semantics of the raising verb's complement, as it is not a semantic argument of the raising verb. This is spelled out in section 6.2 below.

Control, (27) is more problematic: the shared grammatical function is an argument of both the matrix and subordinate verbs. Both verbs apparently need to consume the same subject resource. If the subject's resource is used as a premise in deriving the meaning of the control verb, the resource is consumed and is not available for the embedded verb. Likewise, if the embedded verb consumes the subject's resource, it is unavailable for the control verb.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

However, whether control is in fact problematic depends on the denotation of the controlled complement. If the complement denotes a property, then it does not get saturated by combining with its subject. The control verb can therefore consume the subject without any resulting resource problem; the control verb likewise consumes the property corresponding to the controlled complement. In contrast, if the complement denotes a proposition, it does need to be saturated by its subject and there is apparent resource failure, because both the matrix control verb and the subordinate verb need to consume the single structure-shared resource.

In section 6, I present a Glue analysis of control that solves this problem. It will be shown that the same linear logic combinatorics can yield either the property or propositional reading, depending purely on what happens in the meaning language. Whatever the denotation of a controlled complement, it is the control verb that manages its complement's subject resource. This is purely compositional, though: the controlled complement's subject is also an argument of the control verb and is therefore straightforwardly accessible for composition. Before turning to the analysis, I will spell out in more detail the difference between the two theories of control complement denotation.

5. The denotation of controlled complements

There are two well-established approaches to the semantics of control verbs. The difference between the two approaches has to do with the denotation of the controlled complement of the control verb. The first approach holds that the controlled complement denotes a proposition (Rosenbaum 1967; Higginbotham 1989, 1992; Sag & Pollard 1991; Pollard & Sag 1994), while the second approach holds that it denotes a property (Montague 1974; Chierchia 1984a, b; Dowty 1985; Chierchia & Jacobson 1986). I refer to these respectively as the propositional and property theories of control.

According to the propositional theory of control, the sentence in (28a) would have the translation in (28b). The subject control verb *try* is a function that takes an individual and a proposition as arguments, as in (28c).[10]

(28) (a) Gonzo tried to leave.
(b) try(Gonzo, leave(Gonzo))
(c) try: $\langle e, \langle t, t \rangle \rangle$

The propositional stance is a long-standing view in generative grammar, arguably dating to the original work on control by Rosenbaum (1967). It is a

[10] Recall that the type t is intensional and stands for propositions. For presentational purposes, I write the types for control verbs as picking up the subject first, since this is the structure-shared argument of particular interest. The types could equivalently be written with the control verb picking up its complement first. The propositional *try* would then have the type $\langle t, \langle e, t \rangle \rangle$ and the property *try* would have the type $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$. See, e.g. Carpenter (1997: 48) on permuting arguments in the lambda calculus.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

natural consequence of any syntactic theory that proposes that the controlled complement has a subject at some syntactic level of representation. This includes most well-known recent theories, such as GB (Chomsky 1981, 1986), the Minimalist Program (Chomsky 1995), LFG, and HPSG.[11]

The property theory, by contrast, analyses the controlled complement as denoting a property. Again, this is shown for the subject control verb *try*.

(29) (a) Gonzo tried to leave.
(b) try(Gonzo, leave)
(c) try: $\langle e, \langle\langle e, t\rangle, t\rangle\rangle$

According to typical formulations of the property theory, there is no level of representation in the syntax or semantics where the controlled complement has a subject. The relevant argument of the control verb acts as the 'understood subject' merely due to lexical entailments associated with the control verb (Chierchia 1984a, b). Chierchia (1990) is an exception to this. In that version of the property theory a PRO subject is posited in the syntax but interpreted as a bound variable; the complement thus still denotes a property.

6. Glue Semantics for control and raising

6.1 *Control*

The generalised meaning constructor for the subject control verb *try* is as follows, setting aside the meaning language for the moment:[12]

(30) *try*
$(\uparrow \text{SUBJ})_{\sigma_e} \multimap [(\uparrow \text{XCOMP SUBJ})_{\sigma_e} \multimap (\uparrow \text{XCOMP})_{\sigma_t}] \multimap \uparrow_{\sigma_t}$

Despite the reference by the control verb to XCOMP SUBJ, the analysis is compositional. The control verb does not consume XCOMP SUBJ as an argument. It merely uses the specification XCOMP SUBJ in identifying the $\langle e, t\rangle$ dependency that corresponds to its complement. Furthermore, even if the control verb were to use the specification XCOMP SUBJ in taking an argument the analysis would still be compositional: XCOMP SUBJ is identified with the controller and is therefore also an argument of the control verb. In other

[11] The most notable exception is Categorial Grammar (Chierchia 1984b, Jacobson 1990, Carpenter 1997), with which Glue Semantics has some affinities (Dalrymple et al. 1999a, Asudeh 2004).

[12] A brief technical note: although the meaning language is intensional, the linear logic is extensional (Dalrymple et al. 1999c). In other words, the domain of type t in the meaning language is the power set $P(W)$ of the set of possible worlds W, but the domain of t in the linear logic is $\{0, 1\}$. There is no conflict in typing, since the instances of t belong to distinct logics.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

words, (↑ XCOMP SUBJ) in (30) could be replaced by (↑ SUBJ), since (↑ XCOMP SUBJ) = (↑ SUBJ).

The denotation of the controlled complement – proposition or property – depends entirely on the meaning language. If the control verb feeds the variable corresponding to the controller to the property corresponding to the controlled complement, then the denotation is a proposition, as in (31). If on the other hand the control verb does not feed the controller's variable to the complement property, then the complement remains a property and we have the property denotation, as in (32). I use $s \multimap (s \multimap v_2) \multimap v_1$ as an abbreviation of the linear logic term in (30).

(31) $\lambda x \lambda P.try(x, P(x)) : s \multimap (s \multimap v_2) \multimap v_1$
(32) $\lambda x \lambda P.try(x, P) : s \multimap (s \multimap v_2) \multimap v_1$

P is a type $\langle e, t \rangle$ variable over properties. The same combinatorics can therefore yield either the property or propositional denotation for the complement. In both cases, though, it is the control verb that drives composition. The complement never directly consumes the controlled argument. This is the solution to the structure sharing problem. There is only one resource being contributed by the shared argument, but there is also only one actual consumer: the control verb. Notice that I am not proposing that the two version of the control verb are interderivable or that both versions are instantiated in English, just that either denotation can be accommodated by the theory.

Let us look at a full derivation for example (2), which is repeated here:

(2) Gonzo tried to leave.

This sentence has the c-structure given above in (3). Its f-structure was shown in (27). Using the f-structure labels of (27), we get the lexically contributed meaning constructors in (33), which in any case simply follow the mnemonic premise-naming convention; for now we stick to the property denotation for the controlled complement.[13]

(33) 1. $gonzo : g$ Lex. **Gonzo**
2. $\lambda x \lambda P.try(x, P) : g \multimap (g \multimap l) \multimap t$ Lex. **tried**
3. $leave : g \multimap l$ Lex. **leave**

The Glue proof from these premises is straightforward, and involves only two instances of implication elimination (lexically contributed premises are indicated in bold):

[13] I assume that *to* is a non-contentful co-head and makes no semantic contribution. See footnote 5 above.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

(34)
$$\dfrac{\mathbf{g} \qquad \dfrac{\mathbf{g} \multimap (\mathbf{g} \multimap \mathbf{l}) \multimap \mathbf{t}}{(g \multimap l) \multimap t} \multimap_{\mathcal{E}} \qquad \mathbf{g} \multimap \mathbf{l}}{t} \multimap_{\mathcal{E}}$$

Through the Curry-Howard isomorphism, the two eliminations correspond to functional application in the meaning language.

(35)
$$\dfrac{gonzo : g \qquad \dfrac{\lambda x \lambda P.try(x,\ P) : g \multimap (g \multimap l) \multimap t}{\lambda P.try(gonzo,\ P) : (g \multimap l) \multimap t} \multimap_{\mathcal{E}} \qquad leave : g \multimap l}{try(gonzo,\ leave) : t} \multimap_{\mathcal{E}}$$

If we replace the property *try* in (33) with the propositional *try*, as in (36) (leaving everything else the same), we instead construct the proof (37):

(36) 2. $\lambda x \lambda P.try(x,\ P(x)) : g \multimap (g \multimap l) \multimap t$ Lex. **tried**

(37)
$$\dfrac{gonzo : g \qquad \dfrac{\lambda x \lambda P.try(x,\ P(x)) : g \multimap (g \multimap l) \multimap t}{\lambda P.try(gonzo,\ P(gonzo)) : (g \multimap l) \multimap t} \multimap_{\mathcal{E}} \qquad leave : g \multimap l}{try(gonzo,\ leave(gonzo)) : t} \multimap_{\mathcal{E}}$$

Notice that the linear logic side of (37) is just (34). Nothing needs to be changed about the combinatorics to give the propositional reading.

In sum, the Glue analysis of control proposed here resolves the tension between structure sharing and resource sensitivity by allowing the control verb to drive composition. The same linear logic composition scheme yields either the property or propositional denotation for the controlled complement. The analysis shares this feature with the Type-Logical Grammar analysis of Carpenter (1997). Like that analysis, the Glue analysis offered here is orthogonal to the denotation debate and offers a modular solution that can be coupled with either view. Carpenter (1997: 438) writes that in HPSG and LFG 'the effect [of providing a propositional argument to a control verb] is achieved by identifying the subject of the controlled verb and the controller'. Carpenter thus implies that identification of the subject of the controlled verb and the controller in the syntax entails the propositional denotation for the controlled complement. We have just seen that this is not the case in the present analysis: the presence of a controlled subject in the syntax is also commensurate with a property denotation for the controlled complement. Asudeh (2000) shows that this solves a problem raised by Pollard & Sag (1994: 283) for the property theory based on pronominal agreement, without resorting to the purely semantic theory of agreement of

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

Dowty & Jacobson (1989), which Pollard & Sag (1994: 71–73, 97–99) argue against persuasively.

6.2 *Raising*

The syntactic analysis of raising is similar to that of control, as we have already observed. However, the raised argument bears no semantic relation to the raising verb, and is only interpreted in the semantics of its propositional complement. For example, the raised subject of *seem* in sentence (1) is not the subject of *seem*, because *seem* is semantically a one-place predicate with a propositional argument:

(1) Gonzo seemed to leave.

This distinction between the semantic relationship of the raised argument to the raising verb and the semantic relationship of the controlled argument to the control verb is reflected in Glue Semantics. Here is the meaning constructor for the subject raising verb *seem*.

(38) $seem\colon\ \lambda p.seem(p)\colon (\uparrow \textsc{xcomp})_{\sigma_t} \multimap \uparrow_{\sigma_t}$

The variable p is a type t variable over propositions. A subject raising verb is of type $\langle t, t \rangle$. This is reflected in the linear logic by the fact that the subject raising verb only consumes its XCOMP's meaning to get its own meaning. It is the XCOMP itself that consumes its subject's meaning, even though its subject is also the subject of the raising verb by functional control.

Sentence (1) has the c-structure given in (3) above and the f-structure in (26). The sentence yields these mnemonically named meaning constructors:

(39) 1. $gonzo\colon g$ Lex. **Gonzo**
2. $\lambda p.seem(p)\colon l \multimap s$ Lex. **seemed**
3. $leave\colon g \multimap l$ Lex. **leave**

With these premises we can again construct a simple proof using only implication elimination in the linear logic (lexical premises once again in bold):

(40)
$$\dfrac{\dfrac{\mathbf{g} \qquad \mathbf{g \multimap l}}{l}\multimap\!\mathcal{E} \qquad \mathbf{l \multimap s}}{s}\multimap\!\mathcal{E}$$

This proof is substantially different from the one in (34). The raised subject first combines with the predicate that selects for it, in this case *leave*, to give the meaning of the XCOMP, which is a proposition. The XCOMP then combines with its predicate, the raising verb. The result is that the raising verb is a one-place predicate taking a proposition as its argument.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

The meaning of the sentence is derived with two corresponding functional applications:

(41)
$$\dfrac{\dfrac{gonzo : g \qquad leave : g \multimap l}{leave(gonzo) : l}\multimap\varepsilon \qquad \lambda p.seem(p) : l \multimap s}{seem(leave(gonzo)) : s}\multimap\varepsilon$$

6.3 *Summary*

In this section I have provided Glue analyses of both control and raising. The Glue analysis of control can derive either the property or propositional denotation for a controlled complement. The analysis demonstrates that structure sharing is not at odds with resource sensitivity and that the tension between the two merely entails that the control verb must manage composition, which is a conclusion that has been independently arrived at in Type-Logical Grammar (Carpenter 1997). Contrary to what Carpenter (1997) claims regarding HPSG and LFG, the present analysis can posit syntactic identity of controller and controllee without necessarily adopting a propositional denotation for the complement. The next section shows some empirical results with respect to expletive distribution and scope, and also that the analysis generalises properly to cases of multiple structure sharing.

7. Empirical results

In this section, I show that an analysis that addresses the tension between syntactic structure sharing and semantic resource sensitivity can also achieve good empirical coverage. In sections 7.1 and 7.2 respectively, I discuss expletives and scope possibilities. In section 7.3, I show that the analysis is fully general and also handles multiple structure sharing.[14]

7.1 *Expletives*

Raising verbs can have an expletive target, but control verbs cannot:

(42) There seemed to be a problem.
(43) *There tried to be a problem

This distinction follows from the linear logic side of the meaning constructors for control versus raising verbs. Assuming that an expletive makes no semantic contribution, it therefore contributes no semantic

[14] The empirical results presented in this section are discussed further in Asudeh (2000, 2002a).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

resource.[15] A control verb needs to consume the resource corresponding to the controller, the subject in the case of (43). Clearly this is impossible if no such resource exists. By contrast, the raising verb only needs to consume the resource corresponding to its complement and therefore is equally satisfied whether its subject is contentful and contributes a resource or not.

Similarly, the same linear logic term accounts for non-raised expletives:

(44) It seemed that Gonzo left.

The expletive makes no contribution and the raising verb's requirements are satisfied by consuming its saturated complement.

7.2 *Scope*

The semantics for control and raising developed here yields proper scopal differences between control and raising, which have sometimes been discussed in terms of DE RE (referential) and DE DICTO (non-referential) readings (Montague 1974, Dowty et al. 1981). A quantified subject of a raising verb can take either wide scope (DE RE reading) or narrow scope (DE DICTO reading) with respect to the verb. However, the subject of a control verb cannot take narrow scope with respect to the verb; the DE DICTO reading is unavailable.

7.2.1 *Raising: both scopes available*

Consider the example in (45) below. On the reading with the subject taking wide scope, every goblin was such that it seemed pinch Merry. On the narrow scope reading, it seemed to be the case that every goblin pinched Merry. The former reading entails the existence of goblins, if the quantifier carries the presupposition that its restriction is non-empty. This is a kind of DE RE reading. The latter reading can be true without there actually being such things as goblins; it is a kind of DE DICTO reading.

(45) Every goblin seemed to pinch Merry.

The meaning constructor for the quantified subject is written as usual (see section 3.3 above) and we get the following meaning constructors for sentence (45), naming them mnemonically:

(46)
1.	$\lambda S.every(x, goblin(x), S(x)) : (g \multimap X) \multimap X$	Lex. **Every goblin**
2.	$seem : p \multimap s$	Lex. **seemed**
3.	$\lambda y \lambda x.pinch(x, y) : m \multimap g \multimap p$	Lex. **to pinch**
4.	$merry : m$	Lex. **Merry**

We get the wide scope reading for the quantified subject by making an assumption on the corresponding argument g in the raising verb's complement,

[15] Asudeh (2004: 90ff.) discusses some alternatives to this view of expletives. None of these alternatives would affect the facts at hand.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

deriving the sentence's meaning with the assumption holding the place of the subject's scope, then discharging the assumption and scoping in the subject:

(47) *Wide scope subject*

$$\dfrac{\dfrac{\dfrac{\dfrac{\mathbf{m} \qquad \mathbf{m} \multimap \mathbf{g} \multimap \mathbf{p}}{g \multimap p}\,{\multimap}\mathcal{E} \qquad [g]^1}{p}\,{\multimap}\mathcal{E} \qquad \mathbf{p} \multimap \mathbf{s}}{s}\,{\multimap}\mathcal{E}}{g \multimap s}\,{\multimap}\mathcal{I},1 \qquad (\mathbf{g} \multimap \mathbf{X}) \multimap \mathbf{X}}{every(x, goblin(x), seem(pinch(x, merry))) : s}\,{\multimap}\mathcal{E}, [s/X]$$

The meaning language is omitted except on the final result, since it follows by the CHI and since it does not constrain scopal possibilities, which are derived purely from the linear logic side of meaning constructors.

The narrow scope reading for the subject is derived by scoping in the subject at the first opportunity, when we first derive $g \multimap p$, rather than postponing its scope via assumption:

(48) *Narrow scope subject*

$$\dfrac{\mathbf{p} \multimap \mathbf{s} \qquad \dfrac{(\mathbf{g} \multimap \mathbf{X}) \multimap \mathbf{X} \qquad \dfrac{\mathbf{m} \qquad \mathbf{m} \multimap \mathbf{g} \multimap \mathbf{p}}{g \multimap p}\,{\multimap}\mathcal{E}}{p}\,{\multimap}\mathcal{E}, [p/X]}{seem(every(x, goblin(x), pinch(x, merry))) : s}\,{\multimap}\mathcal{E}$$

Both wide scope (DE RE) and narrow scope (DE DICTO) readings are available for the subject of a raising verb, because it is possible to create a scope for the quantifier in terms of either the raised subject and the raising verb or the raised subject and the subordinate verb that selects for it. In this particular example, we can derive either the linear logic term $g \multimap s$ or $g \multimap p$ as the quantifier's scope.

7.2.2 *Control: only wide scope subject available*

Now let us consider the same sentence with the control verb *try* replacing the raising verb *seem*:

(49) Every goblin tried to pinch Merry.

The resulting sentence only has a wide scope reading for the quantified subject. The meaning of *try* is such that if every goblin tried to pinch Merry,

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

then there must actually be some goblins. The sentence therefore only has a DE RE reading, since it entails that the goblins exist.

I assume appropriate meaning constructors as in (46) above, except with the raising meaning constructor replaced by a control meaning constructor. The wide scope reading for the subject is derived by letting the control verb consume the controlled complement and then letting the quantifier take the remaining dependency from the control verb's subject to the control verb ($g \multimap t$) as its scope:[16]

(50) *Wide scope subject*

$$\dfrac{\dfrac{\dfrac{\dfrac{[g]^1 \quad \mathbf{g} \multimap (\mathbf{g} \multimap \mathbf{p}) \multimap \mathbf{t}}{(g \multimap p) \multimap t} \multimap_{\mathcal{E}} \quad \dfrac{\mathbf{m} \quad \mathbf{m} \multimap \mathbf{g} \multimap \mathbf{p}}{g \multimap p} \multimap_{\mathcal{E}}}{t} \multimap_{\mathcal{E}}}{g \multimap t} \multimap_{\mathcal{I},1} \quad (\mathbf{g} \multimap \mathbf{X}) \multimap \mathbf{X}}{t} \multimap_{\mathcal{E}}, [t/X]$$

There is no possibility of a narrow scope (DE DICTO) reading of the subject. The only way for the quantifier to take narrow scope is to consume the dependency $g \multimap p$. However, this is an argument of the control verb. If the quantifier consumes it in taking its scope, the control verb cannot find its argument and there will be resource failure:

(51) *No proof for narrow scope subject*

$$\dfrac{\dfrac{[g]^1 \quad \mathbf{g} \multimap (\mathbf{g} \multimap \mathbf{p}) \multimap \mathbf{t}}{(g \multimap p) \multimap t} \multimap_{\mathcal{E}} \quad \dfrac{\dfrac{\mathbf{m} \quad \mathbf{m} \multimap \mathbf{g} \multimap \mathbf{p}}{g \multimap p} \multimap_{\mathcal{E}} \quad (\mathbf{g} \multimap \mathbf{X}) \multimap \mathbf{X}}{p} \multimap_{\mathcal{E}}, [p/X]}{\textbf{FAIL}}$$

In the first step on the left hand side, there is an assumption on g, the resource on which the control verb depends. The assumption would have to be discharged, but there is no consumer of the resulting dependency left, because the quantifier has already been scoped in. This leads to another instance of resource failure. The only way to satisfy all requirements is the proof (50) that derives the wide scope reading. Therefore, it is a consequence of the resource sensitivity of linear logic that the Glue analysis given here does not yield a narrow scope reading for a controller.[17] Since the linear logic term is the same

[16] Rather than currying the control verb to allow it to combine with the controlled complement first, we simply make an assumption on the controller to postpone its consumption.

[17] More precisely, the proof (51) fails because a Glue proof for sentential semantics must terminate in a type t linear logic atom and this proof terminates in a type $\langle\langle e, \langle\langle e, t\rangle, t\rangle\rangle \times t\rangle$ conjunction. Thus, the failure of the DE DICTO reading is due to the coupling in Glue

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

whether the controlled complement is given a property or propositional denotation, the scope results stand no matter which denotation is chosen.

7.2.3 *Summary*

It is a consequence of the linear logic meaning constructors that both wide scope (DE RE) and narrow scope (DE DICTO) readings are available for raised arguments but that only a wide scope reading is available for controllers. The result depends on the linear logic terms in the relevant meaning constructors but not on the meaning language terms. It is therefore unaffected by the choice of a property or propositional denotation for the control verb's complement.

7.3 *Multiple structure sharing*

It has already been demonstrated that structure sharing and resource sensitivity can be reconciled, even if controlled complements denote propositions. In this section I will briefly demonstrate the full generality of the result by examining a case where there is multiple structure sharing, resulting from a control verb embedded under a control verb. It should be evident that other possible permutations are similarly unproblematic.

Let us use the following sentence as our example:

(52) Gonzo promised to try to smile.

Assuming standard lexical entries, we get the following f-structure, where there is a single f-structure *g* that is structure-shared as the subject of the verbs *promise*, *try*, and *smile* (I simplify PRED features from now on by leaving out the subcategorisation information):

(53)
$$p\left[\begin{array}{lll} \text{PRED} & \text{`promise'} & \\ \text{SUBJ} & g\left[\text{PRED} \quad \text{`Gonzo'}\right] & \\ \text{XCOMP} & t\left[\begin{array}{ll} \text{PRED} & \text{`try'} \\ \text{SUBJ} & \\ \text{XCOMP} & s\left[\begin{array}{ll} \text{PRED} & \text{`smile'} \\ \text{SUBJ} & \end{array}\right] \end{array}\right] \end{array}\right]$$

Syntactic analysis yields the meaning constructors in (54). The meaning language side is not indicated, since it follows by the Curry-Howard isomorphism and the linear logic is sufficient to show that a proof exists for sentence (52).

Semantics of the resource sensitivity of linear logic to a linguistically motivated proof goal (Asudeh 2004).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

(54) 1. g Lex. **Gonzo**
2. $g \multimap (g \multimap t) \multimap p$ Lex. **promised**
3. $g \multimap (g \multimap s) \multimap t$ Lex. **try**
4. $g \multimap s$ Lex. **smile**

The proof is shown in (55). The intermediate dependency on g by *try* is discharged via assumption. This assumption is then used to construct the dependency on t that *promise* needs to consume. The matrix control verb then consumes the one lexically contributed instance of g and consumes the dependency $g \multimap t$ to yield the semantics for the sentence.

(55)

$$\dfrac{\mathbf{g} \qquad \dfrac{\mathbf{g} \multimap (\mathbf{g} \multimap \mathbf{t}) \multimap \mathbf{p}}{(g \multimap t) \multimap p}\,{\multimap}\varepsilon \qquad \dfrac{\dfrac{[g]^1 \qquad \mathbf{g} \multimap (\mathbf{g} \multimap \mathbf{s}) \multimap \mathbf{t}}{(g \multimap s) \multimap t}\,{\multimap}\varepsilon \qquad \mathbf{g} \multimap \mathbf{s}}{t}\,{\multimap}\varepsilon}{g \multimap t}\,{\multimap}\mathcal{I},1}{p}\,{\multimap}\varepsilon$$

The combinatorics of control as specified by linear logic terms in meaning constructors thus generalise properly to cases of multiple structure sharing.

8. Finite control

Thus far I have concentrated on showing that the apparent resource deficit arising from syntactic structure sharing can be reconciled with resource-sensitive semantic composition. In this section, I discuss how obligatory control of a finite complement gives rise to a problem of RESOURCE SURPLUS. I concentrate on finite control in Serbo-Croatian, but finite control is in fact an areal feature of Balkan languages in general. In addition to Serbo-Croatian, it is found in Modern Greek, Albanian, Romanian, Macedonian, and Bulgarian (Rivero & Ralli 2001). These languages are spoken in neighbouring geographic areas, but are not closely related genetically, except for Macedonian and Serbo-Croatian. Finite control is also the kind of control found in the non-Balkan language Persian (Hashemipour 1989, Ghomeshi 2001). Persian and the Balkan languages share the typological property of lacking true clausal infinitives. I offer a solution to the resource surplus problem and consider the solution's typological implications.

8.1 *Equivalences between the semantics of finite and nonfinite conrol*

Zec (1987) discusses obligatory control in Serbo-Croatian, as exemplified by the following sentence:

(56) Jovan je pokušao da dodje.
Jovan AUX tried that come(PRES)
'Jovan tried to come.' (Zec 1987: 142)

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

The complement to the matrix verb *pokušao* is clearly not a subjectless VP or IP. First, there is an overt complementiser, indicating that this is a CP. Second, Zec argues that there is demonstrably a null pronominal subject in the embedded clause, so there is an f-structure SUBJ. Furthermore, the CP complement is finite, since it is fully inflected for tense and agreement information. Control in Serbo-Croatian thus involves a finite CP complement with a null pronominal subject.

Pokušao nevertheless involves a relationship of obligatory control between its subject and the pronominal subject of its complement. Despite differences in the syntactic realisation of the control relation, there is evidence that the semantics of finite control matches that of English nonfinite obligatory control. The key piece of evidence concerns an inference pattern initially presented by Chierchia (1984a, b) for English:

(57) Nando tries anything Ezio tries.

Ezio tries to jog at sunrise.

Nando tries to jog at sunrise

Crucially, Serbo-Croatian control verbs participate in inferences like this. Zec (1987) shows that (58a) and (58b) together entail (58c).

(58) (a) Petar je pokušao sve što je pokušao Jovan
Petar AUX tried all that AUX tried Jovan
'Petar tried whatever Jovan tried.' (Zec 1987: 144, (16a))

(b) Jovan je pokušao da postane predsednik.
Jovan AUX tried that become president
'Jovan tried to become president.' (Zec 1987: 144, (16b))

(c) Petar je pokušao da postane predsednik.
Petar AUX tried that become president
'Petar tried to become president.' (Zec 1987: 145, (18))

The fact that the same inference pattern holds for infinitival control in English and for finite control in Serbo-Croatian strongly indicates that the two cases should have a unified semantic analysis.

The precise denotation of the controlled complement once again remains open to debate, though. Chierchia (1984a, b) uses the inference pattern in (57) to argue for the property theory of control. If the denotation of the control verb's complement in *Ezio tries to jog at sunrise* is a proposition, *jog*(*ezio*) (ignoring the modifier), then the predicted denotation of the conclusion is *try*(*nando, jog*(*ezio*)), which is not an available meaning for the conclusion of (57) and is therefore incorrect. However, if the relevant denotation is instead the unsaturated property of jogging, *jog*, then the conclusion is that Nando also bears the relation of trying to this property, i.e. *try*(*nando, jog*).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

Zec (1987) argues for a different conclusion on the basis of the Serbo-Croatian data. Working from the assumption that a syntactically saturated clause must denote a proposition, she argues that finite control demonstrates that the inference pattern cannot be due to a property denotation for the complement, since then Serbo-Croatian should not allow the conclusion to go through and should only allow a conclusion like the following:

(59) * Petar je pokušao da Jovan postane predsednik.
Petar AUX tried that Jovan become president
'Petar tried for Jovan to become president.' (Zec 1987: 144, (16c))

However, this sentence is ungrammatical, like its English translation. Zec (1987) is part of a larger tradition which seeks to demonstrate that inferences like (57) are available even in cases where the requisite property denotation is unavailable (Higginbotham 1989, 1992; Sag & Pollard 1991; Pollard & Sag 1994; Dalrymple 2001). Although this tradition raises important questions regarding the connection between inference patterns and denotations of controlled complements (see also Ladusaw 1987), the criticism is tempered by the fact that no alternative explanation of inference patterns like (57) is offered.

The crucial point here is not WHAT the semantics of the controlled complement is, but rather that nonfinite and finite controlled complements of corresponding control verbs in English and Serbo-Croatian have the SAME semantics, whatever that is. The corresponding inference patterns indicate that the semantics developed for nonfinite control equally applies to finite control.

Further evidence for shared compositional semantics comes from the fact that control verbs in Serbo-Croatian share with their English counterparts the property of only allowing wide scope (DE RE) readings for the controller:

(60) Vilenjak je pokušao da ustine Petar.
goblin AUX tried that pinch Petar
'A goblin tried to pinch Petar.'

This sentence entails the existence of a goblin, just like its English translation.

In present terms, these arguments indicate that the analysis of control in section 6, which is compatible with both the propositional and property theories of control and derives the necessity of DE RE readings, also applies to finite control in Serbo-Croatian. I next show the resulting problem of resource surplus, present a solution to the problem, and discuss its implications.

8.2 *Managing resource surplus in finite control*

Recall the Serbo-Croatian sentence (56).

(56) Jovan je pokušao da dodje.
Jovan AUX tried that come(PRES)
'Jovan tried to come.'

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

The f-structure for this sentence, simplifying somewhat, is as follows:

(61)
$$\begin{bmatrix} \text{PRED} & \text{'try'} \\ \text{SUBJ} & j\begin{bmatrix}\text{PRED} & \text{'Jovan'}\end{bmatrix} \\ \text{COMP} & p\begin{bmatrix} \text{PRED} & \text{'come'} \\ \text{SUBJ} & d\begin{bmatrix}\text{PRED} & \text{'pro'}\end{bmatrix} \\ \text{TENSE} & \text{present}\end{bmatrix} \\ \text{TENSE} & \text{past}\end{bmatrix}$$

The f-structure has been labelled according to the Serbo-Croatian words in (56), except for the embedded subject, labelled *pro*. Notice that the complement of the control verb bears the closed grammatical function COMP and that there is no functional control relation between the matrix subject and the embedded, pronominal subject.

The lexical entry for the verb *dodje* 'come' is as follows:

(62) *dodje*: V

$$(\uparrow \text{PRED}) = \text{'come'}$$

$$(\uparrow \text{TENSE}) = \text{PRES}$$

$$come : (\uparrow \text{SUBJ})_{\sigma_c} \multimap \uparrow_{\sigma_t}$$

$$\left(\begin{array}{l} (\uparrow \text{SUBJ PRED}) = \text{'pro'} \\ \lambda z.z \times z : \\ ((\uparrow \text{SUBJ})_{\sigma} \ \text{ANTECEDENT})_e \multimap \\ \quad [((\uparrow \text{SUBJ})_{\sigma} \ \text{ANTECEDENT})_e \otimes (\uparrow \text{SUBJ})_{\sigma_c}] \end{array} \right)$$

The entry for *dodje* is fully general, not just for a controlled complement. The verb optionally specifies its SUBJ PRED as 'pro', since Serbo-Croatian is a pro-drop language. This is standard in LFG analyses of pro-drop, which do not posit a null pronominal subject in c-structure (Bresnan 2001). When the null pronominal subject is contributed by the verb, its semantics is also contributed, in the form of the final meaning constructor. This meaning constructor involves linear conjunction ($\otimes$) and is a standard pronominal meaning constructor (Asudeh 2004). It is discussed in further detail below.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

The full set of lexically contributed meaning constructors for (56) are shown in (63), instantiated to the f-structure (61) in the usual manner.[18] Unlike the entry for *try* in (30) in section 6.1 above, the control verb *pokušao* has two meaning constructors. We will return to this difference below.

(63) 1. $jovan : j$ Lex. **Jovan**
2. $\lambda w \lambda P.try(w, P) : j \multimap (pro \multimap d) \multimap p$ Lex. **pokušao**
3. $\lambda P \lambda x.x : (j \multimap (j \otimes pro)) \multimap (j \multimap j)$ Lex. **pokušao**
4. $come : pro \multimap d$ Lex. **dodje**
5. $\lambda z.z \times z : j \multimap (j \otimes pro)$ Lex. **dodje**

A fuller lexical entry for the control verb is shown here:

(64) *pokušao*: V
$(\uparrow \text{PRED}) = \text{`try'}$
$(\uparrow \text{SUBJ})_\sigma = ((\uparrow \text{COMP SUBJ})_\sigma \text{ ANTECEDENT})$

$\lambda y \lambda P.try(y, P)$:
$(\uparrow \text{SUBJ})_{\sigma_e} \multimap [(\uparrow \text{COMP SUBJ})_{\sigma_e} \multimap (\uparrow \text{COMP})_{\sigma_t}] \multimap \uparrow_{\sigma_t}$

$\lambda P \lambda x.x$:
$[(\uparrow \text{SUBJ})_{\sigma_e} \multimap [(\uparrow \text{SUBJ})_{\sigma_e} \otimes (\uparrow \text{COMP SUBJ})_{\sigma_e}]] \multimap$
$[(\uparrow \text{SUBJ})_{\sigma_e} \multimap (\uparrow \text{SUBJ})_{\sigma_e}]$

First, notice that the meaning language side of the initial, principal meaning constructor treats the denotation of the controlled complement as a property, despite the fact that the the complement is a CP with a contentful null pronominal subject. We could once again have the propositional denotation instead by replacing just the meaning language side of this meaning constructor with:

(65) $\lambda y \lambda P.try(y, P(y))$

Second, notice that this is an instance of obligatory anaphoric control (Andrews 1982, Bresnan 1982a, Zec 1987, Dalrymple 2001): the control verb contains a binding equation that states that the controller is the antecedent of the null pronominal control target. Control is thus established through pronominal binding rather than structure sharing.

Let us further contrast the principal meaning constructor of *pokušao* with the meaning constructor for *try*, which is repeated from (30):

(66) *try*
$(\uparrow \text{SUBJ})_{\sigma_e} \multimap [(\uparrow \text{XCOMP SUBJ})_{\sigma_e} \multimap (\uparrow \text{XCOMP})_{\sigma_t}] \multimap \uparrow_{\sigma_t}$

(67) *pokušao*
$(\uparrow \text{SUBJ})_{\sigma_e} \multimap [(\uparrow \text{COMP SUBJ})_{\sigma_e} \multimap (\uparrow \text{COMP})_{\sigma_t}] \multimap \uparrow_{\sigma_t}$

[18] I make the simplifying assumption that the auxiliary *je* and the complementiser *da* make no contribution, although they would make contributions to the syntax and semantics of tense and mood in a fuller treatment.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

There is a key similarity in these linear logic terms: Each control verb consumes the entire dependency that corresponds to its controlled complement.

However, consuming the controlled complement's dependency has a different effect in the two cases. Let us zoom in on the part of each meaning constructor that consumes the dependency. In the case of *try*, the dependency in question is $[(\uparrow \text{XCOMP SUBJ})_\sigma \multimap (\uparrow \text{XCOMP})_\sigma]$. The case for *pokušao* is slightly different. Its clausal complement is a COMP, not an XCOMP, because the complement has its own subject rather than the subject being structure-shared with another grammatical function by functional control. Thus, the dependency that *pokušao* consumes is $[(\uparrow \text{COMP SUBJ})_\sigma \multimap (\uparrow \text{COMP})_\sigma]$. In neither case is the analysis non-compositional: the control verb makes reference to its complement's subject only to identify the complement; the verb does not manipulate or compose with the complement's subject.

This raises an important difference between the two verbs, which is shown schematically in the following meaning constructors. The key difference is that the infinitival control verb's subject resource is identified with that of its complement's subject, whereas this is not the case for the finite control verb:

(68) *try*

$$\underbrace{a \multimap (a \multimap c)} \multimap v$$

(69) *pokušao*

$$\underset{\lceil____\rfloor}{a} \multimap (b \multimap c) \multimap v$$

In the English control verb, there is a double dependency on the resource contributed by the matrix subject (indicated schematically as a), which functionally controls the embedded subject. By consuming the matrix subject and then consuming its complement's implicational ($a \multimap c$) resource, the control verb manages all the required resources: the subject resource a is used once.

In contrast, the Serbo-Croatian control verb does not have a double dependency on the matrix subject. When it consumes its complement's implicational resource ($b \multimap c$) there is still a resource left over: the resource b contributed by the complement's subject, a null pronoun. This may not be clear at first, because schematically the pronoun's meaning constructor is:

(70) $A \multimap (A \otimes P)$

A is the pronoun's antecedent's resource and P is the pronoun's resource. Consider what this meaning constructor does. It consumes a copy of the pronoun's antecedent, which is specified to be the matrix subject, to give back another copy of the antecedent and a resource corresponding to the pronoun. This is a VARIABLE-FREE treatment of the pronoun (Jacobson 1999).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

It ensures that the pronoun takes the same value as its antecedent (Asudeh 2004).[19] The control verb will consume the resource corresponding to the matrix subject, but since the control verb also consumes the controlled complement's dependency on the pronominal resource (to get the complement's property), there seems to be nothing left to consume the pronominal resource.

This is where the second meaning constructor in the entry for *pokušao* comes in. The meaning constructor is repeated here:

(71) $\lambda P \lambda x.x$:
$[(\uparrow \text{SUBJ})_{\sigma_e} \multimap [(\uparrow \text{SUBJ})_{\sigma_e} \otimes (\uparrow \text{COMP SUBJ})_{\sigma_e}]] \multimap$
$[(\uparrow \text{SUBJ})_{\sigma_e} \multimap (\uparrow \text{SUBJ})_{\sigma_e}]$

This meaning constructor is a MANAGER RESOURCE, as discussed for resumptive pronouns and copy raising (e.g. *Richard seems like he's ill*) by Asudeh (2004, 2002b). Manager resources deal with a resource surplus that arises from an extra pronominal resource and form an integral part of the general theory of resumption presented in Asudeh (2004).

A manager resource identifies and consumes a pronominal function of the kind outlined in (70) above. The schematic form of a manager resource's meaning constructor is shown in (72), where P is a pronoun and A is the pronoun's antecedent.

(72) $\lambda P \lambda x.x$: $(A \multimap (A \otimes P)) \multimap (A \multimap A)$

The manager resource consumes a functional pronominal resource and in the meaning language side disposes of it via vacuous abstraction. The pronoun therefore does not contribute to the semantics. The consequent of the manager resource's main implication is a modifier on the pronoun's antecedent $(A \multimap A)$. A manager resource, a pronoun and the pronoun's antecedent together yield just the antecedent, as if the pronoun had been absent:

(73)
$$\dfrac{[ant] : A \qquad \dfrac{[pro] : A \multimap (A \otimes P) \qquad [manager] : (A \multimap (A \otimes P)) \multimap (A \multimap A)}{(A \multimap A)} \multimap_{\mathcal{E}}}{A}$$

In this case, the manager resource consumes the pronominal function of the controlled complement's subject, the control target. The manager resource relies on the fact that the subject of the control verb has been identified as the control target's antecedent. The instantiated manager resource for sentence (56) is repeated here from (63).

[19] This is a simplified account of pronominal binding which only accounts for intrasentential and bound variable binding. There are dynamic versions of Glue that handle contextual update (Crouch & van Genabith 1999), donkey anaphora (van Genabith & Crouch 1999), and intersentential anaphora (Crouch & van Genabith 1999, Dalrymple 2001, Kokkonidis 2003).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

(74) $\lambda P \lambda x.x\colon (j \multimap (j \otimes pro)) \multimap (j \multimap j)$

The antecedent of the main implication in the manager resource's linear logic term corresponds to the term for the pronominal function contributed by the pronoun in (63) above, repeated here:

(75) $j \multimap (j \otimes pro)$

The following proof demonstrates composition for finite control as exemplified by the Serbo-Croatian sentence (56).

(76)
$$\dfrac{\mathbf{j} \quad \dfrac{\mathbf{j} \multimap (\mathbf{j} \otimes \mathbf{pro}) \qquad (\mathbf{j} \multimap (\mathbf{j} \otimes \mathbf{pro})) \multimap (\mathbf{j} \multimap \mathbf{j})}{\mathbf{j} \multimap \mathbf{j}}\,{\multimap}\varepsilon \qquad \dfrac{j \qquad \mathbf{j} \multimap (\mathbf{pro} \multimap \mathbf{d}) \multimap \mathbf{p}}{(pro \multimap d) \multimap p}\,{\multimap}\varepsilon \qquad \mathbf{pro} \multimap \mathbf{d}}{p}\,{\multimap}\varepsilon$$

This is a proof for a subject control verb with a finite complement, where the complement has a pronominal subject that is the control target. Notice that the subproof ending in the italicised *j* (the first three lines) is formally identical to proof (73). Also, the final three lines of the proof are formally identical to the proof in (34) above for a subject control verb with an infinitival complement. Thus, once the manager resource has disposed of the pronoun, the finite control proof is just like the proof for an English-type control verb. The proof with added meaning terms is shown in figure 1. Although the control verb is shown with a property complement, a propositional complement just requires replacing the control verb's meaning term with the meaning term in (65), as discussed above.

The manager resource is motivated because the pronoun can only be bound by the controlling subject. In effect, it is not contributing a normal pronominal meaning, but is rather part of a mechanism that is employed in certain languages, including finite control languages, to establish a syntactic relation mediated by pronominal binding.[20] We can think of the manager resource as going hand in hand with the anaphoric control equation, just as the embedded verb's contribution of its null subject goes hand in hand with the contribution of a meaning constructor for that subject. The control verb's principal meaning constructor, which gives the semantics of the control verb, is similar to the meaning constructor for the control verb *try* in English, a language that uses functional control in the syntax. In both cases, the matrix subject is consumed to yield an implication that consumes the entire clausal complement to yield the semantics of the outer f-structure and thus the sentence. The typological difference between obligatory anaphoric

[20] It has also been argued, based on case-marking facts, that nonfinite control in Icelandic is obligatory anaphoric control (Andrews 1982).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

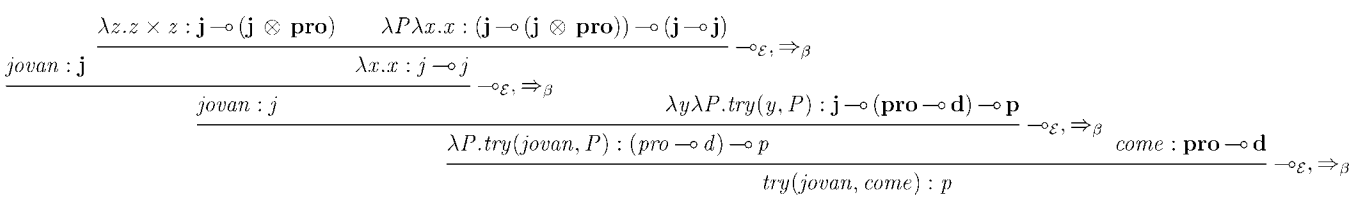


Figure 1
Proof with meanings for *Jovan je pokušao da dodje*

control and functional control in the syntax is reflected by a difference in the linear logic, while allowing the same denotation in the meaning language, or semantics proper.

Although there is a null pronominal subject in the clausal control complement, the present analysis essentially proposes that it is only there to maintain the obligatory syntactic relationship between the controller and the controllee. Thus, the analysis further validates current research on typological variation in the syntactic mechanisms used to establish control relationships (Landau 2000, Wurmbrand 2001). English uses functional control for at least some control verbs, while other languages, such as Serbo-Croatian, uniformly use obligatory anaphoric control. There is a further typological distinction in terms of finiteness of the complement: the Balkan languages have finite controlled complements, whereas English and many other languages have infinitival controlled complements. The differences in the syntactic mechanisms are reflected in Glue Semantics, but it is still possible for the controlled clausal complements to have the same denotation, no matter which syntactic mechanism the grammar of a language employs. Therefore, there is a separation of syntax and semantics, although there is a systematic relationship between the two. There can be typological differences in one, without there necessarily being differences in the other.

Finite control has been analysed as a case of resource surplus requiring extra resource management. As mentioned above, the manager resources involved in this analysis of finite control are also involved in analyses of copy raising, as exemplified by (77).

(77) Gonzo seems like he's having a good time.

Asudeh (2002b, 2004) argues that the syntax of English copy raising should be assimilated to predicative raising, as in (78), with the *like*-complement analysed as a predicate PP.

(78) Gonzo seems happy.

The manager resource contributed by the copy raising verb ensures that there must be a pronominal bound by the matrix subject in the copy raising verb's complement, for reasons of semantic composition. This correctly predicts the ungrammaticality of:

(79) *Gonzo seems like Andrew's having a good time.

The manager resource theory of finite control thus not only relates infinitival control to finite control, it also points to a deeper connection between control and raising. Just as infinitival control and raising are related by the underlying syntactic mechanism of functional control, finite control and copy raising are related by the underlying mechanisms of anaphoric binding and manager resources. Manager resources thus provide a focal point

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

for further explorations of the relationship between control and raising in non-infinitival guises.

9. Obligatory anaphoric control and functional control

The previous section showed that finite control, which involves a syntactic relation of obligatory anaphoric control, constitutes a case of resource surplus. This contrasts with the syntactic relation of functional control used to model nonfinite control in section 2. The structure sharing resulting from functional control potentially leads to the contrasting problem of resource deficit. A valid question to ask is whether functional control in fact is appropriate for English nonfinite control. Perhaps nonfinite control is also a case of obligatory anaphoric control. A proposal along these lines has recently been made by Dalrymple (2001: 313–348), who argues that the complement of English control verbs is a COMP with a null pronominal subject that is obligatorily anaphorically controlled by an argument of the control verb.

If English nonfinite control does not involve functional control, there is no syntactic structure sharing and therefore no potential conflict with semantic resource sensitivity. This could just mean that an analysis similar to the one for finite control should be extended to nonfinite control in English. However, the finite control analysis was itself motivated with respect to the analysis that sought to reconcile structure sharing and resource sensitivity. If the motivation for the latter analysis is removed, then a good part of the motivation for the resource management analysis of finite control is also removed.

From a cross-linguistic point of view there seems to be clear evidence for control as functional control. For example, Kroeger (1993: 97–102) shows that differences between classes of control verbs in Tagalog can be explained if some control relations in Tagalog are represented as functional control and others as anaphoric control. Similar arguments are discussed for other languages in Andrews (1982) and Bresnan (1982a). However, since the proposals in this paper are motivated on the basis of English, it is necessary to show that there are English control verbs that involve functional control as opposed to obligatory anaphoric control. I will argue in this section that this is indeed the case: at least some control verbs in English, such as *try*, should be analysed as involving functional control. Furthermore, I will show that certain tests that Dalrymple (2001) applies do not properly individuate open XCOMP complements that require functional control from closed COMP complements that disallow functional control.

Bresnan (1982a: 396–398) shows that it follows from the distinction between functional control and anaphoric control that the latter allows split antecedents whereas the former does not. Since functional control involves structure sharing, it is not possible for multiple arguments to functionally control the same target without the controlling arguments also being

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

illicitly equated. There is thus no way for separate nominals to control the same controllee via functional control. This is not the case for anaphoric control: the controlled pronoun can in principle have split antecedents just like other pronouns. Obligatory anaphoric control, which requires that the controller is the antecedent of the null pronominal control target, is therefore not exhaustive enough and does not necessarily preclude the controller being just part of a plural antecedent. This is not possible for *try*, though:

(80) The geneticist said that the paleontologist tried to clone dinosaurs.
(Falk 2001: 143, (60b))

In (80) the subject of *clone* is the paleontologist and cannot be both the geneticist and the paleontologist together. Obligatory anaphoric control does not straightforwardly predict this. Functional control, on the other hand, predicts that the subject of *try* must EXHAUSTIVELY control the subject of its complement (Landau 2000).

The related phenomenon of PARTIAL CONTROL (Landau 2000) provides further evidence for the claim that the control relation for some control verbs must be exhaustive. Partial control is demonstrated by a controlled complement that is headed by a collective predicate (Landau 2000):

(81) The chair preferred to gather in the afternoon.

The chair must be one of the people gathering, but s/he clearly cannot be the only one, since *gather* is a collective predicate. The sentence is ungrammatical if *tried* is substituted for *preferred*:

(82) *The chair tried to gather in the afternoon.

Again this shows that the subject of *try* must exhaustively control the subject of the complement. The exhaustivity of control is predicted by functional control. Obligatory anaphoric control does not explain why it is not possible for the subject of *try* to just be one member of the group subject.

Although the distinction between partial control and exhaustive control supports a functional control analysis for exhaustive control, it might seem that partial control itself involves obligatory anaphoric control. However, functional control actually accounts for partial control better than anaphoric control does. Landau (2000) observes that although a partial control verb such as *prefer* licenses semantic plurality on its control target, thus allowing collective predicates and modifiers in the complement, the control target is not syntactically plural and does not license plural agreement or plural anaphors:

(83) (a) John told Mary that he preferred to meet at 6 today.
(b) *John told Mary that he preferred to meet each other at 6 today.
(Landau 2000: 7, (23a–b))

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

In addition, it is not possible for a semantically plural controller to control a semantically singular control target, even if the controller includes the target:

(84) (a) The committee was glad that the chair had agreed to gather before the elections.
(b) *The chair was glad the committee had agreed to wear a tie.
(Landau 2000: 7, (25a–b))

Note that (84) is to be construed with the chair as the chair of the committee.

This data is not predicted by obligatory anaphoric control. If the control target is a pronoun whose reference includes the controller, then it naturally leads to the prediction that the pronoun is plural, since this is the normal result of referential inclusion. Obligatory anaphoric control certainly does not predict that the control target must be singular, like its antecedent. Functional control, on the other hand, predicts that the control target must be syntactically singular if the controller is singular, because it is the very same syntactic element that serves both functions.

This argument for functional control is only compelling if the mechanism can still account for the facts about the possibility of semantic plurality in partial control complements. In fact, functional control permits a simple lexical analysis of partial control that captures the requisite facts using only the analysis of control already developed in this paper and a standard semantics for plurals. Let us assume that the entity type, e, has two subtypes:

(85) (a) e_s is the type of singular entities
(b) e_p is the type of plural entities
(c) $e = e_s \cup e_p$

This is compatible with a variety of theories of plural semantics, but for concreteness I will here adopt a standard lattice-theoretic analysis (Link 1995).

The requirement that a collective predicate such as *gather* have a plural subject can then be enforced by assigning it the type $\langle e_p, t \rangle$. Using the convention of assigning capital variables to e_p, the meaning constructor for *gather* would then be $\lambda X.gather\,(X)$: $(\uparrow_{\text{SUBJ}})_\sigma \multimap \uparrow_\sigma$. The meaning constructor for the partial control verb *prefer* can then be specified as follows:

(86) $\lambda x \lambda P.\exists y[prefer\,(x, P(y)) \wedge x \sqsubseteq y]$:
$(\uparrow_{\text{SUBJ}})_\sigma \multimap [(\uparrow_{\text{XCOMP SUBJ}})_\sigma \multimap (\uparrow_{\text{XCOMP}})_\sigma] \multimap \uparrow_\sigma$

The partial control verb's linear logic for semantic composition is exactly like that of the exhaustive control verb *try* (see section 6), but the meaning language makes the additional statement that the controller is either equal to or a part of the control target. This allows the complement of the partial control verb to be either a semantically singular or plural predicate. An exhaustive control verb, in contrast, lacks the specification of the

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

inclusion relation and therefore does not permit a semantically plural complement unless the controller is itself plural. The inclusion relation in the lexical specification of the partial control shown in (86) holds only in one direction: the controller can be included in the control target, but not vice versa. This immediately accounts for the contrast in (84) above. Lastly, notice that partial control is most straightforwardly compatible with a propositional denotation for the controlled complement, since a statement needs to be made about the relation between the controller and the subject of the complement. However, it has already been demonstrated that functional control is compatible with the propositional denotation.

Functional control therefore captures the behaviour of various English control verbs, including both exhaustive and partial control verbs, better than anaphoric control. Along with the cross-linguistic support for functional control, there is ample evidence that the problem of structure sharing and resource sensitivity in control is a valid one. This in turn means that an analysis based on a solution to this problem, such as the one offered here, is well-motivated.

9.1 *Open and closed complements*

Another part of Dalrymple's (2001) argument for obligatory anaphoric control in English is based on putative evidence that the infinitival complement bears the grammatical function COMP. This is consistent with the obligatory anaphoric control analysis, since the COMP is saturated by the controlled null pronominal, but it is inconsistent with the functional control analysis, which standardly requires an open XCOMP complement. Dalrymple's (2001) argument for English control taking a closed COMP function comes from evidence that Jacobson (1990) provides:

1. Raising verbs cannot undergo VP Complement Drop of their infinitival complement whereas at least some control verbs can.
(Jacobson 1990: 438–445)

(87) * Bill seems to be obnoxious, but I don't think that Sam seems.
(Jacobson 1990: 440, (23))

(88) John tried to take out the garbage, and I think that Bill also tried.
(Jacobson 1990: 439, (21))

2. The infinitival complement of raising verbs cannot be fronted whereas the infinitival complement of at least some control verbs can be.

(89) *To be nice, he seems. (Jacobson 1990: 449, (49))

(90) To win, I will try. (Jacobson 1990: 449, (47))

Dalrymple (2001: 317–326) analyses this difference in LFG terms as having to do with whether the complement is an XCOMP, as in raising, or a COMP, as in

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

control (on her theory): an XCOMP cannot undergo VP Complement Drop or extraction whereas a COMP can.[21]

However, whatever these tests reveal about raising and control, the distinction cannot be reduced to the XCOMP/COMP distinction. There are raising complement XCOMPS, such as the adjectival one in (91), that can be extracted and there are controlled complements that cannot be extracted, as in (92).

(91) Nice, he seems. (Jacobson 1990: 451, (55a))
(92) *To make a fuss, I will threaten.

These examples are not predicted if COMPS can front but XCOMPS cannot. Furthermore, there is little agreement in the literature on the status of even supposedly grammatical fronting of controlled complements as in (90). Jacobson (1990: 449) herself notes that some speakers find the extractions marginal even for control verbs. Radford (2004: 88, (52c)) simply presupposes that the structurally identical and pragmatically more plausible *To give up smoking, I will certainly try* is ungrammatical.

It seems to be true that raising verbs' XCOMPS resist VP Complement Drop, but non-VP predicative XCOMPS can be dropped:

(95) Kim is crazy, but Sandy isn't.

Furthermore, there are control verbs that cannot undergo VP Complement Drop:

(94) *John attempted to leave, but I don't think that Bill attempted.
(Jacobson 1990: 439, (22))

The fact that *attempt* cannot undergo VP Complement Drop but that *try* can is telling, given that the two are extremely close analogues, both in terms of meaning and in terms of syntactic subcategorisation. It casts doubt on these tests as deep probes of syntax and semantics. More importantly, for present purposes, it shows that English control cannot be uniformly obligatory anaphoric control. Even if Jacobson's tests as applied to LFG indicate a

[21] Jacobson's (1990) third test – that a raising verb cannot take an NP or PP complement – is factually incorrect, since raising verbs can in fact take a restricted subclass of PP complements (Maling 1983) and can even take predicative indefinite NPs:

(i) John seems out of his mind.
(ii) It seems a nice page.

http://www.muddlepuddle.co.uk/autumnbandwidthnickerfix/halloween.htm (checked 28/09/2004)

The NP example is probably dialectal, but nevertheless corpus and internet searches reveal it to be quite robust. These examples are in fact a problem for a theory of raising that predicts from the lack of subcategorised VP complements for raising predicates that 'there is no possible synonymous variant where this argument slot is replaced by an NP or PP argument slot' (Jacobson 1990: 448).

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

distinction between XCOMP and COMP, then at least some control verbs must involve functional control, by Dalrymple's (2001) own criteria.

9.2 *Summary*

Evidence from exhaustive and partial control supports a functional control analysis of English nonfinite control over an obligatory anaphoric control analysis. In addition, the putative evidence that English control verbs take closed COMP complements, which would support an obligatory anaphoric control analysis, is problematic. The tests in question do not properly distinguish open, functionally controlled XCOMPS from COMPS. In sum, the potential conflict between structure sharing and resource sensitivity is a genuine problem. There is thus support for the present analysis of nonfinite control and its extension to finite control.

10. Conclusion

Syntactic structure sharing of the kind exhibited by control and raising seems initially to be at odds with semantic resource sensitivity. Raising is unproblematic, though, because the shared resource is consumed in the semantics by only one of its syntactic hosts. Similarly, if the property denotation of controlled complements is maintained, the complement does not take the control target as a direct semantic argument. However, if the complement denotes a proposition there are two semantic consumers of a single resource corresponding to the structure-shared grammatical function, which is potentially problematic.

The analyses developed in this paper ultimately rest on a conception of grammar that involves structure sharing in grammatical structures, where structure sharing can be understood more generally as token identity. This is a common current conception of grammar, found in both transformational and non-transformational work, as discussed in the introduction. However, it is not the only possible conception. Blevins (to appear) argues in a recent paper that there is in fact no explicit empirical motivation for token identity in grammatical structures. He proposes instead that there is only type identity in the structures, with token identity found only in the constraint language that describes them. The proposals made here would potentially be affected by this move: functional control would then only involve token identity in the constraint language and would involve type identity in f-structures. If the syntax–semantics mapping is not adjusted, then there would be no problem of resource deficit and instead potentially only a problem of resource surplus.

The alternative, non-structure-sharing view of grammar deserves further study and its impact on the present work should be explored in the future, if the alternative view proves preferable. There are at least a couple of

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

problems that arise on preliminary consideration, though. First, it is not clear in what sense there could be EMPIRICAL evidence for token identity in the constraint language either. The argument for type identity over token identity rests on the premise that the former is somehow simpler or theoretically superior. However, it has not been demonstrated that having identity in the constraint language instead of in the actual structures is in fact simpler or indeed leads to any substantive differences. Second, if the syntax–semantics mapping is left unadjusted, then type identity in grammatical structures leads to the problem of deciding which of the type-identical syntactic elements to interpret semantically. This leads to problems in interpretation of phenomena like raising and filler–gap dependencies, which are straightforward on the token identity view. For example, in the case of raising there would be two instances of a type-identical subject: one is the raising verb's subject and the other is the raising target's subject. Only one of these should be interpreted, given the semantics of raising, but presumably both of the two separate syntactic elements would have to make semantic contributions. Therefore, one of the elements' semantic contributions must be discarded. In contrast, on the token identity view there is only the one token-identical element that can be interpreted and the issue of which element to interpret simply does not arise. The problem is obviously further compounded in cases that currently involve multiple token identity. Thus, the move to type identity in grammatical structures not only necessitates a complete rethinking of the syntax–semantics interface, but also initiates an ongoing debate about which of the type-identified elements is the one to be semantically interpreted in a large number of phenomena. These could be viewed as either features or bugs, depending on one's perspective.

This paper has demonstrated that the standard approach, with structure sharing in syntactic structures, can in fact be reconciled with resource sensitivity, even in the case of a propositional theory of control. I showed that the same Glue combinatorics can in fact yield either a property- or proposition-denoting semantics for the controlled complement. The analysis is therefore adaptive and does not rely on a particular semantics for control. Furthermore, I showed that the linear logic combinatorics of the analysis suffice to capture empirical generalisations about expletives and scope and that the analysis generalises properly in cases of multiple structure sharing.

Structure sharing in control was understood in terms of resource deficit: there were apparently not enough resources to satisfy resource sensitivity. I showed that finite control demonstrates the opposite problem of resource surplus. Based on the evidence that finite and nonfinite control have comparable compositional semantics, the obligatorily controlled null pronominal in finite control must not saturate the property corresponding to the finite controlled complement. The manager resources proposed in my recent Glue Semantics analysis of copy raising (Asudeh 2004) were used to remove the pronoun from composition, thus yielding a property denotation for the

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

finite complement. Finite control can therefore be seen as the control analogue of copy raising. The analysis has typological implications for control mechanisms and extends the relation between control and raising in a new dimension.

REFERENCES

Andrews, A. (1982). The representation of case in Modern Icelandic. In Bresnan (ed.), 427–503.

Asudeh, A. (2000). Functional identity and resource-sensitivity in control. In Butt, M. & King, T. H. (eds.), *Proceedings of the LFG00 Conference*. Stanford, CA: CSLI Publications. 2–24.

Asudeh, A. (2002a). A resource-sensitive semantics for equi and raising. In Beaver, D., Kaufmann, S., Clark, B. & Casillas, L. (eds.), *The construction of meaning*. Stanford, CA: CSLI Publications. 1–21.

Asudeh, A. (2002b). Richard III. In Andronis, M., Debenport, E., Pycha, A. & Yoshimura, K. (eds.), *CLS 38: The main session* (vol. 1). Chicago: Chicago Linguistic Society. 31–46.

Asudeh, A. (2004). *Resumption as resource management*. Ph.D. dissertation, Stanford University.

Asudeh, A. & Crouch, R. (2002). Glue Semantics for HPSG. In van Eynde, F., Hellan, L. & Beermann, D. (eds.), *Proceedings of the 8th International HPSG Conference*. Stanford, CA: CSLI Publications. 1–19.

Barwise, J. & Cooper, R. (1981). Generalized quantifiers and natural language. *Linguistics and Philosophy* **4**. 159–219.

Blevins, J. P. (to appear). Feature-based grammar. In Borsley, R. D. & Börjars, K. (eds.), *Nontransformational syntax: a guide to current models*. Oxford: Blackwell.

Boeckx, C. & Hornstein, N. (2003). Reply to 'Control is not movement'. *Linguistic Inquiry* **34**. 269–280.

Boeckx, C. & Hornstein, N. (2004). Movement under control. *Linguistic Inquiry* **35**. 431–452.

Bouma, G., Malouf, R. & Sag, I. A. (2001). Satisfying constraints on extraction and adjunction. *Natural Language & Linguistic Theory* **19**. 1–65.

Bresnan, J. (1982a). Control and complementation. *Linguistic Inquiry* **13**. 343–434.

Bresnan, J. (ed.) (1982b). *The mental representation of grammatical relations*. Cambridge, MA: MIT Press.

Bresnan, J. (2001). *Lexical-functional syntax*. Oxford: Blackwell.

Carpenter, B. (1997). *Type-logical semantics*. Cambridge, MA: MIT Press.

Chierchia, G. (1984a). Anaphoric properties of infinitives and gerunds. In Cobler, M., MacKaye, S. & Wescoat, M. (eds.), *Proceedings of the Third West Coast Conference on Formal Linguistics*. Stanford, CA: Stanford Linguistics Association. 28–39.

Chierchia, G. (1984b). *Topics in the syntax and semantics of infinitives and gerunds*. Ph.D. dissertation, University of Massachusetts, Amherst.

Chierchia, G. (1990). Anaphora and attitudes DE SE. In Bartsch, R., van Benthem, J. & van Emde Boas, P. (eds.), *Semantics and contextual expressions*. Dordrecht: Foris. 1–32.

Chierchia, G. & Jacobson, P. (1986). Local and long distance control. In Berman, S., Choe, J.-W. & McDonough, J. (eds.), *Proceedings of NELS* **16**. Amherst, MA: GLSA Publications, 57–74.

Chomsky, N. (1981). *Lectures on Government and Binding*. Dordrecht: Foris.

Chomsky, N. (1986). *Knowledge of language: its nature, origin, and use*. New York: Praeger.

Chomsky, N. (1995). *The Minimalist program*. Cambridge, MA: MIT Press.

Crouch, R. & van Genabith, J. (1999). Context change, underspecification, and the structure of Glue Language derivations. In Dalrymple (ed.), 117–189.

Crouch, R. & van Genabith, J. (2000). Linear logic for linguists. Ms., PARC & Dublin City University. [Available at http://www2.parc.com/istl/members/crouch/; checked 10/02/2005.]

Culicover, P. W. & Jackendoff, R. (2001). Control is not movement. *Linguistic Inquiry* **32**. 493–512.

Curry, H. B. & Feys, R. (1958). *Combinatory logic* (vol. 1). Amsterdam: North-Holland.

Dalrymple, M. (ed.) (1999). *Semantics and syntax in Lexical Functional Grammar: the resource logic approach*. Cambridge, MA: MIT Press.

Dalrymple, M. (2001). *Lexical Functional Grammar*. San Diego, CA: Academic Press.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

Dalrymple, M., Gupta, V., Lamping, J. & Saraswat, V. (1999a). Relating resource-based semantics to categorial semantics. In Dalrymple (ed.), 261–280.
Dalrymple, M., Kaplan, R. M., Maxwell, J. T. & Zaenen, A. (eds.) (1995). *Formal issues in Lexical-Functional Grammar*. Stanford, CA: CSLI Publications.
Dalrymple, M., Lamping, J., Pereira, F. & Saraswat, V. (1999b). Overview and introduction. In Dalrymple (ed.), 1–38.
Dalrymple, M., Lamping, J., Pereira, F. & Saraswat, V. (1999c). Quantification, anaphora, and intensionality. In Dalrymple (ed.), 39–89.
Dalrymple, M., Lamping, J. & Saraswat, V. (1993). LFG semantics via constraints. In *Proceedings of the Sixth Meeting of the European ACL*. University of Utrecht: European Chapter of the Association for Computational Linguistics. 97–105.
de Groote, P. (ed.) (1995). *The Curry-Howard isomorphism*. Louvain-la-neuve, Belgium: Academia.
Dowty, D. (1985). On recent analyses of the semantics of control. *Linguistics and Philosophy* **8**. 291–231.
Dowty, D. & Jacobson, P. (1989). Agreement as a semantic phenomenon. In Powers, J. & de Jong, K. (eds.), *Proceedings of the Fifth Eastern States Conference on Linguistics*. Columbus, OH: Ohio State University. 95–101.
Dowty, D. R., Wall, R. E. & Peters, S. (1981). *Introduction to Montague Semantics*. Dordrecht: Kluwer.
Falk, Y. (2001). *Lexical-Functional Grammar: an introduction to parallel constraint-based syntax*. Stanford, CA: CSLI Publications.
Frank, A. & van Genabith, J. (2001). LL-based semantics construction for LTAG – and what it teaches us about the relation between LFG and LTAG. In Butt, M. & King, T. H. (eds.), *Proceedings of the LFG01 Conference*. Stanford, CA: CSLI Publications. 104–126.
Ghomeshi, J. (2001). Control and thematic agreement. *Canadian Journal of Linguistics* **46**. 9–40.
Girard, J.-Y. (1987). Linear logic. *Theoretical Computer Science* **50**. 1–102.
Halvorsen, P.-K. & Kaplan, R. M. (1988). Projections and semantic description in Lexical-Functional Grammar. In *Proceedings of the International Conference on Fifth Generation Computer Systems*. Tokyo: Institute for New Generation Systems. 1116–1122.
Hashemipour, M. M. (1989). *Pronominalization and control in Modern Persian*. Ph.D. dissertation, University of California, San Diego.
Higginbotham, J. (1989). Elucidations of meaning. *Linguistics and Philosophy* **12**. 465–517.
Higginbotham, J. (1992). Reference and control. In Larson, R. K., Iatridou, S., Lahiri, U. & Higginbotham, J. (eds.), *Control and grammar*. Dordrecht: Kluwer. 79–108.
Hornstein, N. (1999). Movement and control. *Linguistic Inquiry* **30**. 69–96.
Howard, W. A. (1980). The formulae-as-types notion of construction. In Seldin, J. P. & Hindley, J. R. (eds.), *To H. B. Curry: essays on combinatory logic, lambda calculus and formalism*. London: Academic Press. 479–490. [Circulated in unpublished form from 1969. Reprinted in de Groote (ed.) (1995), 15–26.]
Jacobson, P. (1990). Raising as function composition. *Linguistics and Philosophy* **13**. 423–475.
Jacobson, P. (1999). Towards a variable-free semantics. *Linguistics and Philosophy* **22**. 117–184.
Kaplan, R. M. (1987). Three seductions of computational psycholinguistics. In Whitelock, P., Wood, M. M., Somers, H. L., Johnson, R. & Bennett, P. (eds.), *Linguistic theory and computer applications*. London: Academic Press. 149–181. [Reprinted in Dalrymple et al. (eds.) (1995), 339–367.]
Kaplan, R. M. (1989). The formal architecture of Lexical-Functional Grammar. In Huang, C.-R. & Chen, K.-J. (eds.), *Proceedings of ROCLING II*. 3–18. [Reprinted in Dalrymple et al. (eds.) (1995), 7–27.]
Kaplan, R. M. & Bresnan, J. (1982). Lexical-Functional Grammar: A formal system for grammatical representation. In Bresnan (ed.) (1982b), 173–281.
Kaplan, R. M. & Zaenen, A. (1989). Long-distance dependencies, constituent structure, and functional uncertainty. In Baltin, M. & Kroch, A. (eds.), *Alternative conceptions of phrase structure*, Chicago: The University of Chicago Press. 17–42. [Reprinted in Dalrymple et al. (eds.) (1995), 137–165.]
Klein, E. & Sag, I. A. (1985). Type-driven translation. *Linguistics and Philosophy* **8**. 163–201.
Kokkonidis, M. (2003). Glue and λDRT for meaning assembly. Ms., Department of Philosophy, King's College, London.

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press

Kokkonidis, M. (2004). First-order Glue. Ms., Meta Research.
Koopman, H. (2000). *The syntax of specifiers and heads*. London: Routledge.
Koopman, H. & Sportiche, D. (1982). Variables and the Bijection Principle. *Linguistic Review* **2**. 139–160. [Reprinted in Koopman (2000), 19–39.]
Kroeger, P. (1993). *Phrase structure and grammatical relations in Tagalog*. Stanford, CA: CSLI Publications.
Ladusaw, W. A. (1987). Inference patterns from infinitival complements. In Crowhurst, M. (ed.), *Proceedings of the West Coast Conference on Formal Linguistics 6*. Stanford, CA: Stanford Linguistics Association. 163–171.
Landau, I. (2000). *Elements of control: structure and meaning in infinitival constructions*. Dordrecht: Kluwer.
Landau, I. (2003). Movement out of control. *Linguistic Inquiry* **34**. 471–498.
Link, G. (1995). Algebraic semantics for natural language: some philosophy, some applications. *International Journal of Human-Computer Studies* **43**. 765–784. [Reprinted in Link (1998), 189–211.]
Link, G. (1998). *Algebraic semantics in language and philosophy*. Stanford, CA: CSLI Publications.
Maling, J. (1983). Transitive adjectives: a case of categorial reanalysis. In Heny, F. & Richards, B. (eds.), *Linguistic categories: auxiliaries and related puzzles*. Dordrecht: Foris. 253–289.
Montague, R. (1974). The proper treatment of quantification in ordinary English. In Hintikka, J., Moravscik, J. & Suppes, P. (eds.), *Approaches to natural language: proceedings of the 1970 Stanford Workshop on Grammar and Semantics*. Dordrecht: Reidel. 221–242.
Moortgat, M. (1997). Categorial type logics. In van Benthem, J. & ter Meulen, A. (eds.), *Handbook of logic and language*. Cambridge, MA: MIT Press. 93–177. [Co-published with Elsevier Science B.V., Amsterdam.]
Morrill, G. (1994). *Type Logical Grammar*. Dordrecht: Kluwer.
Pollard, C. & Sag, I. A. (1994). *Head-driven Phrase Structure Grammar*. Chicago & Stanford, CA: The University of Chicago Press & CSLI Publications.
Postal, P. M. (1970). On coreferential complement subject deletion. *Linguistic Inquiry* **1**. 439–500.
Pullum, G. K. (1982). Syncategorematicity and English infinitival *to*. *Glossa* **16**. 181–215.
Radford, A. (2004). *Minimalist syntax: exploring the structure of English*. Cambridge: Cambridge University Press.
Rivero, M. L. & Ralli, A. (eds.) (2001). *Comparative syntax of Balkan languages*. Oxford: Oxford University Press.
Rosenbaum, P. S. (1967). *The grammar of English predicate complement constructions*. Cambridge, MA: MIT Press.
Sag, I. A. & Pollard, C. (1991). An integrated theory of complement control. *Language* **67**. 63–113.
van Benthem, J. (1988). Strategies of intensionalization. In Bodnár, I., Máté, A. & Pólos, L. (eds.), *Intensional logic, history of philosophy, and methodology: to Imre Ruzsa on the occasion of his 65th birthday*. Budapest: Department of Symbolic Logic, Eötvös University. 41–59.
van Benthem, J. (1991). *Language in action: categories, lambdas, and dynamic logic*. Amsterdam: North-Holland. [Reprinted 1995. MIT Press.]
van Genabith, J. & Crouch, R. (1999). How to glue a donkey to an f-structure. In Bunt, H. & Muskens, R. (eds.), *Computing meaning* (vol. 1). Dordrecht: Kluwer. 129–148.
Wurmbrand, S. (2001). *Infinitives: restructuring and clause structure*. Berlin: Mouton de Gruyter.
Zaenen, A. & Engdahl, E. (1994). Descriptive and theoretical syntax in the lexicon. In Atkins, B. T. S. & Zampolli, A. (eds.), *Computational approaches to the lexicon*. Oxford: Oxford University Press. 181–212.
Zec, D. (1987). On obligatory control in clausal complements. In Iida, M., Wechsler, S. & Zec, D. (eds.), *Working papers in grammatical theory and discourse structure: Interactions of morphology, syntax, and discourse* (vol. 1). Stanford, CA: CSLI Publications. 139–168.

Author's address: *Linguistics Department, University of Canterbury, Private Bag 4800, Christchurch, New Zealand.*
E-mail: asudeh@csli.stanford.edu

https://doi.org/10.1017/S0022226705003427 Published online by Cambridge University Press