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Katalin É. Kiss
Tamás Zétényi *Editors*

Linguistic and Cognitive Aspects of Quantification

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Introduction

Katalin É. Kiss

Abstract The Introduction briefly discusses some of the issues that quantification raises in syntax, semantics, prosody, and psycholinguistics. It highlights the aspects of quantification that invite experimental testing: the ambiguity of quantificational constructions, the virtual movement rules assumed in their derivation, differences in children's and adults' grammars of quantification, competing semantic and pragmatic accounts of certain interpretations, etc. Psycholinguistic studies testing the role of language in mathematical cognition are also mentioned. The Introduction also summarizes each chapter, surveying the types of quantifiers analyzed, the languages involved, the theories tested and compared, and the experimental methods employed.

Keywords Quantification · Mathematical cognition · Acquisition · Ambiguity Quantifier scope · Quantificational domain · Scalar implicature · Distributivity Eye-tracking · Quantifier spreading

Quantification has been in the focus of interest of generative linguistic theory since the nineteen seventies (see Chomsky 1976; May 1977, 1985; Huang 1982; Reinhart 1983, etc.). The principle of compositionality states that the meaning of a quantified sentence is derived from the meanings of its constituents and the rules used to combine them. Quantified sentences, however, are often ambiguous, sometimes in multiple ways, which is reconcilable with the principle of compositionality only if they are assigned multiple structures. Some (or in certain theoretical frameworks, all) of the structures assigned to a quantified sentence are derived from surface structure representations by virtual movement rules not affecting spellout. The assumption of operations not connected to spellout directly has been a challenge for psycholinguistics, as well.

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A line of psycholinguistic investigations has been testing whether children can access the multiple meanings of quantified sentences; whether the virtual movement rules deriving the logical forms that are subjected to semantic interpretation are parts of child grammar. Results showing that children cannot access certain interpretations, or cannot access the different interpretations with equal ease, have provided arguments for various hypotheses on whether the non-adult-like analysis and interpretation of quantificational structures is the manifestation of immature grammar (Philip 1995; Musolino 1998; Musolino et al. 2000; Roeper et al. 2004), or is due to processing difficulties related to memory limitations (cf. Musolino and Lidz 2003, 2006; Syrett and Lidz 2011), or is the consequence of pragmatic inexperience (see, e.g., Crain and Thornton 1998; Gualmini 2004, 2008; Philip 2011, among many others).

The interpretation of quantified sentences sometimes also causes problems for adults, and the investigation of their difficulties may shed light on how, by what mechanisms quantification is processed by the mature mental grammar (see, e.g., Bott and Schlotterbeck this volume). Psycholinguistic experiments can help us to choose between competing linguistic or psycholinguistic models of the given phenomenon. We can test their predictions on large populations in order to tell which of them matches speakers' behaviour more closely.

It has also been a productive research question how children and adults resolve the ambiguities of quantified sentences; which are their preferred interpretations, and how various pragmatic conditions affect the preferences (see cf. Brooks and Braine 1996; Musolino 2009; Pagliarini et al. 2012; Syrett and Musolino 2015; É. Kiss and Zétényi 2017, among many others). The results of these studies can contribute both to grammatical theory—e.g., by helping to distinguish default and derived structures (Papafragou and Musolino 2003), and to pragmatics—by providing experimental data in sufficiently large numbers to draw reliable generalizations (Surányi and Madarász this volume).

Whereas most psycholinguistic research into quantification has been motivated by questions of linguistic theory, there have also been psycholinguistic studies aiming to understand the role of language in numerical/mathematical cognition. So far these studies have mainly been concerned with the form and structure of number words, pointing out, e.g., that their compositionality in Chinese speeds up arithmetic cognition (Zhang and Simon 1985), or that the specific marking of dual number in Slovenian and Saudi Arabic speeds up the acquisition of the notion of 'two' (Almoammer et al. 2013; Marušič et al. 2016). Dechamps et al. (2015) found differences in the processing of the linguistic expressions *fewer, more* and the symbols <, >. This area of study is still mostly unexplored, providing many untapped research possibilities.

Another line of research investigates the mathematical cognition of speakers of languages with no exact numbers beyond 3 or 4, like Pirahã (Gordon 2004), Mundurukú (Pica et al. 2004), Australian aboriginal languages (Butterworth et al. 2008), or a Nicaraguan sign language (Spaepen et al. 2011), aiming to find out whether language and mathematical cognition interact in a deterministic way. Apparently speakers of languages with no exact numbers lack exact arithmetic, but have approximate arithmetic (Carey 2001; Spelke 2003; Dehaene (1997); Izard et al.

2008). Exact arithmetic is acquired in a language-specific format, as pointed out first by the behavioral and brain-imaging experiments of Dehaene et al. (1999), and confirmed by a large number of studies involving bilingual speakers, e.g., Spelke and Tsivkin (2001).

The majority of the chapters of this volume give account of experiments that were motivated by competing linguistic theories, e.g., theories of quantifier interpretation—concerning the determination of quantifier scope, the determination of quantificational domain, the conditions of distributive versus collective interpretation, etc. The experimental approach of psycholinguistics is particularly suitable to test pragmatic theories, or to confront syntactically or semantically based theories with pragmatic explanations, because the predictions of pragmatic theories are often preferences, the correctness of which can only be proven by statistically evaluated experimental results. The experiments presented involve various types of quantifiers (universals, existentials, numerals), and various languages (English, German, Serbian, Chinese, and Hungarian).

Notwithstanding the linguistic motivation, the results of these studies also bear on basic issues of psycholinguistics, sometimes even of psychology. Most studies have a developmental aspect, testing both children and adults, and some of them also investigate the potential correlation of linguistic achievement with intelligence and attention. Whereas in theoretical linguistics the question of the psychological reality of models rarely emerges, the experiments presented here, especially those involving eye-tracking and reaction time measurements, aim to reveal the mental procedure of quantification, and of sentence processing, in general.

The chapter entitled 'Structural asymmetry in question/quantifier interactions' by Asya Achimova, Viviane Déprez, and Julien Musolino helps to answer a question that has been present in the generative literature since the 1970s (see May 1977). The question is why sentence pairs like (1) and (2) have different scope possibilities; why only the former question elicits a pair-lists answer.

(1) *Which assignment did every student complete?*
(2) *Which student completed every assignment?*

The problem has actually turned out to be even more complex (see Kuno 1991): the pair-list answer becomes possible also in the latter sentence if the universal quantifier *every* is replaced by *each*:

(3) *Which student completed each assignment?*

The structural difference between the minimal pair in (1)–(2) suggests that the scopal difference is the manifestation of a subject-object asymmetry, which early analyses from May (1985) to Chierchia (1993) derived from various structural constraints. The minimal pair in (2)–(3), however, is structurally parallel; what (2) and (3) differ in is the specificity/distributivity of the universal quantifier. Incorporating this observation, more recent proposals (from Szabolcsi 1997 to Agüero-Bautista 2001) argue that quantifier type, too, affects scope possibilities. Achimova et al. tested experimentally whether a pair-list answer (i.e., wide scope) for a quantifier in a wh-question is licensed by structural position or by quantifier type, or whether

the two conditions interact in some way. The experimental data show that both conditions have a role: wide scope assignment is easier to a subject quantifier than to an object quantifier whether the subject quantifier is an *every* or *each* phrase, and, wide scope assignment is easier to an *each* phrase whether it is in subject position or object position. It is proposed that a quantifier can be assigned wide scope if it can be construed as a topic. Subjecthood, and the strong distributivity characterizing *each* facilitate wide scope by evoking topic interpretation.

The chapter 'Children know the prosody-semantic/pragmatic link: Experimental evidence from Rise-Fall-Rise and scope' by Ayaka Sugawara, Martin Hackl, Irina Onoprienko and Ken Wexler investigates what determines the scope interpretation of sentences containing a universal quantifier in subject position and sentential negation (e.g., *All of the apples didn't fall*) by children aged 5;2–5;3 and by adults. Such sentences are, in principle, ambiguous scopally, however, they tend to be disambiguated—by the context and/or by prosody. According to Roberts (1996) and Büring (2003), the inverse scope reading is elicited by the 'contextually given' feature of the universal quantifier functioning as a contrastive topic. Büring (1997) and Krifka (1998), on the contrary, emphasize the role of contrastive prosody (the rise-fall-rise contour) in inverse scope interpretation. Sugawara and her colleagues carried out an experiment testing the role of both factors. The test sentences occurred in two different contexts; in one of them, the universal quantifier was new information, whereas in the other one it was given; and it occurred in both contexts with two different contours. It has turned out that the intonation contour does, the context does not, significantly influence scope interpretation. Somewhat surprisingly, children and adults were sensitive to the role of prosody in similar proportions (about 70% of both groups associated inverse scope with the rise-fall-rise intonation contour). This result also bears on a more basic issue, namely, whether the logical form of sentences subjected to semantic interpretation should include, or should have a direct access to, prosodic information. The finding that prosody plays a crucial role in quantifier scope interpretation is not compatible in a straightforward manner with the currently assumed architecture of grammar, where semantic interpretation has no access to prosodic information and phonological interpretation has no information about the movement rules carried out in logical form.

The question how children interpret the relative scope of negation and a universal quantifier quantifying over the subject also emerges in the chapter entitled *Differentiating universal quantification from perfectivity: Cantonese-speaking children's command of the affixal quantifier* saai3 by Margaret Lei and Thomas Hun-tak Lee. The chapter gives account of a study testing whether Cantonese children can distinguish the quantificational effects of a perfectivity-marking morpheme and a universal quantifier. In incremental-theme contexts a homomorphic mapping takes place between the noun phrase and the verbal predicate, i.e., quantification performed over subparts of an individual or a set is equivalent to quantification over sub-events denoted by a verbal predicate. Consequently, the 'totality of event(s)' meaning conveyed by the perfective aspect marker *zo2* is not distinct from the 'totality of object(s)' reading evoked by the universal quantifier suffix *saai3*. However, the two readings differ under negation. Negated perfective sentences denote the non-realization of the

event, resulting in a 'none' reading. Negated universal quantifiers yield a partial, 'not all' reading—corresponding to the surface prominence of the negative auxiliary over the universal quantifier attached to the verb. The question whether children can access both perfectivity and universal quantification and whether they can distinguish them was tested in the context of negation. The experiment showed that children as young as 3;6–4;6 were able to tell the two readings apart, although a subject–object asymmetry was observed; children had problems with associating the quantifier with subject nominals, which Lei and Lee attribute to the intervention of the negator between the subject and the postverbal universal quantifier. In intransitive sentences denoting motion events, children interpreted quantification on the extent of the path traversed, within the scope of negation. In intransitive sentences containing no potential target of quantification other than the subject, children tended to assign to the universal quantifier scope over negation, i.e., they tended to opt for the 'none' reading.

The paper entitled *Scalar implicature or domain restriction: How children determine the domain of numerical quantifiers* by Katalin É. Kiss and Tamás Zétényi gives account of a series of experiments testing why Hungarian children have difficulties in test situations with accessing the 'at least *n*' interpretation in sentences like 'If a boy has three hits [on the dartboard], he should get a candy'; why they think that boys with four or five hits should get none. Their experiments show that the 'at least *n*' reading of the numeral is only blocked if the domain of quantification is represented as a predetermined, fixed set. If the domain appears to be flexible, manipulatable, especially if it is not clearly demarcated, the majority of children realize that they can perform domain restriction. These results are hard to explain in the framework of the so-called neo-Gricean theory of numeral interpretation, where the basic meaning of a numeral *n* is the 'at least *n*' interpretation, and the 'exactly *n*' reading is a scalar implicature, derived by Grice's maxims of quantity. An alternative theory of numerals, according to which the basic meaning of a numeral is the 'exactly *n*' reading, and the 'at least *n*' interpretation is due to pragmatic inferencing, is discarded on the basis of linguistic evidence (it cannot account for the fact that in the Hungarian sentence, the 'at least *n*' reading is the generally available interpretation; the 'exactly *n*' interpretation arises in the structural focus position, presumably as a consequence of the [+exhaustive]/[+maximal] feature associated with structural focus.) Instead of these two explanations, Stanley and Szabó's (2000) semantic theory is adopted, according to which neither interpretation is derived from the other; the interpretation of a quantifier expression is always contextually determined, and what is flexible and is subject to change is the domain of quantification. The experiments of É. Kiss and Zétényi have shown that children are capable of domain widening and domain restriction depending on relevance, unless the quantificational domain is presented by the experimenter as a predetermined, fixed entity. Their results suggest that children may not follow the complex procedures of logical–semantic models in deriving quantificational domains; they may simply interpret contextual cues and manipulate sets.

Two chapters of the book deal with the phenomenon of distributivity. In the chapter *Universal quantification and distributive marking in Serbian,* Nataša Knežević and

Hamida Demirdache point out interpretive differences between three versions of distributive constructions. Languages may encode distributivity by marking the distributive key, i.e., the event participants over which the distribution takes place (e.g., ***Each boy*** *received an apple*), or by marking the distributed share, i.e., the entity that is being distributed (*The boys received* ***an apple apiece***), or by marking both. A question is if encoding distributivity by a distributive key marker (a universal), and encoding it by a distributed share marker yield equivalent interpretations. It has been argued that, whereas distributive key markers can imply either strong or weak distributivity, distributed share markers enforce strong distributivity. According to Balusu (2006), the strong distributivity of distributed share markers seemingly occurring without a distributive key is due to a covert universal quantifier ranging over spatiotemporal units. Knežević (2015) argued that the distributive-share marker *po* in Serbian is a pluractionality marker; it denotes a plurality of events, enforcing distributivity over spatiotemporal locations. It blocks collective readings, but it does not enforce exhaustivity. The distributive-key marker *svaki* 'every', on the contrary, enforces exhaustivity and atomicity—without blocking collective readings. In their present study, Knežević and Demirdache tested the acquisition of sentences involving both a distributive-key-marking *svaki* in subject position and a distributive-share marking *po* in object position. The acquisition path of distributivity indicates the independence of universal quantification and *po*. *Po* is acquired earlier; children at the age of 9 reject collective interpretations in the presence of *po*, but accept non-atomic interpretations in the presence of *svaki*. This suggests that, in languages that have both pluractional markers and universal quantifiers, such as Serbian, children acquire pluractionals before universal quantifiers.

The distributive–collective ambiguity and Information Structure by Balázs Surányi and Levente Madarász gives account of an experiment testing whether the discourse role of the subject affects the resolution of the ambiguity of sentences having both a collective and a distributive reading. The authors tested sentences with three different types of indefinite subjects, one of which (bare numeral indefinites like *five students*) only has a cardinal reading, while the other two (upward entailing comparative numeral phrases like *more than three students*, and *many* phrases, e.g., *many students*) have both a cardinal and a quantificational interpretation. The experiment was preceded by a series of pretests comparing the acceptance of the collective and distributive interpretations of 162 neutral sentences with subjects of the above three types. Only sentences in the case of which the pretest showed no significant pragmatically motivated bias towards either the collective or the distributive reading were included in the main test. The sentences of the main test occurred in three versions: the subject QNP was either topicalized, or focused, or was left in its base-generated vP-internal position, where it had no special discourse role. (The test was performed with Hungarian speakers in Hungarian, where the topic and focus functions are associated with distinct, easily recognizable structural positions.) It has been found that focusing significantly enhances the likelihood of distributive interpretation for all three subject types. This is only true of topicalization in the case of quantificational subjects (those of the type *more than three students* and *many students*), the quantificational reading of which is inherently distributive. In

the case of focusing, the distributive interpretation is more optimal both for cardinal indefinite subjects, and for *more than* n and *many* subjects under their cardinal indefinite interpretation because it activates a smaller set of focus alternatives than the collective reading, thereby incurring smaller processing costs. Topicalization is argued to strengthen the distributivity of *more than* n and *many* subjects by supporting their quantificational interpretation. The quantification interpretation prevails in topic position because these quantificational expressions are associated with an existential presupposition, which meets the presuppositionality requirement of topic. In the case of bare indefinites, which lack a quantificational reading, topichood does not significantly affect interpretive preferences. The research reported in this paper is also interesting methodologically. The data were collected by crowd sourcing, and a program was developed to exclude spammers and careless respondents. The filtering of participants was partially criteria-dependent and was partially data-driven.

Two further chapters investigating the phenomenon of quantifier spreading, focusing on the processing of sentences containing a universally quantified subject binding an indefinite, also pertain to the issue of distributivity indirectly. The authors of *Quantifier spreading in school-age children*: *An eye-tracking study,* Irina Sekerina, Patricia Brooks, Luca Campanelli, and Anna Schwartz, investigated among children aged 5–12 why a sentence like *Every bunny is in a box* is often rejected in a situation involving, say, three bunnies, each in a box, and an empty box. The experiment involved sentence–picture verification, in the course of which the authors performed eye-tracking, and measured reaction times. They also tested the verbal and non-verbal intelligence of the subjects. They have found that errors involve greater numbers of fixations to the extra objects, which occurred right after the utterance of the quantified noun phrase. This suggests that quantifier spreading cannot be a consequence of children's lack of control of attention, contra the proposal of Minai et al. (2012). Correct responses required longer reaction times, indicating that additional processing is needed for children to correctly restrict the universal quantifier to the appropriate noun phrase. Children's achievement did not correlate with intelligence, and only weakly correlated with their age. The fact that quantifier spreading mistakes only mildly decrease by maturation is hard to accommodate in frameworks that attribute children's errors to immature grammar. It is concluded that the theory which can account for the full range of the facts attested is the theory that attributes errors to the superficial processing of sentence structure (Brooks and Braine 1996; Brooks and Sekerina 2005/2006). Shallow sentence processing generates 'good enough' (underspecified) representations of sentence structures that under most circumstances are sufficient for comprehension. When relying on shallow processing, children (and also adults) use canonical collective and distributive representations as defaults.

The chapter *Turning adults into children: Evidence for resource-based accounts of errors with universal quantification* by Oliver Bott and Fabian Schlotterbeck shows that not only children but adults, too, are prone to commit quantifier spreading errors in circumstances that make great demands on their cognitive resources. Some adults commit the extra object error observed in the case of children, i.e., they reject a sentence meaning 'each pupil was praised by exactly one teacher' in a situation where there is an extra teacher not praising anyone. However, even more adults commit a so-

called branching error not observed before. Namely, they reject sentences meaning 'each pupil was praised by exactly one teacher' in a situation where each pupil was praised by exactly one teacher, but some teacher praised two pupils. The authors were interested in whether current competing theories of quantifier spreading can account for these facts. They tested adults in two conditions. In the first experiment, the picture (a set diagram) and the corresponding sentence were shown incrementally, i.e., the participants saw the sentence word by word after the picture had disappeared. They had to judge at each step whether the unfolding sentence still matches the diagram. The occurrence rate of the branching error was 44%. The experiment was also repeated in an offline version when the picture and the full sentence were shown simultaneously. In this condition, adults made practically no mistakes. No mistakes were attested in a third online version of the experiment, either, where the universal quantifier was replaced by an indefinite. This test excluded the possibility that the errors in the first experiment were retention failures. Bott and Schlotterbeck assume that speakers automatically assign to sentences containing a universal and an indefinite a default symmetrical interpretation, which is the cognitively simplest state of affairs making the sentence true. In the case of an extra object, it is relatively easy to recognize that the default model is a proper part of the actual picture. In the case of a branching line, however, the matching procedure breaks down, they have to verify whether each pupil is connected to exactly one teacher, which is a demanding process affected by resource limitations. None of the current theories of quantifier spreading—which derive spreading errors from a grammatical deficit, or processing problems, or infelicitous pragmatic conditions—can fully account for these findings. The proposed account is a resource-based processing explanation, claiming that the more complex a verification procedure is, the more exposed it is to resource limitations.

In sum: the chapters of this volume have something to offer to linguists, psycholinguists, and psychologists alike. Old puzzles of scope interpretation concerning the relative scope of wh-phrases and universal quantifiers, and universal quantifiers and negation have been resolved. The semantics of distributivity has been completed with further details—concerning the contribution of the different ingredients of distributive constructions, the distributive force of different universal quantifiers, and potential overlaps between cumulativity and distributivity. Theories aiming at psychological plausibility have been supported experimentally—e.g., Stanley and Szabó's (2000) theory of the context dependence of quantifier domain. The papers focusing on sentence processing offer new insights into cognitive processes, among them the interaction of attention, cognitive load, and linguistic analysis. (As expected, intelligence was not among the factors found to correlate with processing achievement.) The existence of shallow sentence processing, generating underspecified or default representations, has been confirmed.

The book also illustrates the great variety of methodological solutions that can be applied in the study of quantification. The experiments employed various versions of truth-value judgement and forced choice tasks involving the verification of sentence–picture and sentence–video pairs. In some cases, acceptibility judgements were supplemented by elicitation tasks. The preponderance of intuitional data reflects the

fact that quantification tends to result in ambiguities, the resolution of which involves a great extent of intuitional uncertainty, deriving from the interaction of structural, semantic, contextual and pragmatic factors. However, some papers also present ways of increasing the objectivity of intuitional data, for example, by a meticulous pretest screening the stimuli so as to exclude all examples with any potentially distracting idiosyncratic features, and by a meticulous post-test screening the seriousness and the concentration of the informants. In some of the experiments described, intuitional results are supplement by biological data—for example, by visual-world eye-tracking in the case of children and self-paced reading and reaction time measurement in the case of adult subjects. The diversity of approaches is in part a consequence of the fact that the experiments range over several age groups from preschoolers to adults, thereby outlining the acquisition path of various quantificational constructions.

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Structural Asymmetry in Question/Quantifier Interactions

Asya Achimova, Viviane Déprez and Julien Musolino

Abstract The interaction of universal quantifiers and *wh*-phrases in questions, such as *Which class did every student take?*, gives rise to structural ambiguities. The availability of pair-list answers (*Mary took Syntax, and Jane took Semantics*) to such questions reveals whether the quantifier can take wide scope over the *wh*. In this paper, we use an acceptability judgment task to test whether, as some theoretical accounts suggest (e.g. May 1985), the quantifier position affects the likelihood of an inverse scope reading for distributive quantifiers, such as *every* and *each*. We show that pair-list answers remain less available for questions with object quantifiers than for questions with subject quantifiers even when the quantifier is *each* (*contra* Beghelli 1997). At the same time, speakers find pair-list answers to questions with *each* more acceptable than to questions with *every*, confirming that the distributivity force of a quantifier also plays a role. We discuss how these findings fit into the existing analyses of quantifier scope in relation to quantifier semantics and discourse structure.

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1 Introduction

Questions with universal quantifiers may be structurally ambiguous and allow multiple readings. The question in (1) can be understood as (1a) where there is a single assignment that every student completed, or as (1b), where there are pairings of students and their individual assignments. Finally, we could specify the pairings of students and assignments not extensively by listing them, but rather by naming a function, in this case, the hardest assignment (1c), which is presumably different for every student.

(1) Which assignment did every student complete?
   a. The semantics assignment. *Single answer*
   b. John completed the semantics assignment, Jane completed the syntax assignment, and Mary completed the phonology assignment. *Pair-list answer*
   c. The hardest assignment. *Functional answer*

May (1985) was one of the first to observe that the position of the quantifier determines the range of possible answers. He argued that pair-list answers (PLA) are lacking for questions with object quantifiers, such as (2).[1]

(2) Which student completed every assignment?
   a. Mary.
   b. *John completed the semantics assignment, Jane completed the syntax assignment, and Mary completed the phonology assignment.

However, this structural restriction on PLA availability does not hold for all universal quantifiers equally. Beghelli (1997) reported that PLAs to questions with *each* (3) in object position freely allow pair-list readings (3b), indicating that the wide scope of the quantifier is possible. Single answers are available as well (3a).

(3) Which student completed each assignment?
   a. John did.
   b. John completed the semantics assignment, Jane completed the syntax assignment, and Mary completed the phonology assignment.

In this paper, we show using experimental tools that the structural position of the quantifier in fact affects the accessibility of a PLA regardless of the lexical differences between universal quantifiers, such as *every* and *each*. The rest of the paper is structured as follows: we first review the theoretical background explaining the role of structure and quantifier semantics. We follow with the results of our acceptability judgment experiments. We conclude with a discussion of the subject-object asymmetry and speculate about the possible sources of this effect.

[1] Since functional answers are not the focus of this paper they will not be discussed further here.

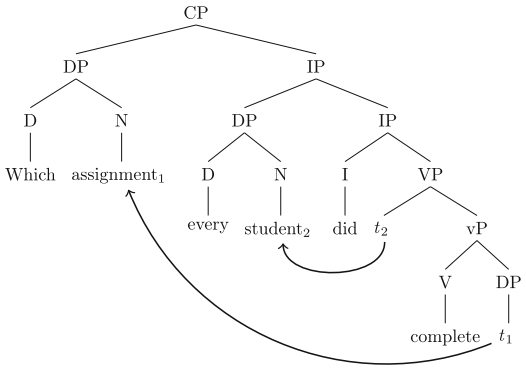
2 Theoretical Background

2.1 Structural Limits on the Wide Scope Reading of Quantifiers

The observation that certain questions with quantifiers in object position lack pair-list readings led to the development of several analyses to account for this fact. We will first review the accounts that attribute the inability of object quantifiers to take wide scope over a *wh*-phrase to syntactic effects.

May (1985) argues that object quantifiers fail to scope over a *wh*-phrase due to a violation of constraints on movement. In May's view, the inverse scope of a quantifier phrase and a *wh*-phrase is possible if they can form a special $\sum$-sequence. Members of the $\sum$-sequence are governed by the same maximal projection. If such a formation is possible at the level of LF, members of the sequence can freely interact and scope over each other giving rise either to a single answer or to a PLA. While subject quantifiers can raise to a position close enough to the *wh*-phrase (4) to form a $\sum$-sequence, the movement path of an object quantifier must cross the movement path of a subject *wh*-phrase in (5).

(4)



(5)