CHAPTER 3

SYNTACTIC STRUCTURE AND SCOPE PREFERENCES

One of the major questions being investigated in this dissertation is how the processor assigns scope to a quantifier. I am especially concerned with cases of ambiguity, where the relative scoping of two quantifiers needs to be determined. In this chapter I will lay the experimental groundwork for the dissertation, establishing the basic principle which governs quantifier scope preferences and the primary factors which influence those preferences (e.g. surface position in the syntax, semantic type of quantifier, thematic role). In future chapters I will investigate the role of secondary factors, particularly the lexical biases of quantifiers.

The focus of the current investigation will be dative sentences which have two quantified phrases within the VP, one as the direct object (DO) and one as the indirect object (IO; the object of the preposition *to*), as in (1):

(1) a. *Kelly showed a photo to every critic last night.*

b. *Kelly showed every photo to a critic last night.*

I have chosen such examples because little research has yet been done on scope preferences in this construction and because the various hypotheses that I consider make quite different predictions about which scoping should be preferred here.

The following section presents an economy-based hypothesis about how the processing of quantifier scope proceeds in sentences like (1). Section 3.2 reports on the experiment designed to test that hypothesis against the theory of Kurtzman & MacDonald (1993). Section 3.3. examines scope preferences in sentences other than datives. Section 3.4 summarizes the findings and outlines the questions that will be addressed in the remainder of the dissertation.

3.1 The Principle of Scope Interpretation

The relative scoping of two quantifiers is determined by the c-command relation between them at LF. Since both grammatical constraints and processing principles determine what LF-structure gets built, scope assignment is governed by both grammatical and processing considerations. The theory of scope preferences that I develop here draws on both of these areas. To begin, I lay out my syntactic and psycholinguistic assumptions.

3.1.1 Background Assumptions

I assume, following Diesing (1992), that the mapping from LF to a tripartite semantic representation is governed by a tree-splitting procedure (the Mapping Hypothesis), which divides the syntactic tree into two parts: the material contained inside the VP, which gets mapped into the nuclear scope, and the material in the rest of the tree, which gets mapped into a restrictor clause. QPs headed by strong quantifiers, such as *every* and *most*, which only have strong/ presuppositional/quantificational readings (where they function as operators), must be external to VP at LF, since they need to have a restrictor clause for interpretation and cannot form one from within VP.

The syntax I adopt is essentially that of Runner (1995), who argues that direct objects, as well as subjects, have moved out of VP at S-structure in English to the specifier position of an agreement phrase. (Diesing does not assume that English objects move at S-structure.) The verb adjoins to the head of a functional projection FP which intervenes between AGRsP and AGRoP:

(2) S-structure of simple subject-object sentence

$[_{AGRsP}$ *Every girl*$_S$ $[_{FP}$ *kicked* $[_{AGRoP}$ *a ball*$_{DO}$ $[_{VP}$ t_S t_v t_{DO}]]]]

PP complements, such as the *to*-phrase in a dative sentence remain in the VP at S-structure. For example, the S-structure of (1a) is as in (3):

(3) S-structure of (1a)

$[_{AGRsP}$ *Kelly*$_S$ $[_{FP}$ *showed* $[_{AGRoP}$ *a photo*$_{DO}$ $[_{VP}$ t_S t_v t_{DO} $[_{PP}$ *to* [*every critic*$_{IO}$]]]]]]

The critical aspect of this structure is that the direct object (*a photo*) asymmetrically c-commands the indirect object (*every critic*).

In terms of syntactic processing, I assume that the processor builds a single S-structure for each input string and computes a single LF representation from this.[1] The construction of a representation for a sentence occurs on line, word-by-word or phrase-by-phrase. The parser adds each word to the larger structure as it is encountered. In doing so it must obey both grammatical and parsing principles.

The LF representation is taken to be the same as the S-structure by default. A separate LF tree (or portion thereof) is only constructed when needed. In building LF structure, the processor follows the processing economy principle in (4):

(4) General Processing Economy

> The processor does not do any more at LF than is required by the grammar, unless the extra structure building, movement, etc. is motivated in some way.

When movement is required, economy still plays a role: the shortest possible movement that satisfies grammatical requirements is used, since shorter movements require less structure building (e.g. require fewer chain links or intermediate traces).

The LF representation is interpreted into a semantic and discourse structure, which includes the construction of tripartite representations. Interpretation of each word or phrase proceeds rapidly.

3.1.2 Scope Interpretation

I propose that the initial scope assignment in a multiply-quantified sentence is determined by

[1]Since I am not concerned with S-structure ambiguities, the assumption that only a single surface representation is built is not a critical one. For multiply-quantified sentences, it is the LF structure which is significant. There is a different LF representation for each scoping. An alternative to the model where only a single LF is constructed, following General Processing Economy, would be a ranked-parallel system in which multiple LFs are built, with Processing Economy determining the ranking. An LF with no unrequired or unmotivated operations would be ranked highest, one with a single unmotivated movement would be ranked next, etc. The two approaches make the same predictions for the cases I will be considering in this chapter. The parallel processing question will be revisited in §3.4.

the Principle of Scope Interpretation (PSI), stated below. The PSI follows directly from Processing Economy in (4).

(5) Principle of Scope Interpretation (PSI)

> The default relative scoping in a multiply quantified sentence is computed from the required LF-structure of that sentence, where the required LF is determined by required grammatical operations acting on the S-structure. The default scoping is the preferred scoping unless there is evidence to go beyond it.

Since required syntactic operations (generally) do not change the c-command relations of QPs, the descriptive C-command Principle, which states that the preferred scoping corresponds to the scoping determined by surface c-command relations (Huang 1982; Reinhart 1983; and others), is a corollary of the PSI. Pica & Snyder (1995) made a similar observation with respect to their theory of scope preferences.

Quantifier Raising (QR), which moves a QP up in the tree and adjoins it to a higher projection, is one operation that applies at LF. Following (4), I assume that it applies only when necessary. For subject and direct object QPs containing strong quantifiers, QR is not required syntactically. These QPs can take scope from their surface positions in [Spec,AGRsP] and [Spec,AGRoP]. The preferred scoping in a simple subject-object sentence like (2) is therefore subject over object:

(6) LF of (2) (= S-structure)

$[_{AGRsP}$ *Every girl*$_S$ $[_{FP}$ *kicked* $[_{AGRoP}$ *a ball*$_{DO}$ $[_{VP}$ t_S t_v t_{DO}]]]]

preferred scope: *every* > *a*

This scoping is called the 'forward' scoping because the first quantifier encountered receives wide scope. In the reverse, or 'inverse,' scoping the second quantifier would have wide scope.

In contrast to subject-object cases, QR **is** needed for strong QPs which remained inside the VP at S-structure, such as the indirect object (IO) in a dative sentence like (1a). The surface structure for such a sentence is given in (7a), repeated from (3), and the LF is shown in (7b).

(7) a. S-structure of (1a)

$[_{AGRsP}$ *Kelly*$_S$ $[_{FP}$ *showed* $[_{AGRoP}$ *a photo*$_{DO}$ $[_{VP}$ t_S t_v t_{DO} $[_{PP}$ *to* [*every critic*$_{IO}$]]]]]]

b. LF of (1a)

[$_{AGRsP}$ *Kelly*$_S$ [$_{FP}$ *showed* [$_{AGRoP}$ *a photo*$_{DO}$ [$_{VP}$ *every critic*$_{IO}$ [$_{VP}$ t_S t_v t_{DO} [$_{PP}$ *to* t_{IO}]]]]]]

The movement of *every critic* in (b) is required by the grammar because, as mentioned above, strong quantifiers cannot be interpreted within the VP. I assume that QR in this case adjoins the QP to VP– the shortest possible movement that satisfies its grammatical requirements.[2] Critically, note that adjoining to VP will not change the c-command relation between the direct object and IO. The direct object (*a photo*) still c-commands the indirect object (*every critic*), as it did at S-structure.

In contrast to (1a), QR is not necessarily needed for (1b), since the strong quantifier phrase *every photo* is already outside the VP at S-structure. The S-structure and LF for (1b) are identical:

(8) S-structure and LF of (1b)

[$_{AGRsP}$ *Kelly*$_S$ [$_{FP}$ *showed* [$_{AGRoP}$ *every photo*$_{DO}$ [$_{VP}$ t_S t_v t_{DO} [$_{PP}$ *to* [*a critic*$_{IO}$]]]]]]

A note should be made about the interpretation of *a critic* in this structure. Recall that in Diesing's system an indefinite can have two readings: a weak/existential reading, which arises when the indefinite is within the VP at LF, or a strong/quantificational/presuppositional reading, which arises when the indefinite is outside the VP at LF. If *a critic* in (1a) is interpreted as weak, then the LF in (8) is appropriate. If, on the other hand, it is interpreted as strong, then QR must apply, yielding the LF in (9) (cf. (7b)):

(9) [$_{AGRsP}$ *Kelly*$_S$ [$_{FP}$ *showed* [$_{AGRoP}$ *every photo*$_{DO}$ [$_{VP}$ *a critic*$_{IO}$ [$_{VP}$ t_S t_v t_{DO} [$_{PP}$ *to* t_{IO}]]]]]]

Whether *a critic* gets a weak or strong reading does not affect the c-command relation between the QPs. *Every photo* c-commands *a critic* in both (8) and (9). Since (9) requires QR at LF while (8) does not, I will assume on economy grounds that (8)– which leads to the indirect object

[2]While Diesing generally assumes that strong quantifiers adjoin to IP, she notes (p. 77) that adjunction to VP is possible, and sometimes necessary, and that a phrase adjoined to VP is not inside VP, in the formal sense of 'inclusion' defined in May (1985)and Chomsky (1986), so will be mapped into a restrictor clause of the tripartite structure and not the nuclear scope.

a critic being interpreted existentially– is the preferred LF for (1b).

Thus, in both quantifier-orders in (1), *a-every* and *every-a*, the direct object c-commands the indirect object in the required LF. According to the PSI, the preferred scoping in doubly-quantified dative sentences like (1) is thus predicted to be the forward scoping of DO > IO.[3] This prediction was tested in Experiment 1, which we will turn to shortly.

As of yet, there has been no mention of what might induce the processor to go beyond the default scoping. Motives include: (i) the default scoping being implausible, (ii) the non-default scoping being clearly intended by the context, and (iii) the non-default scoping satisfying the lexical conditions on the quantifiers involved in the scope relation. The last of these is the central topic of Chapter 5, where the differences in the scope behavior of the quantifiers *each* and *every* are investigated. For the present, I will work with sentences in which none of these factors plays a (strong) role; sentences, in other words, where the default scoping, as determined by the Principle of Scope Interpretation, remains the preferred scoping.

3.1.3 Existential Direct Objects

Above I assumed that the preferred reading of indefinite indirect objects is existential/weak, on economy grounds. Suppose there is also a preference to interpret indefinite **direct** objects as existential. Such a preference could be related to a general strategy of taking material earlier in a sentence to be given and material later in a sentence to be new. Indefinite direct objects (as well as indirect objects) would be taken to be existential because they come late enough to be counted

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[3] I would state that the preferred scoping in (8) is of the strong QP *every photo* over the existential indefinite *a critic*. Note, however, that existential indefinites do not themselves have scope. Their quantificational force comes from the existential closure operator. The tripartite semantic representation of (8) given in (i) makes this clearer (the subject and verb have been left out for simplicity):

(i) *Kelly showed …*

[every$_x$ photo (x) [$\exists_y$ [x to a critic (y)]]

Operator Restriction Nuclear Scope

In other words, *every* is really in a scope relation with the existential closure operator $\exists$ here, not with the indefinite. For ease of discussion, though, in the sections that follow I will continue to refer to the relative scoping of strong QPs and indefinites without mentioning the existential closure operator.

as new. Indefinite subjects, on the other hand, would be counted as given and thus would be preferentially interpreted as strong/quantificational/presuppositional. If this hypothesis were added to the proposal of how scope interpretation proceeds which was laid out in the previous section, how would the scope-preference predictions be affected?

For indefinites to be interpreted existentially, they must be within VP at LF. One way to achieve this with direct objects is to lower them at LF from their S-structure position in [Spec,AGRoP] back into their base position. The second way is to have existential direct objects never leave their base position and to satisfy their Case requirements within VP (cf. de Hoop 1992). Strong/quantificational DOs would still raise to [Spec,AGRoP] at S-structure. Under the latter method, the surface position of an indefinite DO reflects its interpretation, and no movement is necessary for existential DOs. For simplicity, I adopt this second approach.

With these assumptions, the hypothesis that direct objects are preferentially interpreted as existential can be stated as follows:

(10) Existential Direct Objects Hypothesis (EDOH)

> The processor preferentially places indefinite direct objects in their base position in the S-structure representation, where they are interpreted existentially/weakly.

Adopting the EDOH does not change the predicted scope preferences for subject-object sentences. The subject with c-command the object whether the object raises to [Spec,AGRoP] or remains in VP, so the default scoping is subject > object.

The predictions for scope preferences in (1), though, need to be reconsidered. Under the EDOH, the S-structure of (1a) is as in (11a) rather than as in (7), since the indefinite direct object *a photo* does not raise out of VP. Given this S-structure, the Principle of Scope Interpretation predicts that the preferred scoping in (1a) should be *every critic* > *a photo*– contrary to what was predicted without the EDOH. As before, the strong QP *every critic* must raise and adjoin to VP at LF. But now, because the indefinite remains in VP, the [Spec,AGRoP] position is not occupied and the *every*-phrase is higher in the tree. The default scoping from the required LF in (11b) is therefore the inverse scoping, where *every critic* has wide scope.

(11) a. alternative S-structure of (1a)

[$_{AGRsP}$ *Kelly*$_{S}$ [$_{FP}$ *showed* [$_{AGRoP}$ [$_{VP}$ t_S t_v *a photo*$_{DO}$ [$_{PP}$ *to* [*every critic*$_{IO}$]]]]]]

b. alternative LF of (1a)

[$_{AGRsP}$ *Kelly*$_{S}$ [$_{FP}$ *showed* [$_{AGRoP}$ [$_{VP}$ *every critic*$_{IO}$ [$_{VP}$ t_S t_v *a photo*$_{DO}$ [$_{PP}$ *to* t_{IO}]]]]]]

In contrast to (1a), the S-structure and LF for (1b) are not affected by the addition of the EDOH. They remain as given in (8) above. Hence, with the EDOH the *every*-phrase moves out of VP at or before LF in both (1a) and (b) while the *a*-phrase does not. The preferred scoping in (1) is therefore predicted to be wide scope on the *every*-phrase no matter what the order of the quantifier phrases is at S-structure. There should be a preference for inverse scoping in (1a) and forward scoping in (b). These predictions are tested in Experiment 1.

3.1.4 Predictions of Kurtzman & MacDonald (1993)

An alternative to the PSI is the theory of scope preferences offered by Kurtzman & MacDonald (1993) (K&MacD). Recall from the previous chapter that they presented an important set of computer-controlled studies of quantifier scope preferences. Their goal was to evaluate structural principles from the literature which were specifically designed to derive scope preferences. The major findings were a strong preference for forward scoping in active subject-object sentences, such as *A kid climbed every tree*, and a weak preference for forward scoping in passives (*Every tree was climbed by a kid*). In addition, there were some effects of verb type (action/perception; e.g. *climb* vs. *see*) in both actives and passives.

To account for this pattern, K&MacD proposed that there are a number of scope principles which work together to determine scope preferences and that the scope principles are like other probabilistic constraints that influence ambiguity resolution (MacDonald 1994). Alternative scope interpretations are initially considered in parallel. The interpretation which is most consistent with the scope principles is built; this is the preferred scoping. If two principles are in opposition, one scoping is chosen at random; so neither scoping is preferred. For their results, at least one

principle which favors forward scoping in both actives and passives (such as the Linear Order Principle or C-command Principle) is needed, and at least one principle which favors forward scoping in actives but inverse scoping in passives (such as Thematic Hierarchy Principle, which also can account for verb-type effects) is needed. In actives, these principles all converge on a preference for forward scoping. In passives, the principles conflict, so that there is no strong scope preference.

The various scope principles that K&MacD entertained make conflicting predictions about which scoping of the quantifiers is preferred in the dative cases in (1). Because they all relate only to subjects and/or topics, the Surface Subject, External Argument, Topic, and Single Reference Principles do not apply. The Linear Order and C-command Principles predict a preference for wide scope on the direct object: *a photo* in (a) and *every photo* in (b). The Thematic Hierarchy Principle predicts the opposite, favoring wide scope on the indirect object, since the θ-hierarchy puts recipient (*critic*) above theme (*photo*). Thus, following the reasoning they use in their own second experiment on passives, K&MacD would predict that neither scoping is particularly favored in datives.

3.1.5 Summary

K&MacD's approach and the Principle of Scope Interpretation yield different predictions as to which scoping should be preferred in dative sentences where both the direct and indirect objects are quantified. Moreover, the predictions of the PSI are affected by whether the Existential Direct Objects Hypothesis is adopted or not, since the EDOH determines the position of indefinite DOs in the required LF representation.

There has been very little previous experimental work on scope preferences in datives. Ioup (1975) and VanLehn (1978) report informant data on a few relevant examples, but their results do not agree. Both Micham et al. (1980) and Gillen (1991), who ran more-controlled experiments than Ioup and VanLehn, included some dative sentences with quantified DOs and IOs in their studies, but it is impossible to draw general conclusions from their data about preferred scoping

in these structures. Gillen did not run both quantifier orders, and Micham et al. did not present the dative results separately from the results for the other construction they used.

Hence, in order to determine which, if any, of the predictions laid out above were correct, I carried out a scope preference study on dative sentences.

3.2 Experiment 1 – Scope Preferences in Dative Sentences

The experiment was conducted using word-by-word self-paced reading along with a stops-making-sense judgement task. Participants read the items at their own pace and were able to indicate if/when an item no longer made sense to them. Self-paced reading was employed in order to get closer to normal reading and comprehension than previous experiments on scope preferences, which have used a wide variety of techniques. The stops-making-sense component was included so that it would be easier to compare the results to those from K&MacD's series of studies, which also included a judgement task.

3.2.1 Method

Materials and Design. The design was based on that used by K&MacD. Each item consisted of a quantified dative sentence (S1) followed by a continuation sentence (S2) intended to be consistent only with one reading of S1, as indicated:

(12) a/b. *Kelly showed a photo to every critic last month.*

a. *The photo was of a run-down building.* forward scope: *a > every*

b. *The photos were of a run-down building.* inverse scope: *every > a*

c/d. *Kelly showed every photo to a critic last month.*

c. *The critic was from a major gallery.* inverse scope: *a > every*

d. *The critics were from a major gallery.* forward scope: *every > a*

When *every* has wide scope in (a/b), the photo in question can vary with each critic

considered. So there can be more than one relevant photo in the discourse model and a plural continuation makes sense.[4] When *a* has wide scope, it is the same photo that is shown to every critic. There is only one relevant photo in the model, and hence a singular continuation is appropriate. Parallel reasoning applies in (c/d). If the relative scope of the quantifiers has been determined by the time the subject noun and verb in S2 are read, then there will be slower reading times on those words when the assigned scoping does not mesh with the number marking. In addition, participants may indicate that the item has stopped making sense at or after the subject noun or verb in S2 when the number marking is inconsistent with the scoping which was assigned.

Summarizing the predictions laid out above for scope preferences in dative sentences like (12), the Principle of Scope Interpretation predicts that forward scoping should be preferred in (a/b) and (c/d), since in the required LF-structure of the sentence the direct object (*photo*) c-commands the indirect object (*critic*). *A* should get wide scope in (a/b), favoring the singular continuation (i.e. the singular continuation should be read faster), and *every* should get wide scope in (c/d), favoring the plural continuation. In terms of reading times, continuation (a) should be faster than (b), and continuation (d) should be read faster than (c). In contrast, the PSI combined with Existential Direct Objects Hypothesis predicts a preference for wide-scope *every* in both (a/b) and (c/d), so the plural continuations should always be read faster: a>b and c>d. Lastly, according to K&MacD's constraint-based approach both continuations should be equally good (a=b and c=d), since the scope principles are in conflict. The Linear Order and C-command Principles predict forward scoping in both (a/b) and (c/d), but the Thematic Hierarchy Principle predicts inverse scoping.

One important caveat needs to be raised here. As was pointed out in the discussion of K&MacD's studies in Chapter 2, there are various ways in which a singular continuation may be compatible with the *every>a* scoping. First, it could be understood with a discourse subordinated

[4]There may also be additional photos in the model which are not relevant for the current sentence, having been excluded by a contextual restriction earlier in the discourse.

reading, as in *In each case, the critic was from a major gallery*. Since discourse subordination occurs only under particular discourse conditions, however, it is doubtful that it would be employed in this experiment (see §2.5.2.8 for discussion). A second consideration is that semantically all that the *every photo > a critic* scoping means is that it is **possible** that there is a different critic for each photo; it does not require it. In other words, giving *every* wide scope in (c/d) is consistent with there being one or more critics. Given this, a preference for the *every>a* scoping may be indicated by the plural and singular continuations being read equally fast. We will return to this point in the Discussion section.

Twenty sentence pairs like those in (12) were constructed (see Appendix B for a complete list). The items were counterbalanced so that each participant saw each item in only one condition. Controls and fillers included items in which the noun picked up in S2 was a noun from an *every*-phrase (since in the experimental items it was always the noun in the indefinite phrase which was repeated), items without quantifiers where the continuation sentence referred to participants (some singular, some plural) that had antecedents in S1 (so that it was not only in the experimental items that S1 and S2 were related in this way), items which contained pronominal anaphora, and unrelated items of various types, some of which consisted of only single sentences. Of the 85 fillers, 22 were intended to stop making sense at some point, including examples like the following:

(13) a. *The girl stared the whole group because she was interested in the new boy.*

b. *The small sailboat sank in the yesterday cove. Everyone on board swam to shore safely.*

c. *The monkey that is losing hair swung all day long from tallest the tree.*

d. *The boy practiced this morning that Luke coaches.*

None of these "no sense" items contained quantifiers. In all, a total of 105 sentences or sentence pairs was presented.

Procedure. Each pair of sentences was presented on a computer screen using a self-paced (participant-paced) word-by-word stops-making-sense reading task. A moving-window display was employed (Just et al. 1982), such that every word appeared in its spatially correct position.

Each trial began with a series of dashes (-) marking the length and position of the words in the sentences, printed approximately a third of the way down the screen. The participant would then press the space bar to bring up the first word. When the button was pressed again, the second word appeared and the first was replaced by dashes, and so on. Participants had the ability to stop presentation of the sentence at any point where it stopped making sense to them, by pressing a different key than the one used to bring up the next word. After a "stop-judgement," the current item terminated (without presentation of the remaining words) and a new item began. The amount of time the participant spent reading each word was recorded, as was the speed and position of a stop-judgement, if there was one. Simple true/false comprehension questions followed one-third of the items (as long as the sentence had not been terminated early), to make sure that the participant was indeed reading and comprehending the material. Of the items which were intended to elicit a stop-judgement, only the more subtle ones like (13d) were ever followed by questions.

In the presentation of the sentences, care was taken that a critical word or phrase did not appear at the right edge, where new-line effects could lengthen reading times. Approximately one third of all the sentences stopped making sense before the end of S2. The items were randomized separately for each participant. Before the main experiment, a short list of practice items was presented in order to familiarize the participant with the task. Each session with a participant averaged 30-45 minutes.

Participants. The study population consisted of undergraduate students from introductory linguistic at the University of Massachusetts in Amherst. They were given class credit for their participation. Twenty-six participants were tested.[5] The participants were native speakers of

[5]I attempted to increase the number of participants in the experiment by running a group of introductory psychology students. However, the data from these participants alone revealed no significant effects. We have found in the past that participants run at the end of the semester, as these were, are often unmotivated to do well in an experiment, yielding poor data. For these reasons, the data from the second group of participants is not included in the analysis below. When ANOVAs were performed on all data with Group as a factor, all of the significant effects reported below remained significant. In addition, there were reliable effects of and interactions with Group.

English and naive as to the purposes of the study.

3.2.2 Results

For the purposes of analysis the items were divided into regions as indicated by vertical bars in (14).

(14) *Kelly showed | a photo | to every critic | last month. | The photo(s) was/were | of a run-down | building.*

Only data from sentences which were judged to make sense in their entirety were analyzed. In addition, the data from three participants has been eliminated completely. One participant rejected every item in one of the conditions, another rejected all but one item in one condition, and the third answered less than 65% of the comprehension questions for the target correctly. The remaining data were trimmed to within 3 standard deviations of the mean for each word. Times above the cutoff (= 2% of data points) were ignored.

The mean residual (length-adjusted) reading times for each analysis region are shown in Figure 3.1 (pg. 67). See Appendix A for a table of raw and residual reading times and raw time analyses.

In the critical 3-word region consisting of the subject DP and following auxiliary or verb in S2, a two factor ANOVA yielded a main effect of Q-order (-47.11 *a-every* vs. -83.82 *every-a*), $F_1(1,22) = 10.57$, $p = .004$; $F_2(1,19) = 6.17$, $p = .023$; and a marginal effect of Number in the analysis by participants (-58.28 plural vs. -72.66 singular), $F_1(1,22) = 3.25$, $p = .085$; $F_2(1,19) = 3.0$, $p = .102$. The Q*N interaction was also significant, $F_1(1,22) = 9.61$, $p = .005$; $F_2(1,19) = 9.74$, $p = .006$. Means comparisons indicated that, as predicted by the PSI, the effect of Number in the *a-every* conditions was reliable (a<b), $F_1(1,22) = 12.54$, $p = .002$; $F_2(1,19) = 11.32$, $p = .003$. On the other hand, as expected under K&MacD's account but not under the PSI, there was no true difference between the *every-a* conditions (c) and (d), $F_1(1,22) = 2.25$, $p > .14$; $F_2(1,19) < 1$.

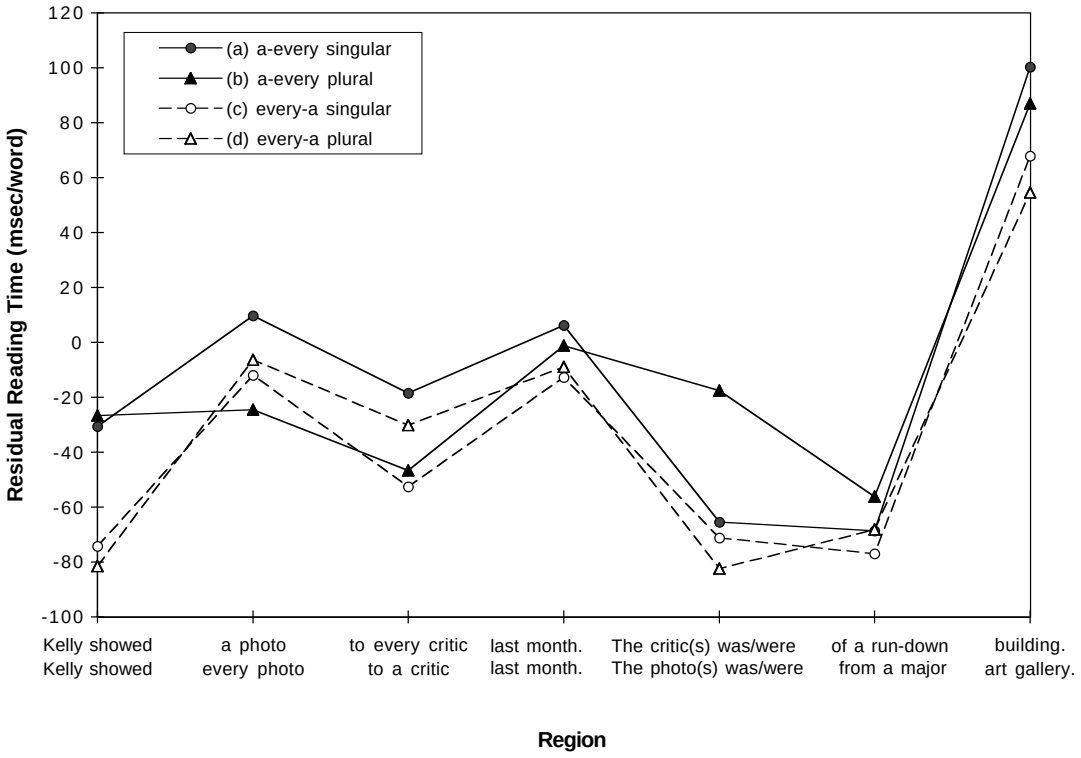

Figure 3.1 Length-adjusted reading times for each analysis region in Experiment 1 (given as deviations from predicted)

In region 6, the three words following the critical region, the effect of Q-order was marginal by participants, with *every-a* continuing to be faster (-64.84 *a-every* vs. -82.93 *every-a*), $F_1(1,22) = 3.58$, $p = .072$ (the items analysis could not be performed due to unequal N). In the final region of the continuation sentence there were no significant effects.

Region analyses were also conducted for S1. Except for an effect of Q-order in the subject region, $F_1(1,22) = 6.64$, $p = .017$; $F_2(1,19) = 6.88$, $p = .017$, before any differences were present and thus presumably due to an accidental effect brought on by the task, all effects were thoroughly non-significant. That there were no reliable differences in reading times across conditions in S1 is a new and informative result; Kurtzman & MacDonald (1993) did not report reading times in their article. This finding suggests that there are no robust on-line effects of reading different quantifier-orders in multiply-quantified sentences, either at the quantified phrase or a few words downstream.

Residual reading times (deviations from predicted scores) have been presented here in order to factor out the effects of length as best as possible. While this technique is not perfect, it is better than using either raw scores or the msec./character correction (Trueswell, Tanenhaus, & Garnsey 1994, App. B). Although residual scores are adjusted for length, I would like to argue further that the effects detected at the critical region in S2 are not due to the length confound in that region (the plural continuation was on average one character longer than the singular). While in principle it is possible to account for the main effect of Number based on length differences, since plurals did take longer to read than singulars, the main effect of Q-order does not fall out of such an analysis. Furthermore, the fact that there is a Q*N interaction argues that the effect of Number is a true effect. If there were a length penalty for plurals, we would expect it to show up equally in both plural conditions. Instead, the data show that condition (b) was the worst cell.

One possible explanation for the Q-order effect in the critical region is that it is simply a lexical access effect, since different lexical items were used in the different quantifier-orders. Two points argue against such an analysis. First, this is the second time the word was seen (it occurred after *a* in S1) and thus lexical effects should be small. Second, the Q-order effect is reflected in the following region as well, where lexical effects are not likely to show up. In sum, there is good reason to believe that the effects observed at the critical region in S2 are true effects.

Table 3.1 (pg. 69) presents the number of stop-judgements which occurred at or after the critical subject noun in S2 (i.e. after *the*) for each condition. The figure in parentheses is the percentage of available trials that were rejected at or after this point (out of a total over all participants and items of between 105 and 113, depending on the condition, once early rejections have been factored out).

Table 3.1 Total Number and Percentage of Sentences
Rejected at or after the Subject Noun in S2 in Experiment 1

	singular	plural
a-every	(a) 9 (8%)	(b) 4 (4%)
every-a	(c) 7 (7%)	(d) 13 (12%)

As the table indicates, there were very few rejections for the dative sentences. A two factor ANOVA yielded a significant interaction of Q-order and Number by participants, marginal by items, $F_1(1,22) = 7.83$, $p = .010$; $F_2(1,19) = 3.68$, $p = .070$, reflecting the difference between (d) and the other conditions. This difference may be due to the fact that in (c) and (d) there is a smaller distance between the first and second instances of the noun *critic* than there is between the instances of the noun *photo* in (a) and (b). In (d) vs. (c) this shorter distance may create a problem since the two occurrences of the noun do not match in number marking. The greater number of rejections in (d) may simply reflect the subject noticing this number mismatch.

For fillers which stopped making sense and for other subexperiments the percentage of stop-judgements was much higher, indicating that the participants were indeed performing the stops-making-sense task and not simply doing self-paced reading.

Twelve of the twenty target items were followed by simple comprehension questions. In all conditions the percentage of questions answered correctly was at or above 90%. An ANOVA performed on the error data indicated no significant effects (all Fs < 2). The overall comprehension rate on questions was 93%.

3.2.3 Discussion

On the face of it, the outcome of Experiment 1 appears to fully support neither the Principle of Scope Interpretation which I proposed nor Kurtzman & MacDonald's (1993) combination of principles. Only one prediction of each of these approaches was confirmed. The PSI predicted the a<b finding (the singular continuation being read faster than the plural continuation in the *a-*

every order) and K&MacD predicted the c=d finding (the two continuations being read equally quickly in the *every-a* order). I will argue that the pattern of results is difficult to reconcile with K&MacD's theory without making considerable changes to it, but that it is easily explained under the PSI once facts about the semantics of scope are incorporated into the theory. We will see, though, that the results of Experiment 1 provide no support for combining the Principle of Scope Interpreta-tion with the Existential Direct Objects Hypothesis. This theory predicted a preference for wide-scope *every*, and therefore faster reading time on the plural continuations, in both quantifier-orders.

3.2.3.1 The Principle of Scope Interpretation and Vagueness

According to the PSI, it is the first quantifier in the quantified sentences in (15), repeated from (12), which should be given wide scope, since it c-commands the second quantifier in the required LF representation.

(15) a/b. *Kelly showed a photo to every critic last month.*

a. *The photo was of a run-down building.*

b. *The photos were of a run-down building.*

c/d. *Kelly showed every photo to a critic last month.*

c. *The critic was from a major gallery.*

d. *The critics were from a major gallery.*

This theory predicts that the singular continuation (a) should be read faster than the plural continuation (b) in the *a-every* quantifier-order. In the quantified sentence in (a/b), *a photo* is given scope over *every critic*. As a result, the processor commits to there being a single relevant photo in the model. The plural continuation (b) causes difficulty since it requires multiple relevant photos. As predicted by this reasoning, reading times for the critical region (subject + aux/verb) in S2 were found to be significantly slower in (b) than in (a).

In (c/d), the plural continuation (d) was expected to be favored, since it was assumed that when *every* is given wide scope over an indefinite DP there is more than one instantiation of that

indefinite in the model (here, more than one critic). Contrary to these expectations, there were no differences between (c) and (d) at the critical region. Nevertheless, this finding makes sense if we recall the point made earlier about the semantics of scope. The *every photo* > *a critic* scoping does not require that there is a different critic for each photo, it merely makes it possible. The wide-scope *every* interpretation in (c/d) allows there to be one or more critics. I propose that when the processor gives *every* wide scope it can remain vague on how many critics are involved. This information can then be filled in by subsequent context, as it is by the continuation sentences in (15). On this approach, stated in (16), the singular and plural continuations are equally easy– both fill in information about the number of critics, which was not previously specified– and the c=d result is explained.

(16) Vagueness Principle

> When the processor gives *every* wide scope over an indefinite, it can remain vague (underspecified) as to whether the indefinite is multiply instantiated or not. This information can be filled in by further inferencing or by subsequent context.

Underspecification has been proposed to account for other phenomena in language processing as well (see e.g. Frazier & Rayner 1990).

Angelika Kratzer (p.c.) has suggested another account for the results obtained in Experiment 1. It still assumes the PSI, but approaches the semantics differently. Suppose that indefinites are ambiguous not between a strong/quantificational reading (serving as an operator) and a weak/existential reading (being bound by the existential closure operator) as Diesing argues, but between a quantificational and referential reading (cf. Fodor & Sag 1982). On a referential interpretation, an indefinite refers to a singular entity in the world/model. The identity of this referent does not vary, no matter which elements *every* scopes over. It's as if the indefinite has wide scope. Suppose that sometimes the processor chooses a quantificational interpretation for an indefinite and sometimes a referential one. In (a/b), if the indefinite is taken to be quantificational, we expect longer reading times in (b) since the indefinite gets wide scope and the singular continuation is supported, as described above. On a referential reading, the indefinite appears to have wide scope, so the same result is expected.

In (c/d), on the other hand, the two readings of the indefinite result in different (apparent) scopings. If quantificational, *every* is given wide scope over *a* by the PSI, and the plural continuation (d) is favored and read faster than the singular continuation (c), d<c. If referential, it is as if the indefinite had wide scope and the singular continuation is favored, c<d. If approximately half the time the processor chooses one interpretation for the indefinite and half the time the other, these will cancel each other out, c≈d.

Although this proposal is interesting, it is not supported by further examination of the data from Experiment 1 or by what we know in general about language processing. First, for this approach to account for the present pattern of results it is necessary to assume that the processor is choosing 50/50 between the quantificational and referential reading of the indefinite – as if it were flipping a coin. However, there is little evidence within psycholinguistics that the processor ever proceeds in such a fashion. Rather, it is influenced in its decisions by general processing principles, lexical biases, and other factors.

Secondly, if this "coin toss" hypothesis were correct we would expect greater variation in the (c) and (d) continuations than in the (a) and (b) ones, since it would be as if the (c) and (d) cases contain two distributions. In (c) and (d), if the indefinite were taken to be quantificational, the singular (c) should have been hard and the plural (d) easy; vice versa if the indefinite were taken to be referential. So responses to (c) and (d) should have each varied between being easy and hard, fast and slow. On the Vagueness account, on the other hand, (c) and (d) are expected to be equally easy. Examination of the standard deviations for the critical region in S2 (subject + aux/verb), given in Table 3.2 (pg. 73), supports the Vagueness approach over the coin toss hypothesis. The SDs for the (c) and (d) items are not higher than those for the (a) and (b) items.

It is certainly possible that indefinites can get either a quantificational or referential interpretation in the grammar, but it is unlikely that the processor chooses randomly between them. There is no evidence that a referential reading is entertained for the indefinites in the dative sentences used in Experiment 1. Perhaps this is because both the direct object and the indirect object occur rather rightward in the sentence, while referential readings are often

Table 3.2 Standard Deviations for Residual Reading Times at the Critical Region in S2 (Subject + Aux/Verb) by Participants in Experiment 1 (by Items in parentheses)

	singular		plural	
a-every	(a) 71.83	(44.62)	(b) 63.30	(67.96)
every-a	(c) 68.21	(52.09)	(d) 86.45	(34.03)

associated with leftward phrases such as subjects.

To account for the results of Experiment 1, then, I adopt the Principle of Scope Interpretation in conjunction with the Vagueness Principle.[6] Note that if the Vagueness approach is correct, a methodological problem with Experiment 1 and the experiments in K&MacD is confirmed. The continuation sentences were not consistent with only one scoping of the quantifiers in the quantified sentence as they were intended to be. This point underscores the need, which K&MacD also recognize, for better techniques for studying scope ambiguities, techniques which can measure in the quantified sentences themselves.

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[6]Recall from Chapter 2 that Gillen (1991) included some dative sentences in her later experiments. In principle, her data could potentially help to further support the theory proposed here, but it is in fact not very enlightening. The dative items were tested along with other DP PP items as in (i). The quantifier-order for these items was indefinite-first.

(i) *Margaret served a scone to some customers.*
Bob suggested a schedule for all teachers.

Based on the results from my Experiment 1, I would expect a preference for wide-scope *a* here. In Gillen's Experiment 10, which used continuation sentences like those I employed, the singular continuation should have been read faster. Unfortunately, the reading times for the different continuations were not reported, so this prediction cannot be tested definitively. However, overall in the experiment (which also included double object sentences with the indefinite QP occurring second) the singular continuation was faster and Gillen comments (p. 176) that this effect was particularly strong in the DP PP items, advancing some support for the prediction.

In Gillen's Experiment 8, the wide-scope indefinite diagram should have been preferred for sentences like (i). This was not found. For these items and overall in the study the wide-scope universal diagram was accepted more often. This is the reverse of the main effect of diagram in her passive/active study. It is unclear what is behind these diagram effects.

Furthermore, it is probable that the various DP PP sentences that Gillen used do not have the same syntactic structure. The kind of preposition or the location of the PP in the structure could effect scope preferences (cf. Pica & Snyder, 1995).

3.2.3.2 Evaluation of Predictions Made by Kurtzman & MacDonald (1993)

The theory that initial quantifier scope preferences are determined by the interaction of a number of constraints on scope assignment in the way that K&MacD (1993) suggested cannot account for the results of Experiment 1 without a number of changes, including the addition of the Vagueness Principle. Their approach predicted that there would be no strong scope preferences in dative sentences, as in passives, since the scope principles are in conflict: the C-command (or Linear Order) Principle favors forward scope, and the Thematic Principle favors inverse scope.[7]

A critical difference between K&MacD's theory of scope preferences and the PSI-based theory is the claim that something other than the relative c-command relation of the QPs influences which scoping is preferred. They propose that the relative position of the thematic roles of the QPs on the thematic hierarchy plays a role as well. The results of Experiment 1 seriously question this claim.

Under K&MacD's theory without the Vagueness Principle, the result that the (c) and (d) continuations are read at about the same speed is interpreted as indicating that there is no scope preference in (15c/d), as was predicted. But the finding of a strong preference for the forward scoping in (15a/b) is left unexplained.

With the addition of the Vagueness Principle, on the other hand, the puzzling aspect of the results of Experiment 1 for K&MacD's theory concerns the Thematic Hierarchy Principle. Under Vagueness, Experiment 1 provides evidence for forward scoping in both (a/b) and (c/d), supporting the Linear Order and/or C-command Principles but not the Thematic Principle. Perhaps the Thematic Principle is ranked below the Linear Order and C-command Principles,

[7]It is worth noting here that Pica & Snyder's (1995) theory of scope preferences also wrongly predicted that neither scoping would be particularly preferred in datives. Their approach is somewhat similar to mine, but they allowed the *to*-phrase the choice to either c-command the direct object at LF, or be c-commanded by it. If half the time one position is selected and half the time the other is, both scopings will be equally supported. They do not go into what might determine the choice. See Chapter 2 for a review of their paper.

and that is why it appears to have little effect. K&MacD briefly mention sentence processing models which rank constraints but do not attempt to rank the scope principles. Alternatively, the Thematic Principle could be wrong altogether: it predicted wide scope for the indirect object, opposite to the other principles, and there is no obvious way to reconcile the results with this prediction. Whether it is discarded or lowly ranked, the Thematic Principle and the scope preference data it is meant to account for (in K&MacD and elsewhere) should be re-examined.

As a first step to doing this, I tried to replicate the findings from K&MacD's Experiment 1, where simple subject-object active sentences were tested. K&MacD used two types of verbs in that study: action verbs like *climb* and perception verbs like *see*. With action verbs, the thematic roles of the subject and object QPs are agent and theme, respectively, while with perception verbs they are experiencer and theme. In both cases, the Thematic Principle predicts wide scope on the subject should be preferred (just as C-command does). Moreover, since agent and theme are farther apart on the thematic hierarchy than experiencer and theme, the Thematic Principle predicts a greater preference for subject wide scope with action verbs than with perception verbs. K&MacD found some effects along these lines. Replicating these findings would offer support for the Thematic Principle.[8]

Running the subject-object sentences also gave me an opportunity to see whether the pattern of results found above in the dative sentences were particular to the dative construction or to sentences in which both quantifiers were non-subjects.

3.2.3.3 Attempted Replication of Kurtzman & MacDonald's Experiment 1

For the attempted replication of K&MacD's first experiment a self-paced region-by-region reading task was used. Their 32 target items were run in four conditions: Quantifier-order (*a-every*, *every-a*) was crossed with Number (singular, plural); see (17). Half the items contained

[8]However, how influential the Thematic Principle could be in cases where it is in conflict with c-command, such as in datives and passives, would still be unclear.

action verbs, half perception verbs.[9] The quantified sentence was presented in a single region, followed by the continuation sentence in a single region. One or two additional sentences were added after the continuation sentence in each item in order to match the length of other items in the experiment. These sentences were presented in regions of similar length to the quantifier and continuation sentences. There was a total of 96 items in the study. After each item, a yes/no comprehension question was given.

(17) a/b. *A kid climbed every tree.*

a. *The kid was full of energy.*

b. *The kids were full of energy.*

c/d. *Every kid climbed a tree.*

c. *The tree was full of apples.*

d. *The trees were full of apples.*

The results from 40 participants revealed two reliable main effects in the continuation sentence, of Quantifier-order and Number; *a-every* items were read more slowly than *every-a* items, and plural continuations were read more slowly that singular continuations (see Figure 3.2, pg. 77). As K&MacD found, there was a larger effect of Number in the *a-every* conditions than in the *every-a* conditions, so that the plural continuations in the *a-every* sentences were read particularly slowly. Although this pattern did not give rise to a significant interaction between Q-order and Number, it was supported statistically in the pair-wise contrasts. There was a significant effect of Number in the *a-every* conditions (a/b; marginal in the items analysis), versus a nonsignificant effect of Number in the *every-a* conditions (c/d). Furthermore, one-factor ANOVAs on the effect of condition showed (i) that there was some difference among the four conditions, (ii) that conditions (a,c,d) differed from condition (b), and (iii) that conditions (a,c,d) did not differ from each other. In other words, condition (b) was the worst cell, as in

[9]In addition, all of the continuation sentences started with the determiner *the*. K&MacD used *that* in half of the items, but found no effect of determiner.

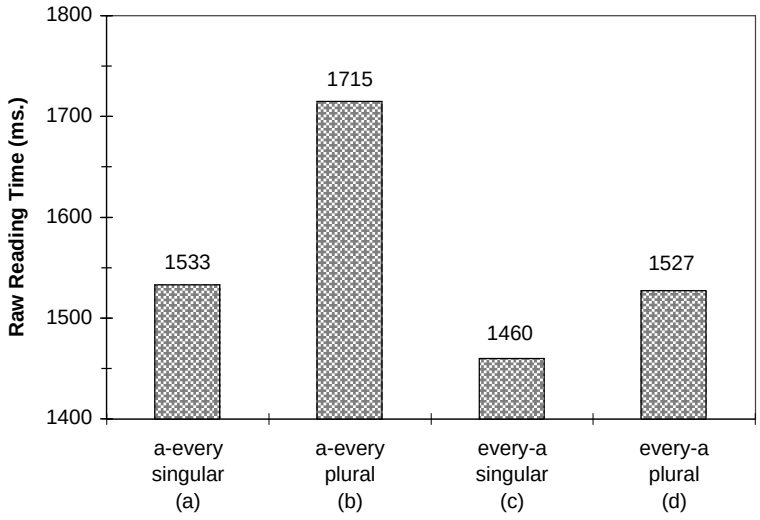


Figure 3.2 Raw reading times for S2 in
attempted replication of Kurtzman & MacDonald's Experiment 1

Experiment 1.[10]

There were no significant effects in the quantified sentence or in the first region after the continuation sentence.

As for Verb Type, the pattern of means did not match that found by K&MacD, and no reliable effects were found. Thus the results which supported the Thematic Principle were not replicated, calling the role of this principle in determining scope preferences further into question.

Importantly, though, the basic pattern of reading time results for subject-object sentences shown in Figure 3.2 reflects the primary compatibility-judgement findings that K&MacD report. It also matches the pattern of reading time results for dative sentences in my own Experiment 1. The PSI, in combination with the Vagueness Principle explains this pattern as follows: Forward

[10]Raw reading times have been presented here rather than residual times (corrected for length) because the correlations of reading time and length were quite low for most participants. Since condition (b) is generally two characters longer than condition (a), one might argue that the effect of (b) being read more slowly is just due to length. However, this reasoning predicts that (d) would have been slower than (c), which was not found.

scope is preferred in both constructions, in both quantifier-orders. When *every* has scope over *a*, the processor remains vague about whether the indefinite is multiply instantiated or not. As a result, both plural and singular continuation sentences are compatible with the scoping and are read with little difficulty. When *a* has scope over *every*, multiple instantiation of the indefinite is not possible, so only the singular continuation is consistent with the scoping. Hence, this continuation is read more quickly than the incompatible plural continuation.

One might ask, however, why there seems to be a preference for the plural continuation over the singular continuation with the *every-a* items in K&MacD's study. There is no such preference in the attempted replication: a contrast looking at the effect of Number in the *every-a* conditions was not significant. K&MacD do not report a corresponding contrast, but the numeric pattern of responses is suggestive of a reliable effect. Estimating from their graph, the percentage of Yes/Compatible responses for the singular continuation (c) was 46%, while for the plural condition (d) it was 74%. Why did K&MacD find a preference for the plural continuation with the judgement task while I found no such preference with a straight reading task? One possibility is that by the time a participant had read the entire continuation sentence and decided whether it was a good continuation or not, higher level processes had kicked in which resolved vagueness to a multiple instantiation of the indefinite, favoring the plural continuation. The reader may have reasoned that since the quantifier-order *every-a* was used, *every>a* scoping was intended, and the most informative interpretation of that scoping is multiple/plural. If the speaker knew that there was only one entity associated with the indefinite, s/he would have chosen to use a sentence for which the default scoping was *a>every*. In the reading task, these processes have not applied by the time the participant presses the space bar to see the next segment of the item, and the Vagueness Principle allows both continuations to be read easily.

3.2.3.4 A Preference for Existential Direct Objects?

Before moving on, I turn briefly back to the Existential Direct Objects Hypothesis. The EDOH, in combination with the Principle of Scope Interpretation, predicted wide-scope

every would be preferred in both quantifier-orders, and therefore the same pattern of results would be observed in the two orders. But there is no evidence that the *every>a* scoping is preferred for the *a-every* quantifier-order. The EDOH as stated is wrong. This does not necessarily mean that there is not a preference to interpret DOs as existential/weak; the preference may have been overridden in the experimental items. Further research into whether/which indefinites prefer an existential reading is necessary, independent of questions of relative scope preferences. For the remainder of the dissertation, I will assume that DOs do not have an existential preference and, as stated in section 3.1.1 before the EDOH was proposed, that all DOs raise to [Spec,AGRoP] at S-structure.

3.3 Scope Preferences in Other Constructions

According to the Principle of Scope Interpretation, the preferred scoping of a quantified sentence is computed from the required LF structure of that sentence, where the required LF is determined by required grammatical operations acting on the S-structure. Generally, syntactic operations do not change the c-command relations between QPs, so surface c-command is often a good predictor of scope preferences. Experiment 1 provided support for the PSI in looking at scope preferences in datives. The attempted replication of K&MacD's Experiment 1 did the same with active subject/object sentences. In this section I consider the predictions of the PSI for scope preferences in a variety of other constructions and review the relevant experimental results when there are results available.

3.3.1 Passives

While there is considerable disagreement about how to analyze passive constructions syntactically and semantically, under most analyses the (surface) subject c-commands the *by*-phrase, and there is no grammatical reason to move the DP in the *by*-phrase above the subject at LF. According to the PSI, then, there should be a preference for the forward scoping of *a>every* in a sentence such as (18):

(18) *A puppy was hugged by every boy.*

The available data generally supports this prediction, but it also suggests that the preference in passives may be less strong than in corresponding active sentences.

While a c-command-based principle predicts a forward scoping preference in passives, other principles, such as the Thematic Hierarchy Principle which K&MacD advocate for, predict an inverse scoping preference. Thus, if something other than c-command is at work in resolving scope ambiguities, evidence for it might show up well in passives.

In their Experiment 2, Kurtzman & MacDonald investigated the passivized versions of the items they had used in Experiment 1, using the same design and procedure. The results yielded a slight preference for wide scope on the subject significant by participants but not by items, as opposed to the strong preference for subject wide scope in the corresponding actives. Kurtzman & MacDonald take the combined results of their Experiments 1 and 2 to indicate that more than one principle is involved in determining quantifier scope (e.g. the C-command Principle and the Thematic Principle). They suggest that the principles converge on the forward scoping in actives, yielding strong preferences for that interpretation, but in passives the principles are in conflict, sometimes one "wins" and sometimes another does, so that there is no consistent preference for one scoping or the other.

There is clearly a contrast between actives and passives in Kurtzman & MacDonald's data which deserves an explanation, but in presenting one Kurtzman & MacDonald seem to lose track of the fact that statistically the forward scoping was significantly preferred in the passives (though only on the analysis by participants). In their terms, one principle was, in fact, winning more often in the passives, just not as frequently as in the actives. I would argue that this principle is the PSI, and that other factors are coming in to override the default forward scoping. The degree to which there is a difference in the strength of scope preferences in actives vs. passives, however, is still unclear.

Studies by Catlin & Micham (1975) and Gillen (1991) found little or no effect of voice. Gillen compared the active and passive versions of subject-object sentences in the same experiment. Her

results provide further support for the theory that scope preferences are generally determined by c-command relations. They contrast with Kurtzman & MacDonald's findings in that passives patterned with actives, rather than passives showing weaker effects.

The differences between the results of the two studies could perhaps be ascribed to the differences in task. In both experiments, participants began by reading a doubly quantified sentence. Following this, Gillen had participants judge whether a diagram accurately represented the meaning of the quantified sentence, while Kurtzman & MacDonald had participants judge whether a second sentence was a compatible continuation. More reflection about the meaning of the quantified sentence could be needed for the former task than for the latter. In addition, people are used to reading sentences but not to looking at the kinds of diagrams that Gillen used. Hence, her findings could be argued to be less of an indication of the natural understanding of the quantified sentence.

In terms of getting at a reader's first interpretation of a quantified sentence, however, both tasks are lacking. A simple self-paced reading task, without a secondary judgement task of any kind, would be better suited. Additional data on scope preference in passives as compared to actives might reasonably be gathered in a self-paced reading study using the ambiguous items from Kurtzman & MacDonald's Experiments 1 and 2, crossing voice with quantifier order and interpretation. Reading times on the continuation sentence could be compared across conditions. On the theory I have developed in this chapter, a preference for forward scoping in both actives and passives is expected. Given the various differences between the two constructions, though, it would not be surprising to find that the strength of scope preferences differed as well. Factors other than c-command may be involved, which can override the default forward scoping on some occasions. Considering the results of my Experiment 1 on datives and of the attempted replication of K&MacD's study on actives, the Thematic Hierarchy Principle does not seem to be the answer. Hence what the critical factors are remains to be determined. [11]

[11]For a review of early psychological studies on how various discourse factors influence the use of actives vs. passives, see Anisfeld & Klenbort (1973).

3.3.2 Double Object Constructions

Double object constructions, like dative constructions, contain both a direct object (DO) and an indirect object (IO). In double object sentences, such as (19), the indirect object precedes the direct object, and neither object is introduced by a preposition.

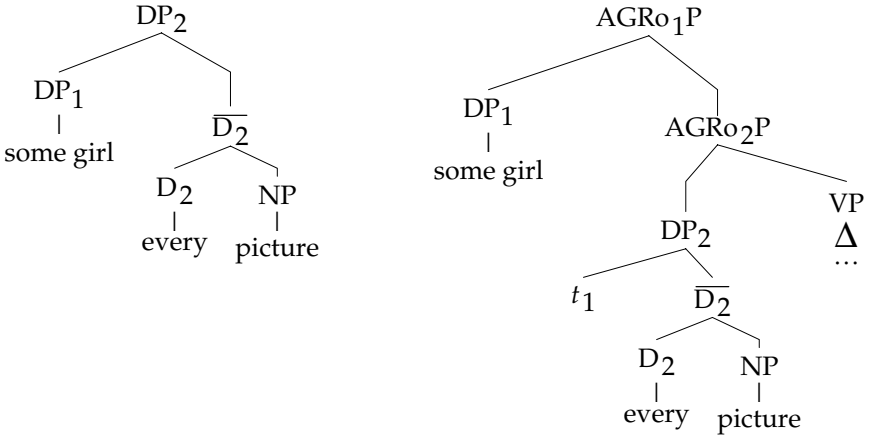
(19) *Sarit showed some girl every picture.*

A variety of syntactic tests indicate that the indirect object asymmetrically c-commands the direct object. It is widely agreed that there is a very strong preference for the indirect object to take scope over the direct object when quantified phrases occupy both positions– stronger than for the forward scope reading in a dative sentence. Many researchers take this further and claim that sentences like (19) are unambiguous, with the inverse scoping being unavailable (among them Larson 1988; Hornstein 1995).

The forward scope preference is what is predicted by the PSI, but the question arises as to why it should be so strong. Under most syntactic analyses of the double object construction, the scope bias is accounted for by having the inverse scoping violate a syntactic constraint of some kind.

According to Runner (1995), for example, the two objects underlyingly form a 'clausal DP' constituent (a variation on a proposal by Johnson, 1991), as schematized in (20a). Both objects appear in [Spec,AGRP] positions at S-structure: DP_1 in [Spec,$AGRo_1P$] and DP_2 in [Spec,$AGRo_2P$]. DP_2 contains the trace of DP_1, as shown in (20b).

(20) a. Underlying clausal DP b. Surface structure



In order to satisfy the ECP (a grammatical condition on traces), *some girl* must c-command its trace. As a result, it also always c-commands *every picture*, since there is no way for *every picture* to QR over *some girl* and leave the trace of *some girl* behind.

Aoun & Li (1989; 1993) propose a general theory of which sentences should be scopally ambiguous. Differences across constructions, as well as across languages, are ascribed to differences in syntactic structure. They assume that double object sentences generally only have the forward scoping, but do admit there is some variability. In their (1989) article they report that they asked numerous native English speakers their intuitions on the sentences in (21) and (22). None of their informants found the examples in (21) ambiguous, but some speakers could get both scope readings for (22).

(21) a. *The committee gave some student every book in the library.*

b. *John asked two students every question.*

(22) *Mary showed some bureaucrat every document she had.*

To account for the variable judgements for (22), they suggest that for certain speakers and/or certain verbs, double object sentences have a different structure than usual, one which permits both scopings. They do not attempt to explain why this should be the case.It is unclear how often the inverse scope interpretation is available in double object sentences. Empirical data on scope

preferences in the construction is sparse. While Micham et al. (1980) looked at sentences with verbs that can occur in both the double object and dative constructions and verbs that take double PP complements, they do not give the results from the two sets of verbs separately. Gillen (1991) ran double objects sentences in her Experiments 8 and 10 (see Chapter 2 for a review), but the results are not very informative. She ran only one quantifier order– the indefinite was always second. Samples of her double object items are given in (23):

(23) *Margaret served some customers a scone.*

Bob left all teachers a schedule.

If these sentences scopally unambiguous, then the wide-scope indefinite reading should be unavailable. This prediction cannot be tested by looking for a very low rate of acceptance of wide-scope indefinite diagrams in Gillen's Experiment 8 or slow reading times of singular continuations in her Experiment 10, since the Vagueness Principle allows for these to be compatible with a wide-scope universal interpretation. Gillen did find, though, that reading times for quantified double object sentences were faster than for related DP PP sentences in both studies. Possibly a strong scope preference in double objects leads to an easier and faster interpretation.While experimental data is lacking, that there is at least a strong preference for forward scoping in double object constructions is fairly clear. By itself, my theory cannot handle this; something extra is needed to get the difference in the strength of the preference for forward scoping between double objects and datives. The "something extra" is a grammatical constraint. Giving *every picture* inverse wide scope in (15) not only violates the PSI but the ECP as well. Grammatical conditions should be very hard to override. Therefore, the *every>some* reading should be very hard to get. For further discussion on the role of grammatical conditions, see sections 5.6.2 on sentences where one QP is contained within another.

Conceptually there is a difference between a sentence being ambiguous and having a very strong preference for one reading, but with the other reading still obtainable under certain conditions, and a sentence being unambiguous with the second reading absolutely unavailable. Depending how the data in scope-preference studies is gathered, though, these two cases may

look the same. It seems that at least for certain constructions participants ought to be asked not only what their preferred interpretation is, but also whether the other reading is available to them or not. Ioup's (1975) technique of using an ambiguity scale could potentially get at this question as well. Double objects are an obvious place to use one of these alternative methods.

3.3.3 Double PPs

Consider the double PP construction in (24). On standard analyses, c-command does not seem to obtain between the two QPs at S-structure. Given this, the C-command Principle for determining scope preferences, which is defined on surface c-command relations, does not apply. VanLehn (1978) makes a similar point in discussing the judgements he gathered for this example (p. 38):

(24) a. *Ron talked about a problem to each woman.* 50% *each* > *a*

b. *Ron talked to each woman about a problem.* 50% *each* > *a*

c. *Ron talked about each problem to a women.* 80% *each* > *a*

d. *Ron talked to a woman about each problem.* 75% *each* > *a*

From the judgements VanLehn provides, it appears that surface order does not play a role here either: there is no difference between (a) and (b) or between (c) and (d) (his linear order hierarchy does indeed predict no preference here, since both PPs are verb-phrase PPs). According to VanLehn, the higher percentage of wide-scope *each* in (c/d) must be due to other factors.

Although the C-command Principle makes no prediction in double PP constructions, the Principle of Scope Interpretation does. When the LF structure of these sentences is considered, the forward-scope reading is predicted to be favored. Runner (1995) argues that the first DP (quantified or otherwise) must raise at LF to [Spec,AGRoP] to get Case, and from that position it asymmetrically c-commands the second DP. Even if the second DP contains a strong quantifier, as in (24a,d), and must raise out of VP, by shortest-movement economy it will adjoin to VP rather than to a higher node and will still be c-commanded by the first DP in [Spec,AGRoP]. Based on this required LF structure, the PSI predicts the *a>each* scoping will be preferred in (24a) and (d)

and the *each>a* scoping will be preferred in (b) and (c).

These predictions are not supported by VanLehn's data, but that is just a single example. Other experimental data is not available. (Recall that Micham et al., 1980, included PP PP items in their study, but that the results from them were not reported separately from the results for double objects and datives.) It would certainly be interesting to gather more data on scope preferences in the various PP cases, though Kyle Johnson points out (p.c.) that verbs which take two PP complements are quite rare and the construction may be outside the core grammar.

3.3.4 One QP Within Another

Sentences like (25) and (26), in which one quantified phrase is contained within another (so-called inverse-linking structures), have always posed a problem for theories of scope based on surface c-command relations, since intuitions suggest that the lower quantifier generally takes wide scope over the higher quantifier. As is the case with the double object construction, many researchers go further and claim that only one scoping is available (though here it is the inverse scoping and with double objects it is the forward scoping).

(25) [$_{QP1}$ *All the gifts to* [$_{QP2}$ *some girl*]] *were wrapped in red paper.*
Reinhart (1983:196)

(26) *At the conference yesterday, I managed to talk to a guy from each/every raw rubber producer from Brazil.*
100% *each* > *a*
85% *every* > *a*
VanLehn (1978: 31)

The PSI correctly predicts that inverse scope should be preferred here. I will discuss these cases in detail in Chapter 5, where the results from two studies by Kurtzman & MacDonald (1993) on the construction are presented.[12] Briefly, my account goes as follows: For (semantic) type reasons, QP_2 must raise and adjoin to a clausal projection at LF to be interpreted. QP_1 cannot raise above QP_2, because then QP_2's trace would not be bound, violating the ECP. In the

[12]The topic of Chapter 5 is the effects of individual quantifiers on scope preferences, particularly *each* vs. *every.* The discussion of K&MacD's experiments on examples like (25) is postponed until then because they compared the behavior of *each* and *every* in their items.

required LF, then, QP_2 scopes over QP_1, so that is the preferred scope.

3.3.5 Summary

In this chapter I have developed a general theory of how quantifier scope preferences are determined. This theory was initially motivated and supported by two constructions. In this section I have examined the predictions of the Principle of Scope Interpretation for scope preferences in a number other constructions. In two of the cases considered here– passives with QPs as surface subject and in *by*-phrase, and double objects with QP objects– the leftward quantified phrase asymmetrically c-commands the other at S-structure. Thus the PSI predicts a preference for forward scoping. For passives, there is experimental data confirming this prediction, but it is unclear how strong the effect is. For double objects, there is wide intuitive support for the prediction. A third construction considered was double PP sentences. In these c-command does not obtain between the two QPs at S-structure, but required grammatical operations at LF yield forward scoping as the expected preferred scoping. There are no experimental results for these cases, and intuitions vary, so the prediction cannot yet be evaluated. For all three of these constructions, the gathering of more scope preference data in controlled experiments would be quite useful. At this point, the available data provides promising evidence for the PSI.

3.4 Concluding Remarks

Experiment 1 offers insight into basic questions related to the processing of quantifiers and paves the way for further research. I have argued that the preferred relative scoping of two quantified phrases is computed from the required LF structure and have accounted for this preference by a fundamental principle of processing economy, the Principle of Scope Interpretation. I have also provided support for the idea that when *every* has scope over *a*, the processor does not commit to how many entities the *a*-phrase represents (the Vagueness Principle). This number is left underspecified. Both economy and underspecification can be

considered parts of the general language processing system. There is evidence for these concepts in other domains.

The present study concerned scope preferences in dative sentences. Scope preferences in active and passive subject-object sentences, double object sentences, and double PP sentences were also discussed. As a general rule, when there is no evidence to change the default scoping as established by the PSI, the preferred scoping in a doubly-quantified sentence is the forward scoping of QP_1 over QP_2, when QP_1 c-commands QP_2 at S-structure. This is so because the required LF usually maintains the surface c-command relations between DPs. In other words, the C-command Principle falls out of the PSI in most cases. One place where the C-command Principle and the Principle of Scope Interpretation diverge is in complex NP structures, where one quantified phrase is contained within another, such as *a picture of every child*. These cases will be examined in detail in Chapter 5.

In addition to Experiment 1 on datives, I conducted an attempted replication of K&MacD's experiment on active subject-object sentences. This study provided additional support for the PSI and the Vagueness Principle– precisely the same pattern of results obtained for these items as obtained in the dative items. Both Experiment 1 and the attempted replication also yielded evidence against the Thematic Hierarchy Principle playing a role in determining scope preferences.

I have assumed that the processor builds only a single LF for each S-structure, according to General Processing Economy. An alternative would be to construct multiple LFs in parallel, ranking them by how economical they are. The preferred scoping would be the one computed from the most highly ranked LF. The PSI and Vagueness Principle can handle the results of Experiment 1 just as well in such a model as in a single LF system. The inverse scoping is dispreferred because the building of its LF involves an unrequired instance of QR to raise QP_2 above QP_1. Thus the LF for the inverse scoping is ranked below the LF for the forward scoping. The present findings therefore do not decide between the single LF approach vs. the ranked multiple LFs approach. Factors involved in constructing LFs other than those considered

here might distinguish the two views. I leave investigation of this question to future research.

The PSI was designed to provide an answer to the question of how structural factors affect quantifier scope preferences. The role of other factors was not considered in any detail. In the coming chapters the PSI-based theory will be expanded to incorporate the influence that individual quantifiers may have in determining scope preferences. Ioup (1975a), VanLehn (1978), and others argue for a hierarchy of a quantifier's tendency for taking wide scope. Fodor (1982) speaks of a quantifier's "hunger," its need to have something to scope over. *Each* precedes *every* on the hierarchy; that is, *each* is hungrier for wide scope. In investigating lexical biases, I will focus on the *each/every* contrast, attempting to define the differences between them in an explanatory way and to relate those differences to the manner in which quantifiers are processed in general. Chapter 4 presents the first part of this project, where I develop a linguistically motivated analysis of the differences in the meanings of *each* and *every*. In Chapter 5, I combine that analysis with the Principle of Scope Interpretation to provide an analysis of the differences in the scope behavior of these quantifiers and, more generally, present a theory of exactly when effects of individual quantifiers are expected in determining scope preferences.