DYNAMIC WH-TERMS

ANDREAS HAIDA

Zentrum für Allgemeine Sprachwissenschaft (ZAS)
Berlin, Germany
haida@zas.gwz-berlin.de

The grammatical analysis of wh-questions presented in Groenendijk and Stokhof 1982 does not account for the close affinity between indefinite and interrogative pronouns. However, *wh*-terms can be treated in the same way as indefinites if existential quantification is dynamic. In this paper, the question denotations of G&S (1982) are reproduced in a dynamic framework in which *wh*-terms translate as existential GQs. In addition to this, the syntactic and semantic consequences for explaining the intervention effect in *wh*-questions are explored.

1. Introduction

Indefinite and interrogative pronouns are closely related in the majority of the world's languages.[1] This is exemplified in (1) and (2) with data from German and Lakhota, respectively.[2] As indictated, the *in-situ wh*-pronoun in both strings is ambiguous between an indefinite and an interrogative construal.[3]

(1) Wer hat was gekauft?
who has what bought
a. 'Who bought something?'
b. 'Who bought what?'

(2) šų́ka ki tákų yaxtáka he
dog the what bit Q
a. 'Did the dog bite something?'
b. 'What did the dog bite?'

If explanatory adequacy is to be achieved, a theory of interrogatives must therefore incorporate a compositional analysis of *wh*-questions in which *wh*-terms are treated essentially like indefinites. The question theory presented in Groenendijk and Stokhof 1982 is not equipped with such an analysis. Rather, this theory seems to entail that *wh*-terms are syncategorematic and that their closest categorematic counterparts are universally quantified terms.[4] However, with the development of dynamic semantics for natural language, an adequate conclusion could be reached: "Treating

[1] See Bhat 2000.
[2] For the latter, see Van Valin 1993.
[3] The two construals are disambiguated prosodically: if the *wh*-pronoun is accented, it must be construed as a question word, and otherwise as an indefinite. This seems to be a very general pattern.
[4] See Groenendijk and Stokhof 1982, p. 196 and 204f.

[*wh*-terms] like indefinites in a dynamic framework would mean translating them in terms of dynamic existential quantification. [...] [W]e might do so if for whatever reason this seems to be desirable after all." (G&S 1992, p. 122) In the following section, it is discussed how this proposal can be spelled out.

2. Question Denotations in a Dynamic Framework

According to G&S (1982), the denotation of an n-constituent interrogative is an index-dependent proposition that can be represented by a Ty2 expression of the form (3), where ϕ and ψ are saturated relations $\beta(i)(x_1, \ldots, x_n)$ and $\beta(j)(x_1, \ldots, x_n)$, respectively.[5]

(3) $\lambda j(\lambda x_1 \ldots \lambda x_n.\phi = \lambda x_1 \ldots \lambda x_n.\psi)$

The gist of my account is that (4) denotes the same proposition as (3) if the existential quantifier and the biconditional connective are interpreted dynamically.

(4) $\lambda j(\exists x_1 \ldots \exists x_n.\neg\neg\phi \leftrightarrow \exists x_1 \ldots \exists x_n.\neg\neg\psi)$

For reasons of space, I will only give an intuitive argument for this equivalence. To simplify the discussion, assume that ϕ and ψ do not have context change potential themselves. Then it must be shown that $\lambda x_1 \ldots \lambda x_n.\phi = \lambda x_1 \ldots \lambda x_n.\psi$ and $\exists x_1 \ldots \exists x_n.\phi \leftrightarrow \exists x_1 \ldots \exists x_n.\psi$ have the same truth conditions.

Consider first that an equation of the form $\lambda x_1 \ldots \lambda x_n.\phi = \lambda x_1 \ldots \lambda x_n.\psi$ can be equivalently[6] given as $\forall x_1 \ldots \forall x_n((\phi \rightarrow \psi) \wedge (\psi \rightarrow \phi))$, and that universal quantification is distributive over conjunction:

$$\begin{gathered}\lambda x_1 \ldots \lambda x_n.\phi = \lambda x_1 \ldots \lambda x_n.\psi \\ \Leftrightarrow \\ \forall x_1 \ldots \forall x_n(\phi \rightarrow \psi) \wedge \forall x_1 \ldots \forall x_n(\psi \rightarrow \phi)\end{gathered}$$

In dynamic semantics, $\forall x(\Phi \rightarrow \Psi)$ is equivalent to $\exists x.\Phi \rightarrow \Psi$. Therefore, the following equivalence holds:

$$\begin{gathered}\forall x_1 \ldots \forall x_n(\phi \rightarrow \psi) \wedge \forall x_1 \ldots \forall x_n(\psi \rightarrow \phi) \\ \simeq \\ (\exists x_1 \ldots \exists x_n.\phi \rightarrow \psi) \wedge (\exists x_1 \ldots \exists x_n.\psi \rightarrow \phi)\end{gathered}$$

As can be easily verified, the last formula is true iff $\exists x_1 \ldots \exists x_n.\phi$ and $\exists x_1 \ldots \exists x_n.\psi$ have the same context change potential. It can then be asked for which connective '$\circ$' the formula $\Phi \circ \Psi$ is true iff Φ and Ψ have the same context change potential. As is

[5] Cf. Groenendijk and Stokhof 1990, p. 1-9.

[6] In the following, the symbols '$\Leftrightarrow$' and '$\simeq$' are used to denote the equivalence of two formulas of static and dynamic logic, respectively.

argued below, the sought-after connective is the dynamic biconditional '$\leftrightarrow$'. That is, the following equivalence can be derived:[7]

$$(\exists x_1 \ldots \exists x_n.\phi \rightarrow \psi) \wedge (\exists x_1 \ldots \exists x_n.\psi \rightarrow \phi)$$
$$\simeq$$
$$\exists x_1 \ldots \exists x_n.\phi \leftrightarrow \exists x_1 \ldots \exists x_n.\psi$$

□

The dynamic biconditional is defined as given in (5) (where for each formula Φ, $/\Phi/_{\mathcal{M},g}$ is the set of output assignments of Φ with respect to $\mathcal{M}$ and g).[8]

(5) **Definition:** $[\![\Phi \leftrightarrow \Psi]\!]_{\mathcal{M},g} = 1$ iff $/\Phi/_{\mathcal{M},g} = /\Psi/_{\mathcal{M},g}$

The reason for choosing this definition is that it implies that '$\leftrightarrow$' is the object-language counterpart of the metalanguage equivalence notion '$\simeq$' (as defined along the lines of G&S (1991)):

(6) **Fact:** $\Phi \simeq \Psi$ iff $\forall \mathcal{M} \forall g : [\![\Phi \leftrightarrow \Psi]\!]_{\mathcal{M},g} = 1$

2.1. The grammar of *wh*-questions

Due to the equivalence of (3) and (4), *wh*-terms can be treated in the same way as indefinites. That is, *wh*-terms can be translated as existential generalized quantifiers (see 7) if the semantic representation language is interpreted dynamically.[9]

(7) a. who$_k$, what$_k$ $\rightsquigarrow \lambda P.\exists x_k.P(i)(x_k)$
b. which$_k$ $\alpha \rightsquigarrow \lambda P.\exists x_k(\alpha'(i)(x_k) \wedge P(i)(x_k))$, where $\alpha \rightsquigarrow \alpha'$

Moreover, the interrogative complementizer Q can be given a unique translation:

(8) Q $\rightsquigarrow \lambda p \lambda j(p(i) \leftrightarrow p(j))$

On these assumptions, the denotation of a *wh*-question can be compositionally derived as exemplified in (9). On the basis of the syntactic structure (9a), the *de dicto* reading of *which girl which boy loves* is derived as indicated in (9b). Thereby, $\mathbf{Q} = \lambda p \lambda j(p(i) \leftrightarrow p(j))$ and $\mathbf{E}_k = \lambda P \lambda P'.\exists x_k(P(i)(x_k) \wedge P'(i)(x_k))$.

(9) (I wonder) which girl which boy loves
a. [Q [which$_2$ girl [which$_1$ boy loves $t_{\text{which}_2\text{ girl}}$]]]
b. $\mathbf{Q}(\lambda i.\mathbf{E}_2(\text{girl}')(\lambda i \lambda v'.\mathbf{E}_1(\text{boy}')(\lambda i \lambda v.\text{love}'(i)(v, v'))))$

[7] There is reason to assume that the dynamic biconditional is externally dynamic. Therefore, the equivalence below should rather be written as truth-conditional equivalence (s-equivalence in the sense of Groenendijk and Stokhof 1991).
[8] Neither in Staudacher 1987 nor in Groenendijk and Stokhof 1991 is a dynamic biconditional defined.
[9] The expressions given below have the appearance of Ty2 expressions, but this is only for notational convenience. They are best to be considered as abbreviations for expressions that encode the notion of context change in the object language. See Muskens 1996.

Note in particular that both *wh*-phrases are interpreted in the position in which they occur in the overt syntactic structure: *which girl* is interpreted *ex situ* and *which boy in situ*.

3. The Intervention Effect

The dynamic treatment of *wh*-terms does not only account for the affinity between indefinite and interrogative pronouns but also explains another crosslinguistic phenomenon, namely the intervention effect in *wh*-questions. In Beck (to appear), the intervention effect is characterized as follows: Certain elements, so-called interveners, may not occur between a *wh*-phrase and its licensing complementizer (see 10). Interveners are focusing elements such as *only*, the sentence negation *not*, and quantifiers such as *most* and *never*.

(10) *[Q [. . . [intervener [. . . *wh*-phrase. . .]]. . .]]

The deviance of the constructions in (11) exemplifies this phenomenon.

(11) a. *mâymiikhray chôop ʔáan nagsii lêmnay (Thai)[10]
nobody like read book which
'Which books does nobody like to read?'
b. ??Wer hat niemandem was gezeigt? (German)[11]
who has nobody what showed
'Who showed what to nobody?'

In Honcoop 1996, it is observed that the expressions that induce the intervention effect[12] "all create so-called *inaccessible* domains for binding, i.e. an indefinite DP that occurs inside the syntactic scope of these expressions cannot bind a pronoun that occurs outside of their syntactic scope." (Honcoop 1996, p. 93) This is illustrated with the discourses in (12).[13]

(12) a. John did*n't* buy a car$_i$ (*n't* $>$ O). *It$_i$ was too expensive.
b. *Most students* bought a car$_i$ (S $>$ O). *It$_i$ was quite expensive.
c. John *never* bought a car (*never* $>$ O). *It$_i$ was too expensive.

The intervention effect therefore indicates that the relation between a *wh*-phrase and its licensing complementizer is anaphora like (in the sense that the context change brought about by the former is evaluated by the latter). Note that this is exactly

[9] = (1a) in Beck (to appear)
[10] = (21) in Beck (to appear)
[11] Cf. (11a) in Beck (1996).
[12] Honcoop 1996 is concerned with a variant of the intervention effect that does not fall under the description given above (at least superficially). However, Honcoop's analysis can be easily adapted to account for the intervention effect as it is conceived here.
[13] Cf. (13) and (16) in Honcoop 1996.

how this relation is analyzed here.[14] Therefore, the dynamic approach predicts that a *wh*-term cannot function as a question constituent in an intervention configuration. However, in its current form it fails to account for the deviance of the constructions in (11).

This becomes evident by considering an example: (11a) has the syntactic structure simplistically sketched in (13a) and its denotation is derived as specified in (13b). (Below, $\mathbf{E}_k = \lambda P.\exists x_k.P(i)(x_k)$ and $\mathbf{Q}$ is as defined before.) What can then be observed is that (13b) does not represent the extension of a *wh*-question, but of a yes/no question, namely the extension of (13c).

(13) a. [Q [nobody$_1$ [read what$_2$]]]
b. $\mathbf{Q}(\lambda i.\neg\mathbf{E}_1(\lambda i\lambda v.\mathbf{E}_2(\lambda i\lambda v'.\text{read}'(i)(v,v'))))$
c. = Does nobody read anything? / Does somebody read something?

How can this result be interpreted? On the one hand, the derived effect (unavailability of a certain reading) clearly differs from the intervention effect (deviance). On the other, the distribution of the derived effect is the same as of the intervention effect. Therefore, the goal must be to strengthen the derived effect.

3.1. Non-interrogative indefinites

The above problem raises the deeper question of what distinguishes interrogative from non-interrogative indefinites. This question is answered as follows: Due to a morphosyntactic property, interrogative indefinites enter into a syntactic relation with an interrogative complementizer Q. As a consequence of this relation, interrogative indefinites share a syntactic index with Q. These indices are interpreted in such a way as to guarantee that the biconditional connective evaluates the context change of *all* and *only those* indefinites that are co-indexed with Q.

According to these assumptions, the questions *Who read what?* and *Who read something?* differ from each other in the way specified in (14) and (15). Thereby, $\mathbf{Q}^V = \lambda p\lambda j(p(i) \overset{V}{\leftrightarrow} p(j))$.

(14) a. [Q$^{\{1,2\}}$ [who$_1$ [read what$_2$]]]
b. $\mathbf{Q}^{\{x_1,x_2\}}(\lambda i.\mathbf{E}_1(\lambda i\lambda v.\mathbf{E}_2(\lambda i\lambda v'.\text{read}'(i)(v,v'))))$

(15) a. [Q$^{\{1\}}$ [who$_1$ [read something$_2$]]]
b. $\mathbf{Q}^{\{x_1\}}(\lambda i.\mathbf{E}_1(\lambda i\lambda v.\mathbf{E}_2(\lambda i\lambda v'.\text{read}'(i)(v,v'))))$

The relativized biconditional connective '$\overset{V}{\leftrightarrow}$' is defined in (16). By this definition, the context change brought about by non-coindexed (that is, non-interrogative) indefinites is ignored.

(16) $[\![\Phi \overset{V}{\leftrightarrow} \Psi]\!]_{\mathcal{M},g} = 1$ iff $/\Phi/^V_{\mathcal{M},g} = /\Psi/^V_{\mathcal{M},g}$, where $A^V = \{h_{|V} \mid h \in A\}$

[14] See Butler 2000 for a comparable approach which, however, remains largely inexplicit.

To rule out the intervention construction (17a), it must be assured that $\Phi \overset{V}{\leftrightarrow} \Psi$ is undefined if there is a variable in V that is not subjected to an accessible modification in Φ and Ψ.

(17) a. [$Q^{\{2\}}$ [nobody$_1$ [read what$_2$]]]
b. $\mathbf{Q}^{\{x_2\}}(\lambda i.\neg\mathbf{E}_1(\lambda i\lambda v.\mathbf{E}_2(\lambda i\lambda v'.\text{read}'(i)(v,v'))))$

This is achieved by partializing the evaluation contexts (left out for reasons of space).

Acknowledgements

Thanks to Sigrid Beck, Regine Eckardt, Cornelia Endriss, Gisbert Fanselow, Stefan Hinterwimmer, Manfred Krifka, Chris Potts, Uli Sauerland, and Peter Staudacher for helpful discussions.

Bibliography

Beck, S.: to appear, Intervention effects follow from focus interpretation, *Natural Language Semantics*

Bhat, D. N. S.: 2000, The indefinite-interrogative puzzle, *Linguistic Typology* 4, 365–400

Butler, A.: 2000, Semantic control and intervention, in C. Pilière (ed.), *Proceedings of the ESSLLI-2000 Student Session*, pp 45–54

Groenendijk, J. and Stokhof, M.: 1982, Semantic analysis of *wh*-complements, *Linguistics and Philosophy* 5, 175–233

Groenendijk, J. and Stokhof, M.: 1990, *Partitioning Logical Space*, Annotated handout ESSLLI 1990, Leuven

Groenendijk, J. and Stokhof, M.: 1991, Dynamic predicate logic, *Linguistics and Philosophy* 14, 39–100

Groenendijk, J. and Stokhof, M.: 1992, A note on interrogatives and adverbs of quantification, in C. Barker and D. Dowty (eds.), *Proceedings from SALT II*, pp 99–124, The Ohio State University, Columbus, Ohio

Honcoop, M.: 1996, Towards a dynamic semantics account of weak islands, in T. Galloway and J. Spence (eds.), *Proceedings from SALT VI*, pp 93–110, Cornell University, Ithaca

Muskens, R.: 1996, Combining Montague semantics and discourse representation, *Linguistics and Philosophy* 19, 143–186

Staudacher, P.: 1987, Zur Semantik indefiniter Nominalphrasen, in B. Asbach-Schnitker and J. Roggenhofer (eds.), *Neuere Forschungen zur Wortbildung und Historiographie der Linguistik*, pp 239–258, Narr, Tübingen

Van Valin, Robert D., J.: 1993, A synopsis of role and reference grammar, in R. Van Valin (ed.), *Advances in Role and Reference Grammar*, pp 1–164, Benjamins, Amsterdam