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Connectivity at the Interface: Scope, Binding and Weak Islands*

Introduction

It seems as though there is not always a perfect match between syntax and semantics. The apparent mismatches most often (if not always) involve certain discrepancies between the semantic scope of an expression and its syntactic scope. That is, whether or not the valuation of β is a function of the valuation of α does not invariably depend on whether or not α c-commands β. Examples of this type of mismatch are provided in (1), assuming that bound variable anaphora in general require c-command (cf. Reinhart 1983). Following the terminology of Barss (1986,1988), we will refer to facts such as those in (1) as 'Connectivity'.

(1) *Connectivity*
   a. Which part of his_i life does no $politician_i$ like?
   b. There is a (certain) part of his_i life that every $politician_i$ dislikes

In this paper, we will explore the empirical and theoretical consequences of a uniform account of Connectivity which invokes quantification over so-called Skolem functions.[1] On this approach, 'disconnected' anaphora such as *his* in (1) are not syntactically bound

* This paper has also been presented at the *Colloque de Syntaxe et Semantique de Paris* in October 1997. I want to thank this audience as well as the audience present at the *Interface Strategies Colloquium* for their questions and comments. Over the past year or so, this paper has seen many different versions. The following people deserve special mention for their contribution to its present shape: Gennaro Chierchia, Carmen Dobrovie-Sorin, Manuel Español-Echevarria, Teun Hoekstra, Pauline Jacobson, Ed Keenan, Dominique Sportiche, and Jan-Wouter Zwart. Very special thanks go to Crit Cremers and Anna Szabolcsi, with whom I had many in-depth discussions on various aspects of this paper, and Michael Redford for sharing his intuitions with me. Finally, I wish to thank the two anonymous reviewers for their many helpful suggestions. For any remaining errors, I am entirely to blame.

[1] Cf. Jacobson (1994, 1997) for an account of Connectivity effects in copular constructions in terms of Skolem functions. The possibility of resolving non-c-command anaphora inside *wh*-phrases through quantification over Skolem functions is at least implicit in Engdahl (1986). For a very accessible discussion of Skolem functions, the reader is referred to Partee et al. (1990).

by their antecedents, but rather semantically. This type of distinction between syntactic and semantic binding is made possible by the fact that Skolem functions formally encode a more general distinction between syntactic scope (that is, c-command) and semantic scope (i.e. dependency of valuation). On the empirical side, this paper will demonstrate that a Skolem function-approach to 'disconnected' anaphora directly facilitates a natural account of certain intricate interactions between Connectivity and Weak Islands. On the theoretical side, this paper will reveal that a Skolem function-approach to Connectivity directly supports the following general strategy when studying properties of the interface: problems pertaining the matching of syntax and semantics are best accounted for, not by complicating the syntax of scope, so that it fits its semantics (i.e. Quantifying-In, Reconstruction, LF pied-piping etc.), but by complicating the semantics of scope, so that it fits its syntax.

1. The plan

This paper is organized as follows. In the next section, we will first show how 'disconnected' anaphora such as those in (1) can be resolved *in situ* by means of quantification over Skolem functions. In Section 3, we will discuss Weak Island effects on Connectivity. We will show that on a Skolem function-approach to 'disconnected' anaphora, their sensitivity to Weak Islands can be straightforwardly derived from Szabolcsi and Zwarts's (1993) semantic-algebraic theory of Weak Islands. A key observation here concerns the proper join semilattice structure of the set of all partial functions from (singular and plural) individuals to (singular and plural) individuals. Our discussion of binding interveners (such as *no politician* in 1a) versus non-binding interveners will make it clear that, even though the disconnected anaphora in (1) are not syntactically bound by their antecedents, they are semantically bound by them. Finally, Section 4 will conclude this paper with a discussion of the general plausibility and interest of the 'interface strategy' discussed above.

2. Connectivity and quantification over Skolem functions

Different readings of *wh*-sentences and relative clause constructions can be distinguished on the basis of their possible answers and continuations respectively. Consider for example the *wh*-interrogative in (2) below. As indicated in (2a–c), we can distinguish between three different readings on the basis of the different possible answers they determine.

(2) Which book did every politician$_i$ read?
  a. *single constituent reading*: Machiavelli's 'The Art of War'.
  b. *pair-list reading*: Kok read 'Frankenstein', Bolkestein 'The Art of War', ...
  c. *functional reading*: The book he$_i$ got on his$_i$ last birthday.

Likewise, Groenendijk and Stokhof (1983) have observed that different readings of relative clause constructions can be identified on the basis of their different possible continuations. This is illustrated in (3).

(3) There is a (certain) book that every politician$_i$ read, namely ...
  a. *single constituent reading*: ... Machiavelli's 'The Art of War'.
  b. *pair-list reading*: *... Kok read 'Frankenstein', Bolkestein 'The Art of War', ...
  c. *functional reading*: ... the book he$_i$ got on his$_i$ last birthday.

In the following, we will not be concerned with what actually explains the distribution of the readings identified in (2) and (3). We just make a note here of two relevant observations that can be made in this connection. Firstly, the presence of a bound variable anaphor inside a *wh*-phrase or 'antecedent' DP in constructions such as (2) and (3) eliminates the single constituent reading. The reason for this is intuitively clear. Due to the presence of a bound variable anaphor, the interpretation of the *wh*-phrase in (4) and the 'antecedent' DP in (5) must vary with respect to the interpretation of the binder of the anaphor. Secondly, only universal distributive DPs can support pair-list readings of matrix interrogatives (cf. especially Beghelli 1997 and Szabolcsi 1997). These two observations entail that the *wh*-sentence in (4) and the relative clause construction in (5) can only receive a functional reading (henceforth: *f*-reading).

(4) *Question*: Which part of his$_i$ life does no politician$_i$ like? (*f*-reading only)
  Possible Answer: His$_i$ days in college.

(5) *Statement*: There is a part of his$_i$ life that every politician$_i$ dislikes. (*f*-reading only)
  Possible Continuation: Namely, his$_i$ days in college.

Note that the examples in (4) and (5) were used in the Introduction to illustrate the general problem whereby the syntactic scope of an expression (here *no/every politician*) does not coincide with its semantic scope. It is natural then to see whether there are certain distinctive properties of the *f*-readings expressed through (4) and (5) that would void the need for any special syntactic machinery (such as the use of copies and LF deletion in present-day Minimalism; cf. Chomsky 1995) by means of which the syntactic scope of *no/every politician* can be aligned with its semantic scope. To this end, consider first the LF representations of (4) and (5) in (6a) and (7a) below respectively. These representations accord with Chierchia's (1993) proposal with respect to the LF of *f*-readings. On Chierchia's proposal, functional *wh*-operators leave behind a doubly indexed trace *e* where the subscript corresponds to the functional variable *f* bound by the *wh*-operator, and where the superscript corresponds to the argument variable of *f* (henceforth: *f*-argument) which is bound by the subject.[2] These LFs can be compositionally

[2] The use of doubly indexed traces can be dispensed with by means of a simple type-shift operation on likes′ if Jacobson's (1994, 1996, 1997) variable-free account of binding is assumed. To see how this would work, consider first (ia) below with the given indexing. On Jacobson's approach, the meaning of (ia) is to be composed as indicated in (ib–d) (ignoring intensions), where for any function R of type $\langle X,\langle e,Y\rangle\rangle$ (X and Y any type that ends in t), $\mathbf{z}(R) =_{def} \lambda f \lambda x\ (R(f(x))(x))$, and where f is of type $\langle e,X\rangle$.

(i) a. Every American$_i$ loves his$_i$ car translated into (6b) and (7b) respectively, where (6b) represents the meaning of (6a) on a Karttunen-style approach to the semantics of questions (cf. also Engdahl 1986). These logical representations in turn can be paraphrased as in (6c) and (7c) respectively. A final note of clarification: f in (6b) and (7b) is a functional variable ranging over (partial) Skolem functions from individuals to individuals (type $\langle e,e \rangle$).

(6) a. $[_{CP}$ $[_{DP}$ which part of his life$]_f$ does $[_{AgrSP}$ no politician$_i$ $[_{AgrOP}$ $[e_f^i]_j$ $[_{VP}$ like $e_j]]]]$
b. $\lambda p \exists f$ $(\forall z$ (part-of$'(\iota y$ (life-of$'(z)(y)))(f(z))) \wedge {}^{\vee}p \wedge p = {}^{\wedge}_\forall x$ (politician$'(x) \rightarrow$ $\neg$like$'(f(x))(x)))$
c. For which f, f a function which maps every person to a part of that person's life, no politician x likes $f(x)$?

(7) a. There is $[_{DP}$ a $[_{NP}$ part of his life$]$ $[_{CP}$ O_f that $[_{AgrSP}$ every politician$_i$ $[_{AgrOP}$ $[e_f^i]_j$ $[_{VP}$ dislikes $e_j]]]]]$
b. $\exists f (\forall z$ (part-of$'(\iota y$ (life-of$'(z)(y)))(f(z))) \wedge \forall x$ (politician$'(x) \rightarrow$ dislikes$'(f(x))(x)))$
c. There is a function f, f a function which maps every person to a part of that person's life, such that every politician x dislikes $f(x)$

The representations in (6b) and (7b) give rise to a rather surprising conclusion: the 'disconnected' anaphora in (4) and (5) do not pose any problem for a theory of binding which requires c-command. The bound variable anaphora are simply not bound by the subject DP. If anything, the subject DPs in constructions such as (4) and (5) bind the f-argument of the functional trace left behind by *wh*-movement, as shown in the LF representations in (6a) and (7a). Why then do we have the impression that in sentences such as (4) and (5) the bound variable anaphor is referentially dependent on the subject? According to the present analysis, this deception originates from a conspiracy of two distinctive properties of the functional questions/statements expressed by these sentences. Firstly, the subject binds the f-argument in the nuclear scope of the existential quantifier over Skolem functions denoted by the *wh*-phrase or 'antecedent' DP. Secondly, the bound variable anaphor provides the f-argument in the restrictive clause of the existential quantifier over Skolem functions denoted by the *wh*-phrase or 'antecedent' DP. Thus, we can schematize over (6b) and (7b) as follows:

(8) $\exists f(_{\text{Restrictive Clause}}\ \forall z\ (P(f(\text{pronoun}_z))))\ (_{\text{Nuclear Scope}}\ DP'_x\ (Q(f(x))))$

b. $\lambda P \forall x$ (american$'(x) \rightarrow P(x))(\mathbf{z}($loves$')(\lambda v \iota y$ (car-of$'(v)(y))))$
c. $\lambda P \forall x$ (american$'(x) \rightarrow P(x))(\lambda f \lambda x$ (loves$'(f(x))(x))(\lambda v \iota y$ (car-of$'(v)(y))))$ (def. of $\mathbf{z}$)
d. $\forall x$ (american$'(x) \rightarrow$ loves$'(\iota y$ (car-of$'(x)(y)))(x))$ (λ-conversion)

Thus, the functional traces e in (6a) and (7a) in the main text can simply be replaced by e_f if we assume that likes$'$ type-shifts into $\lambda f \lambda x$ (likes$'(f(x))(x))$ through $\mathbf{z}$.

Anticipating the outcome of our discussion of (4) and (5) in the main text, we may note that Jacobson's variable-free semantics offers an extremely natural environment for a Skolem-function approach to Connectivity, since the type-shift operation $\mathbf{z}$ through which binding is mediated on her account introduces functional variables f.

Hence, our feeling that the subject actually binds the pronoun inside the *wh*-phrase or 'antecedent' DP, whereas on our analysis it would be more appropriate to say that the pronoun is bound internal to the *wh*-phrase or 'antecedent' DP. Assuming the usual c-command requirement on bound variable anaphora (thus including our *f*-arguments), the two properties combined allow us to dispense with the need for any special syntactic device by means of which we can align the syntactic scope of *no/every politician* in (4) and (5) with its semantic scope. In fact, we will see in the next section that in view of certain distinctive scopal properties of 'Skolemized' logical representations, there is a clear sense in which the subject DPs in (6a) and (7a) can be said to semantically bind the relevant 'disconnected' anaphora, even though they do not bind them syntactically for lack of c-command. To conclude our discussion in this section, we observe that it is possible to resolve 'disconnected' anaphora *in situ* by means of quantification over Skolem functions.[3]

3. Weak Islands and the correlation between functional readings and Connectivity

A Skolem function-approach to Connectivity predicts that whenever an *f*-reading is not available, the corresponding Connectivity construction is ungrammatical. Cresti (1995) makes the interesting observation that *f*-readings of *wh*-phrases are not licensed in case i) they are extracted out of a *whether*-clause, and ii) the antecedent of the *f*-argument of the functional trace finds itself within the scope of the *whether*-clause. In fact, we will see shortly that Cresti's observation can be generalized into the following general constraint on *f*-readings:

(9) $*\text{Wh-Op}' (\lambda f (\ldots (_{\text{Weak Island}} \ldots \text{DP}'_x (\ldots f(x) \ldots) \ldots) \ldots))$

In words: *f*-readings are not available in case i) the *wh*-operator has been extracted out of a Weak Island (WI), and ii) the antecedent of the *f*-argument of the functional trace is contained in the scope of that WI.[4] The contrast between (10) and (11–12) exemplifies the generalization expressed in (9).[5]

(10) a. *Question*: Which novel do you think that every writer$_i$ likes?
Possible Answer: His$_i$ own novel.
b. *Statement*: There is a (certain) novel that I think that every writer$_i$ likes.
Possible Continuation: Namely, his$_i$ own novel.

[3] A functional account of Connectivity can be straightforwardly extended to 'disconnected' anaphora in *wh*-sentences that are licensed on a pair-list construal, if the latter type of reading is nothing but a special type of functional reading, as argued by Chierchia (1993).
[4] If Chierchia's (1993) approach to pair-list readings is adopted (cf. note 3), the generalization in (9) will also correctly describe the distribution of pair-list readings.
[5] As usual, the judgments here as well as below reflect our response to the relevant sentences in a neutral context of utterance. Cf. Szabolcsi and Zwarts (1993) for discussion of the relevance of context in determining the strength of WI violations.

(11) a. *Question*: Which novel do you wonder whether every writer$_i$ likes?
Possible Answer: *His$_i$ own novel.
b. Which novel do you regret that every writer likes? (*f-reading)
c. Which novel does nobody think that every writer likes? (*f-reading)

(12) a. *Statement*: There is a (certain) novel that I wonder whether every writer$_i$ likes.
Possible Continuation: *Namely, his$_i$ own novel.
b. There is a (certain) novel that I regret that every writer likes (*f-reading)
c. There is a (certain) novel that nobody thinks that every writer likes (*f-reading)

Before we explain the generalization in (9), we may first observe on the basis of the contrast between (13) and (14–15) below that, as predicted, the availability of an f-reading directly determines the well-formedness of the corresponding Connectivity construction. That is, the well-formedness of the sentences in (13) corresponds to the availability of f-readings in (10), and the ill-formedness of the sentences in (14) and (15) corresponds to the absence of f-readings in (11) and (12) respectively. This strong correlation therefore provides striking evidence in favor of a functional approach to Connectivity.

(13) a. Which part of his$_i$ life do you think that every politician$_i$ dislikes?
b. There is a (certain) part of his$_i$ life that I think that every politician$_i$ dislikes

(14) a. *?Which part of his$_i$ life do you wonder whether every politician$_i$ dislikes?
b. *?Which part of his$_i$ life do you regret that every politician$_i$ dislikes?
c. *Which part of his$_i$ life does nobody think that every politician$_i$ dislikes?

(15) a. *?There is a (certain) part of his$_i$ life that I wonder whether every politician$_i$ dislikes
b. *There is a (certain) part of his$_i$ life that I regret that every politician$_i$ dislikes
c. *There is a (certain) part of his$_i$ life that nobody thinks that every politician$_i$ dislikes

In the rest of this section, we will attempt to derive the generalization in (9) from Szabolcsi and Zwarts's (1993) semantic-algebraic theory of WIs, which is arguably the most comprehensive and elegant account of WIs to date. This theory will be briefly discussed in Section 3.1. Given that the set of all (partial) functions from (singular and plural) individuals to (singular and plural) individuals forms a proper join semilattice, as will be established in Section 3.2, it follows that the generalization in (9) can be subsumed under Szabolcsi and Zwarts's approach to WIs. Finally, we will delve in Section 3.3 into the reasons why the potentially damaging effect of a WI can be neutralized, if the expression which induces the WI binds an f-argument in the functional trace. We will argue that this fact can be reconciled with Szabolcsi and Zwarts's account, if we look more closely into the distinctive scopal properties of 'Skolemized' logical representations. This discussion will also make it clear that on a Skolem-function approach, Connectivity involves semantic rather than syntactic binding.

3.1 *Szabolcsi and Zwarts (1993)*

Szabolcsi and Zwarts's (1993) (henceforth: Sz&Z) semantic-algebraic theory of WIs centers around the following principle:

(16) *Scope and Operations* (cf. Sz&Z: 6)
Each scopal element SE is associated with certain (Boolean; MH) operations. For a *wh*-phrase (or any quantified expression, for that matter; MH) to take scope over some SE means that the operations associated with SE need to be performed in the *wh*-phrase's denotation domain. If the *wh*-phrase denotes in a domain for which the requisite operation is not defined, it cannot scope over SE.

Let us first provide a simple illustration of the principle in (16). Consider the *wh*-interrogative in (17a) on a wide scope reading of the *wh*-phrase *who*, assuming John, Bill and Mary are the only individuals in the domain D of our model. In order to answer (17a), we need to construct for each individual i the set of people that i likes, union the results and take its complement. This procedure is summarized in (17b), where 'L' is the denotation of 'likes′', 'j' is the denotation of 'john′', etc.

(17) a. Who does nobody like?
b. $\mathrm{D} - \cup \{\{a\text{: } \langle \mathrm{j}, a\rangle \in \mathrm{L}\}, \{a\text{: } \langle \mathrm{b}, a\rangle \in \mathrm{L}\}, \{a\text{: } \langle \mathrm{m}, a\rangle \in \mathrm{L}\}\}$

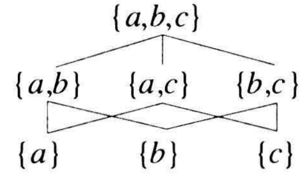
This simple example thus shows that when a *wh*-phrase takes scope over some scopal expression SE, the computation/verification of the relevant answer requires performing the Boolean operations associated with SE (join and complement in 17) in the denotation domain of the *wh*-phrase. The reason why (16) can be executed so smoothly in (17) resides in the fact that a *wh*-phrase such as *who* ranges over individuals. Individuals can be collected into unordered sets, such as the set of individuals that John likes. All Boolean operations are defined on sets of individuals, since the power set of any set of individuals forms a Boolean algebra.

To get a rough sense of how Sz&Z's theory works, we will show in the remainder of this section how it affords an elegant account of the classical WI effects in (18). To facilitate the discussion, it will simply be assumed here that i) all expressions which create WIs are associated with Boolean meet and/or complement, as was already demonstrated for *nobody* in (17b), and ii) the denotation domain of the *wh*-adverb *how* has the algebraic structure of a proper join semilattice (the reader is referred to Sz&Z for detailed arguments in support of both assumptions).

(18) a. *How did you wonder whether to fix the car?
b. *How did you regret that Peter fixed the car?
c. *How did nobody fix the car?

Let us first briefly clarify the pivotal concept of a proper join semilattice. A proper join semilattice is a partially ordered set (or poset) $\langle A, \leq \rangle$, where $\leq$ is a partial order (i.e. $\leq$ is a reflexive, anti-symmetric and transitive relation), which is closed under Boolean join, but not under meet or complement. The structure represented in (19) below for example is a proper join semilattice. To see that, note first that $A = \wp(\{a,b,c\})-\{\varnothing\}$ is a set which is partially ordered by the subset-relation $\subseteq$. Thus, $\langle A,\subseteq\rangle$ is a poset. Furthermore, A is closed under join since for every a, $b \in A$, the join of a and b (written: '$a \vee b$'; here the set-theoretic union $\cup$ of a and b) is in A as well. However, A is not closed under meet (written: '$\wedge$'; here set-theoretic intersection $\cap$) as for example $\{a\} \cap \{b\} \notin A$. Nor is A closed under (unique) complement since A does not even have a bottom element $\perp$ (i.e. there is no $a \in A$ such that for all $b \in A$, $a \subseteq b$).[6]

(19) *A proper join semilattice*



How does all this relate to the WI effects in (18)? Sz&Z observe that none of the bad interveners in (18) (i.e. *whether*, *regret* and *nobody*) can either scope over the *wh*-adverb *how* or support a scopally independent (i.e. branching or cumulative) reading. In line with the principle in (16) then, we must perform the Boolean operations associated with these interveners in the denotation domain of *how*. But since a proper join semilattice is not closed under either meet or complement, we cannot ascribe a proper question denotation to the sentences in (18). This accounts for their ill-formedness.

3.2 *A semantic-algebraic account of the sensitivity of functional readings to Weak Islands*

Observe now that the generalization in (9) above would immediately follow from Sz&Z's semantic-algebraic theory of WIs, if we could show that the set of all (partial, type $\langle e,e\rangle$) functions from the domain of individuals D into D (notation: $[D \rightarrow D]$) forms a proper join semilattice. Then, we can simply account for our earlier observations in (11–12) and (14–15) along the lines of Sz&Z's account of the WI effects in (18). In this section, we will show that $[D \rightarrow D]$ inherits whatever algebraic structure the range of the functions in $[D \rightarrow D]$ (that is, D) has.[7]

It is standardly assumed that the domain of (singular and plural) individuals has the structure of a proper join semilattice, i.e. a poset which is closed under join but which lacks a bottom element. This assumption has proven very fruitful in the study of collective and distributive predication (cf. Link 1983). For reasons of simplicity, we will furthermore follow Landman (1989a,b) in assuming that D's structure can be characterized in terms of set-theory; i.e. $D = \wp(E)\text{-}\{\varnothing\}$ where E is some set of objects simpliciter.

[6] In general, A is closed under (unique) complement just in case for every $a \in A$, there is a $b \in A$ such that $a \wedge b = \perp$ and $a \vee b = \top$, where _ is the top element of A (i.e. for any $a \in A$, $a \leq \top$). For a comprehensive exposition on lattice theory, cf. Partee et al. (1990).

[7] Thanks to Ed Keenan for his invaluable assistance on these matters.

On this conception, singular (atomic) individuals are singleton sets and plural (non-atomic) individuals are multi-membered sets. To see that the structure of D is inherited by $[D \rightarrow D]$, consider first the following relation $\leq$ on $[D \rightarrow D]$:

(20) *Definition.* For any $f, g \in [D \rightarrow D]$:
$f \leq g$ just in case $\mathrm{Dom}(f) \subseteq \mathrm{Dom}(g)$ and for any $x \in \mathrm{Dom}(f)$, $f(x) \subseteq g(x)$

where $\mathrm{Dom}(f)$ is the domain of f. For example, if $f = [\{a\} \rightarrow \{c\}, \{b\} \rightarrow \{a,c\}]$ and $g = [\{a\} \rightarrow \{b,c\}, \{b\} \rightarrow \{a,b,c\}, \{c\} \rightarrow \{a\}]$, where $\{a\}$, $\{b\}$ and $\{c\}$ are atomic individuals and $\{a,c\}$, $\{b,c\}$ and $\{a,b,c\}$ are plural individuals, then $f \leq g$. Since it is relatively easy to see that $\leq$ is reflexive, anti-symmetric and transitive, it follows that $\langle [D \rightarrow D], \leq \rangle$ is a poset. Does it have a bottom element? Suppose, aiming for a contradiction, that there is an $f \in [D \rightarrow D]$ such that for all $g \in [D \rightarrow D]$, $f \leq g$. According to (20), for any such g, $\mathrm{Dom}(f) \subseteq \mathrm{Dom}(g)$ and for any $x \in \mathrm{Dom}(f)$, $f(x)$ ($\in D$!) $\subseteq g(x)$. But this is impossible, since D by assumption lacks a bottom element. We therefore have:

(21) *Fact.* $[D \rightarrow D]$ does not have a bottom element, i.e. $\neg \exists f \forall g$: $f \leq g$

where f and $g \in [D \rightarrow D]$. Furthermore, since $[D \rightarrow D]$ lacks a bottom element, $[D \rightarrow D]$ cannot be closed under meet. Suppose for example that f and g are atoms in $[D \rightarrow D]$, i.e. for all $h \in [D \rightarrow D]$, if $h \leq f$ (or g), then $h = f$ (or g). Then $f \wedge g$ is not in $[D \rightarrow D]$. The fact that $[D \rightarrow D]$ lacks a bottom element also means that it cannot be closed under (unique) complement (cf. our discussion surrounding 19 above). Thus, if $[D \rightarrow D]$ is closed under join, $[D \rightarrow D]$ constitutes a proper join semilattice. Consider next the following definition of the join of two functions f and $g \in [D \rightarrow D]$:

(22) *Definition.* For any $f, g \in [D \rightarrow D]$, and for any $x \in \mathrm{Dom}(f) \cup \mathrm{Dom}(g)$:

$$(f \vee g)(x) =_{def} \begin{cases} f(x) \cup g(x) & \text{if } x \in \mathrm{Dom}(f) \cap \mathrm{Dom}(g) \text{, or} \\ f(x) & \text{if } x \in \mathrm{Dom}(f)\text{-}\mathrm{Dom}(g) \text{, or} \\ g(x) & \text{if } x \in \mathrm{Dom}(g)\text{-}\mathrm{Dom}(f). \end{cases}$$

For example, if $f = [\{a\} \rightarrow \{c\}, \{b\} \rightarrow \{a\}]$ and $g = [\{b\} \rightarrow \{c\}, \{c\} \rightarrow \{a\}]$, then $f \vee g = [\{a\} \rightarrow \{c\}, \{b\} \rightarrow \{a,c\}, \{c\} \rightarrow \{a\}]$. To see that (22) indeed defines the join of any two functions from individuals to individuals, we observe that for any f, g and $h \in [D \rightarrow D]$: i) $f \leq f \vee g$ and $g \leq f \vee g$ ($f \vee g$ is an upper bound for f and g), and ii) if $f \leq h$ and $g \leq h$, then $f \vee g \leq h$ ($f \vee g$ is the least upper bound for f and g). From (22), it follows that $[D \rightarrow D]$ is closed under join. That is, for any $f, g \in [D \rightarrow D]$, $f \vee g \in [D \rightarrow D]$. Note for instance that (22) defines the function $f_{\top}$ which maps every $a \in D$ to $\cup D$ (the top element of D) as the top element of $[D \rightarrow D]$, i.e. $f_{\top} = \vee [D \rightarrow D]$. We have thus obtained the desired result in (23).

(23) *Fact.* $\langle [D \rightarrow D], \leq \rangle$ is a proper join semilattice.

Given (23), we can now account for our earlier observations in (11–12) and (14–15) along the same lines as Sz&Z's account of (18). Consider for example the absence of a functional reading in (11c) above, repeated here as (24).

(24) *Which novel$_f$ does nobody think that every writer$_i$ likes e_f^i? (cf. 11c)

It was already observed in Section 2 that only universal distributive DPs can support pair-list construals of matrix interrogatives. Thus, even independently of one's point of view on how to model pair-list readings (but cf. note 3), we know that the negative quantifier nobody′ must scope under the *wh*-phrase in (24). In accordance with Sz&Z's principle in (16) above, we must perform the Boolean operations associated with nobody′ (most notably complement) in the denotation domain of the *wh*-quantifier. Given that (23) informs us that this denotation domain has the structure of a proper join semilattice, complement is not available here. This accounts for the ill-formedness of (24) with the given indexing. The other cases in (11) and (12), as well as their Connectivity counterparts in (14) and (15), can be explained along similar lines. For example, consider the connectivity counterpart of (24) in (14c) above, repeated here as (25).

(25) *Which part of his_i life does nobody think that every politician_i dislikes? (cf. 14c)

In order to license the 'disconnected' pronoun *his*, the *wh*-phrase must quantify over Skolem functions. Given (23), we know that the set of all Skolem functions $[D \rightarrow D]$ has the structure of a proper join semilattice. Since the negative quantifier nobody′ obligatorily scopes under the *wh*-phrase, just as in (24), it follows from (16) that we must perform the Boolean operations associated with nobody′ (most notably, complement) in the denotation domain of the *wh*-phrase. But this is impossible, since a proper join semilattice is not closed under complement. Hence, the ill-formedness of (25).

3.3 *Binding versus non-binding interveners*

A potential problem for the semantic-algebraic account of the WI sensitivity of *f*-readings presented in the previous section is constituted by the fact that (9) appears to be too strong for our purposes. For example, as it stands, it would incorrectly rule out (1a) above, repeated here as (26), on account of the fact that we abstract here over a functional variable *f* which is contained in a WI.

(26) Which part of his life_f does no politician_i like e_f^i?

Our findings with respect to the distribution of *f*-readings might be reformulated as follows. From what we have seen so far, it appears that the potentially damaging effect of a WI can be neutralized just in case the expression which induces the WI binds an *f*-argument in the functional trace $e_f^{i_1,\ldots,i_n}$. This refinement of our original generalization in (9) concerning the distribution of *f*-readings is suggested especially by the contrast between (14c) above, which was repeated above as (25), and (27a). The relevant difference between the two constructions is that only in (27a) does the negative DP bind an additional *f*-argument in the functional *wh*-trace. Given this indexing, possible answers to the question expressed by (27a) have to specify functions from ordered pairs of individuals to individuals, as indicated in (27b).

(27) a. *Question*: ?Which picture that she took of him_f does no girl_i believe that every guy_j would like to keep $e_f^{i,j}$?
b. *Possible Answer*: The picture that she_i took when he_j just woke up.

Why would the fact that a potentially harmful intervening expression binds an f-argument in a functional trace make any difference from the point of view of Sz&Z's semantic-algebraic theory of WIs? I suggest that an answer to this question can be found in the rather distinctive scopal properties of 'Skolemized' logical representations. Historically, quantification over functions was introduced in logic to make sure that each (negation normal form) formula in predicate logic can be transformed into a logically equivalent formula in which all existential quantifiers precede the universal ones (these functions are called Skolem functions in honor of the Polish mathematician who proved the general theorem). To take a simple example, it can be shown (by making use of the so-called Axiom of Choice) that (28a) below is logically equivalent to (28b). Intuitively, to say that $\exists$ in (28a) has narrow scope with respect to $\forall$ really amounts to the same thing as saying that the valuation of the variable y is a function of the valuation of the variable x which is bound by $\forall$. Therefore, if (28a) is true, then there is a function which maps each x to some y such that R holds of x and y. The implication from (28b) to (28a) is even more trivial. A similar reasoning will also reveal that (28c) and (28d) are equivalent.

(28) a. $\forall x \exists y\ (\mathrm{R}(x,y))$ c. $\forall x \exists y\ (\neg \mathrm{R}(x,y))$
b. $\exists f \forall x\ (\mathrm{R}(x,f(x)))$ d. $\exists f \forall x\ (\neg \mathrm{R}(x,f(x)))$

Suppose now that the meaning of a given LF $\alpha(\beta(\gamma))$ is to be represented as in (28b) or (28d). Syntactically, the expression α the meaning of which is represented by $\exists f$ takes scope over the expression β the meaning of which is represented by $\forall x$, as the former c-commands the latter. However, in the light of what was said above, β takes scope over α in a semantic sense: since the valuation of whatever argument position α binds in γ is a function of whatever argument position β binds in γ, we could have represented the meaning of $\alpha(\beta(\gamma))$ as in (28a) or (28c) respectively.

Consider in this light the problematic examples presented in (26) and (27a) above. Since the harmful interveners in these constructions bind an f-argument in the functional gap associated with the *wh*-phrase, the valuation of that gap will be a function of the valuation of the argument position quantified over by these interveners. Therefore, even though the harmful interveners here scope under the *wh*-phrase in a strictly syntactic sense, they scope over the *wh*-phrase in the semantic sense discussed above: the functional question expressed by (26) for example can be paraphrased either as in (29a) (cf. also 6c above) or as in (29b). That (29a) and (29b) paraphrase the same meaning follows from the fact that $\exists f\ (\forall z\ (\mathrm{P}(f(z))) \wedge \forall x\ (\neg \mathrm{R}(x,f(x))))$ and $\forall x \exists y\ (\mathrm{P}(y) \wedge \neg \mathrm{R}(x,y))$ are logically equivalent (this requires a slight generalization of the proof which shows that 28c and 28d are equivalent).

(29) a. For which f ,f a function which maps every person to a part of that person's life, no politician x likes $f(x)$?
b. Tell me for every politician x, which part of x's life does x not like?

Recall now Sz&Z's principle in (16) above which states that if a *wh*-phrase takes scope over some scopal element, the Boolean operations associated with that scopal element need to be performed in *wh*'s denotation domain (and *vice versa* of course). It is clear that the relevant notion of scope intended here is semantic, rather than syntactic. If so, it follows that the Boolean operations associated with the harmful interveners in (26) and (27a) need not be performed in the denotation domain of the relevant functional *wh*-phrases. In (29b) for example, we are certainly not required to perform Boolean operations in the denotation domain of a *functional wh*-phrase. This is as it should be since at least one of the Boolean operations with which WI inducing expressions are associated cannot be executed in the proper join semilattice functional variables range over. In this way, we can reconcile the observation that the potentially devastating effect of a harmful intervener can be neutralized just in case the intervener binds an *f*-argument in the functional trace with Sz&Z's theory of WIs.

To conclude the discussion in this section, note that the equivalence of the two paraphrases in (29) of the functional question expressed by (26) also reveals the sense in which one might say that on a functional approach, disconnected anaphora are bound semantically by their antecedents (cf. 29b), even though they are not bound syntactically by them for lack of c-command (cf. 29a).

4. On complicating the semantics of scope, so that it fits its syntax

Summing up, we have seen in this paper that on a Skolem function-approach to 'disconnected' anaphora, Connectivity involves semantic, rather than syntactic binding. The use of Skolem functions complicates the semantics of scope in such a way that it yields the required distinction between the syntactic scope of an expression and its semantic scope. We have argued that a functional approach to Connectivity, when coupled with Szabolcsi and Zwarts's (1993) semantic- algebraic theory of WIs, automatically accounts for certain intricate interactions between Connectivity and WIs. Theoretically, our findings suggest the following 'interface strategy': problems which pertain to the matching of syntax and semantics are best accounted for, not by complicating the syntax of scope so that it fits its semantics (through Quantifying-In, Reconstruction, LF pied-piping etc.), but by complicating the semantics of scope so that it fits its syntax. This strategy has already been fruitfully applied to the problem of donkey-anaphora. Dynamic Semantics (cf. especially Groenendijk and Stokhof 1990 and Chierchia 1995) voids the need for complicated LF construal rules to see to it that for example *a donkey* properly binds *it* in the classical (30a). In this theory, the structure in (30a) can be directly (that is, compositionally) translated into (30b), whose static (i.e. truth-conditional) content can be represented as in (30c) (assuming the so-called 'strong' definition of dynamic implication $\underline{\rightarrow}$).

(30) a. $[_{IP}\ [_{DP}$ Every farmer $[_{CP}$ who owns a donkey$_i$]] beats it$_i$]
b. $\mathrm{A}x\ ({\uparrow}\mathrm{farmer}'(x) \underline{\wedge}\ \mathrm{E}y\ ({\uparrow}\mathrm{donkey}'(y) \underline{\wedge} {\uparrow}\mathrm{owns}'(y)(x)) \underline{\rightarrow} {\uparrow}\mathrm{beats}'(y)(x))$
c. $\forall x \forall y\ (\mathrm{farmer}'(x) \wedge \mathrm{donkey}'(y) \wedge \mathrm{owns}'(y)(x) \rightarrow \mathrm{beats}'(y)(x))$

The key to its success in accounting for donkey-anaphora lies in the fact that Dynamic Semantics complicates the semantics of scope in such a way that it effects a radical distinction between the syntactic scope of a simple indefinite and its semantic scope.

Note for example that in Dynamic Semantics, it holds that $Ex(\Phi) \underline{\wedge} \Psi \equiv Ex(\Phi \underline{\wedge} \Psi)$. Thus, the success of Dynamic Semantics in unraveling the mystery of donkey-anaphora establishes the general plausibility and interest of the 'interface strategy' discussed above, and which has been applied in this paper specifically to the problem of Connectivity.

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