

Pied Piping and the Syntax and Semantics of Complex *wh*-Phrases

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Abstract

This paper investigates the so-called pied piping problem or, more generally, the syntax and semantics of complex *wh*-phrases. Having discussed the most prominent previous approaches — the reconstruction approach, the choice function approach and the presuppositional approach — it will be argued that all interrogative *wh*-constructions — *wh*-phrases and *wh*-interrogatives — should be treated both syntactically and semantically in a uniform way. To this effect, an analysis is presented that generalizes the treatment of pronominal *wh*-phrases and *wh*-interrogatives developed in Reich (2002) to arbitrary instances of complex *wh*-phrases. It turns out that *wh*-phrases differ from *wh*-interrogatives only in that they are assigned an additional functional projection that accounts for their specific phrasal behaviour.

1 (LF) Pied Piping — The Problem

As Nishigauchi (1990) argues in great detail, Japanese — which is a *wh*-in-situ language — shows pied piping effects quite similar to those observable in so-called *wh*-movement languages like English or German. To account for these effects, he proposes to assume that there is in fact pied piping in Japanese, though on the level of logical form, and that in a Japanese *wh*-question like the one corresponding to the English phrase *you read the book that who wrote* it is the whole object *the book that who wrote* that is moved to the front rather than just the *wh*-pronominal *who*, cf. (1a).

- (1) a. [[dare-ga₁ kai-ta] hon-o]₂ [ka [Kimi-wa [t₂ yomi-masi-ta]]
[[who₁ write-P] book-A]₂ [Q [you-T [t₂ read-P]]]
'you read the book that who wrote'
b. For which *x, y*, *x* a person, *y* a book s.t. *x* wrote *y*: you read *y*.
c. Austen-ga kai-ta hon desu.
Austen-N write-P book be
'(I read) the book that Austen wrote'

As far as the semantic interpretation of this logical form is concerned, Nishigauchi (1990) just gives an informal paraphrase, cf. (1b), which he takes to be statable in more precise terms within a set of propositions semantics for *wh*-interrogatives like the one proposed in Karttunen (1977). However, elaborating on an objection by B.H. Partee (cf. Nishigauchi 1990: fn. 24, chap. 2), von Stechow (1996) shows that the most straightforward representation of (2a) — i.e., (2b) — predicts the question (1a) to be semantically equivalent to the question (2c), which is a clearly false prediction.

- (2) a. For which x, y , x a person, y a book s.t. x wrote y : you read y .
 b. $\lambda p \exists x \exists y [person(x) \wedge book(y) \wedge wrote(y)(x) \wedge p = you\ read\ y]$
 c. Which book (that somebody wrote) did you read?
 d. I read “Die Buddenbrooks”, ...

The reason for this is as follows: Since the whole DP *the book that who wrote* is moved to [Spec,C], only one trace is left within the scope of the Q-morpheme or interrogativator ‘?’ (which is interpreted as ‘ $p = \dots$ ’), namely the one corresponding to the whole DP — i.e., y in (2a) and (2b). Therefore, (the variable x introduced by) *who* has no effect on the shape of the propositions in the question’s denotation and is simply interpreted as the indefinite *some person*. As a consequence, the Japanese question *you read the book that who wrote* is assigned exactly the same representation as the question *which book that somebody wrote did you read*, cf. (2b); as a further consequence, (2d) is wrongly predicted as a well-formed answer to the question (1a).

It is immediately clear that exactly the same problem occurs in corresponding examples of overt pied piping in German and English, consider for example the Swabian example (3a):¹

- (3) a. Wem sein Buch hast du gelesen?
 who.dat ’se book have you read
 ‘Whose book did you read?’
 b. $[[who_1]’se\ book]_2\ ?\ you\ read\ t_2$
 c. For which x, y , x a person, y a book s.t. x wrote y : you read y .
 d. Which book (that somebody wrote) did you read?
 e. I read “Die Buddenbrooks”, ...

Thus the question emerges whether it is possible — and if so, *how* it is possible — to adequately interpret overtly or covertly pied piped material in *wh*-interrogatives ‘in situ,’ i.e., out of the scope of the ‘Q-morpheme’ or ‘interrogativator’ ‘?’. This is, in a nutshell, the ‘pied piping problem.’

¹Swabian is a German dialect spoken in the southwest of Germany.

2 Three Approaches to the Pied Piping Problem

To my knowledge, there are basically three approaches to the pied piping problem, the reconstruction approach, the choice function approach and the presuppositional approach. Let's first consider the reconstruction approach as developed in von Stechow (1996).

2.1 The Reconstruction Approach

To account for the data observed by Nishigauchi (1990), and to derive at the same time the correct semantic interpretation, von Stechow (1996) follows Nishigauchi (1990) in assuming that there is in fact pied piping on the level of logical form in Japanese, cf. (4a), but in addition stipulates a second layer of abstract syntax — called 'WH-structure' — following the level of logical form. On WH-structure, he argues, the pronominal *wh*-phrase *who* adjoins to the pied piped phrase, cf. (4b), and the remnant is reconstructed (into its base position), cf. (4c).

- (4) a. LF: [a book that who_x wrote] $_y$? [you read y]
b. WH-1: [who_x [a book that x wrote] $_y$] ? [you read y]
c. WH-2: [who_x $___$] ? [you read [a book that x wrote]]
d. $\lambda p \exists x [\textit{person}(x) \wedge p = \textit{you read a book that } x \textit{ wrote}]$
e. I read a book, that "Wolf von Niebelschütz" wrote; ...

Since the trace x of the *wh*-pronominal *who* is reconstructed into the scope of the interrogator '?', *who* is interpreted as a 'real' *wh*-phrase and an adequate set of propositions seems to be derived, cf. (4d).

There are, however, also some non-trivial problems with this approach. First of all, this approach predicts island-sensitive *wh*-movement on the level of logical form, and island-insensitive *wh*-movement on the level of WH-structure (in Japanese). Second, the only constituent that is predicted to be minimally focussed in congruent answers is the constituent corresponding to the *pronominal wh*-phrase, cf. (5b).

- (5) a. Wem seine Mutter hast du getroffen?
Who 'se mother have you met?
Whose mother did you meet?
b. [[Dem PEter]_F seine Mutter] habe ich getroffen.
[[The PEter]_F 's mother] have I met.
'I met PEters mother.'
c. *[Dem PEter]_F
d. [[Dem PEter]_F seine Mutter]

However, given straightforward assumptions about the elliptical process involved in the derivation of term answers, this property wrongly predicts (5c) to be a well-formed answer to the question (5a) (cf. Reich 2001, 2002).

Third, in case of multiple *wh*-phrases with relational nouns (e.g. *which friend of which woman*) reconstruction of the remnant (i.e., of $[t_1 \text{ of } t_2]$) is not interpretable, since the preposition is semantically empty (Sauerland, p.c., cited in Sternefeld 2001b). To avoid this consequence, one is forced to assume that, in general, the restriction of a *which*-phrase has to be reconstructed too; reconstruction of the restrictions of *which*-phrases, however, predicts — contrary to fact — that the following two questions are semantically equivalent (cf. Heim 1993):

- (6) a. Which toys are gifts?
 b. Which gifts are toys?

Last but not least, reconstruction allows, at least in principle, for a non-available intensional reading of the reconstructed material in intensional contexts, cf. (7) and von Stechow (2000) for further discussion.

- (7) Wem sein Buch *musst* du lesen? / Whose book do you have to read?
 a. $\text{who}_x \text{ ? must}_w (\lambda w. \text{you read}_w x\text{'s book}_w)$
 b. Which x : it follows from the ‘law’ that y is x ’s book & you read y .

2.2 The Choice Function Approach

Actually, the last criticism relates to a problem that basically all approaches are faced with that try to circumvent the pied piping problem by interpreting the restriction of a *which*-phrase or the remnant of any other complex *wh*-phrase within the scope of the interrogator ‘?’, namely the so-called ‘Donald Duck problem.’ As Reinhart (1994) points out, an utterance of *John will be offended, if we invite Donald Duck* — who we take, for the moment, to be no philosopher — is predicted to be a well-formed answer to the question (8a), if the restriction of the *wh*-phrase *which philosopher* is interpreted ‘in situ,’ i.e., within the antecedent of the conditional, cf. (8b): The assumption that Donald Duck is no philosopher falsifies the antecedent, and the falseness of the antecedent suffices for the truth of the conditional as a whole.

- (8) a. Who will be offended, if we invite which philosopher?
 b. Which x, y : if y is a philos. & we invite y , then x will be offended.

To avoid the Donald Duck problem, Reinhart (1994) proposes to introduce choice functions into the semantic analysis of *wh*-phrases:² a choice function variable f is taken to apply in situ to the extension of the *wh*-phrase’s

²Roughly speaking, a (extensional) choice function f is any function that chooses from a given set of objects one of its elements. More formally, f is a (extensional) choice function iff for some $\sigma \in \mathbf{type}$: $f \in D_{\langle(\sigma,t),\sigma\rangle}$ and $f(X) \in X$ for all X in the domain of f . In the remainder of this subsection, the variables f and g are always intended to range over choice functions.

restriction and to select one of its elements;³ the choice function variable f itself gets existentially bound by a Q-morpheme ‘?’ such that the choice of a philosopher depends on the choice of the choice function, cf. (9).

- (9) a. Who will be offended, if we invite which philosopher?
 b. For which x , f : x will be offended, if we invite $f(\text{philosopher})$
 c. $\lambda p \exists x \exists f [person(x) \wedge p = x \text{ will be off.}, \text{ if we invite } f(\text{philosopher})]$

In Hagstrom (1998) and Sternefeld (2001a) this analysis is generalized to pied piping phenomena, and in von Stechow (2000) an analysis of multiple *wh*-phrases in terms of choice functions is discussed. Sternefeld’s (2001a) analysis of *wh*-interrogatives like (10a), for example, is as follows: The pronominal *wh*-phrase *who* denotes the set of persons; by type coercion, the property of being a set of objects is inherited by the phrase *whose book* that denotes the set consisting of *the book of a*, *the book of b*, and so on, cf. (10b). The remainder of the interpretation mechanism is basically equivalent to the one proposed in Reinhart (1994) — apart from the fact that in this approach it is absolutely straightforward to reconstruct the complex *wh*-phrase semantically, rather than syntactically (cf. Sternefeld 2001a).

- (10) a. Wem sein Buch hast du gelesen?
 b. $\llbracket_{[DP \text{ whose book}]} \rrbracket = \lambda x. \exists y [person(y) \wedge x = \text{the book of } y]$
 $= \{\text{the book of } a, \text{ the book of } b, \dots\} =: A$
 c. $\lambda p \exists f [p = \text{you read } f(A)]$

At first sight one is tempted to think that this approach would solve the pied piping problem, since all the propositions in the question’s denotation seem to be of the form *you read the book of x*, and the problems of the reconstruction approach are avoided by the use of choice functions applying to the extension of the *wh*-phrase’s restriction.

It turns out, however, that it is exactly the extensionality of *wh*-phrases that leads to wrong predictions within this choice function approach (cf. Reich 2001, Sternefeld 2001b): Because of the extensionality of *which*-phrases the set A in (10b) is simply (equivalent to) a set of books, and, consequently, the question (10a) is — again — predicted to be semantically equivalent to (a contextually restricted variant of) the question *Which book (by some author) did you read?* Exactly the same criticism applies to a nested choice function analysis like the one in (11), which extends von Stechow’s (2000)

³To prevent the world-variable introduced by the *wh*-phrase’s restriction from being bound by some λ within the scope of the Q-morpheme or interrogator ‘?’, Reinhart (1994) actually makes use of *intensional* choice functions, i.e., functions from $D_{\langle s, \langle \langle \sigma, t \rangle, \sigma \rangle \rangle}$ to D_σ , that choose an element from the propertie’s extension in the actual (or local C) world. For reasons of simplicity, however, I will stick to the use of extensional choice functions and I will henceforth (implicitly) assume that the restriction of any (complex) *wh*-phrase always introduces a special world variable, say @, that mustn’t be bound by any operator and thus always points to the actual world.

analysis of multiple *wh*-phrases to all kinds of complex ones.

- (11) a. Wem sein Buch hast du gelesen?
 b. $\lambda p.\exists f\exists g[p = \text{you read } f(\text{book-by } g(\text{person}))]$

2.3 The Presuppositional Approach

Finally, let's have a short look at the presuppositional approach advocated by Rullmann & Beck (1998) and Sternefeld (2001b). Basically following Reinhart (1994), Rullmann & Beck (1998) propose to interpret (the restriction of) *which*-phrases in situ; contrary to Reinhart (1994), however, they claim that the restriction of a *which*-phrase should be considered as introducing a presupposition, cf. (12a) and its interpretation (12b) in the notation of Heim & Kratzer (1998).

- (12) a. Which book did you read?
 b. $\lambda p\exists x[p = \lambda w : x \text{ is a book in } w. I \text{ read } x \text{ in } w]$
- (13) a. I read 'Die Buddenbrooks'.
 b. that I read 'Die Buddenbrooks'

Since (12a) is a set of partial propositions and the intuitively well-formed answer (13a) is a total one, the answerhood condition needs to be relativized to the context c , cf. (14) (cf. Heim 2001).

- (14) A is an answer to Q relative to c iff $\llbracket A \rrbracket_c \in \llbracket Q \rrbracket_c$, where
- a. $\llbracket A \rrbracket_c := \lambda w : w \in c.\llbracket A \rrbracket(w)$ and
 b. $\llbracket Q \rrbracket_c := \lambda p\exists q[q \in \llbracket Q \rrbracket \wedge p = \lambda w : w \in c.q(w)]$

According to (14), (13a) is an answer to (12a) iff the context c entails *that 'Die Buddenbrooks' is a book*, i.e., iff it is presupposed *that 'Die Buddenbrooks' is a book*; and the latter seems to be a quite reasonable assumption. In Sternefeld (2001b) the analysis of Rullmann & Beck (1998) is generalized to also capture instances of pied piping, cf. the presuppositional analysis of (15a) in (15b).⁴

- (15) a. Whose book did you read?
 b. $\lambda p.\exists x\exists y[p = \lambda w : y \text{ is a book by } x \text{ in } w. \text{ you read } y \text{ in } w]$

Now, following exactly the same line of reasoning, (13a) — *I read 'Die Buddenbrooks'* — is predicted to be an answer to (15a) iff the context c entails *that there is some person x such that 'Die Buddenbrooks' is a book of x* . To my opinion, there's absolutely no problem with assuming that the latter is always the case, if it is already presupposed that 'Die Buddenbrooks' is a book, for any book is written by some person. In any case, it is easy to

⁴Cf. also Heim 2001 for recent discussion.

construct an intuitively well-formed context that directly fulfills this presupposition, cf. (16a), and shows that (16b) is wrongly predicted to be a well-formed direct answer.⁵

- (16) a. A: Let's see. 'Die Buddenbrooks' is written by Thomas Mann
and 'Der Untertan' is written by Heinrich Mann.
Now, tell me: Whose book did you read?
b. B: *I read 'Die Buddenbrooks'.
c. B': I read the book by Thomas Mann (i.e., 'Die Buddenbrooks')

All in all, we seem to have to conclude that neither of the present available approaches is able to deal with the pied piping problem in a really satisfactory way: Whereas the reconstruction approach is faced with the problem that reconstruction predicts unavailable readings and non-existing equivalences, the choice function approach — as presented above — makes wrong predictions concerning well-formed answers (since it mimics the pied piping problem in situ, cf. Sternefeld 2001a), and so does the presuppositional approach (since it is far too liberal in that it allows the previous context to satisfy the presupposition that should be triggered by the answer).

3 A Uniform Approach to *wh*-Constructions

As far as I can see, the main problem with both the choice function approach and the presuppositional approach is that they simply cannot force an 'answer' to convey enough information such that its utterance is intuitively felt as a well-formed direct answer — and this seems to be a problem that relates to the informational weakness of the unstructured propositional account as has already been discussed for example in Krifka (2001). In the following, I will present a structured approach to the pied piping problem that treats complex *wh*-phrases as a kind of 'generalized' *wh*-constructions, i.e., I will propose to model all interrogative *wh*-constructions in a basically uniform way. Since this proposal extends the analysis of pronominal *wh*-phrases and question/answer-congruence presented in Reich (2002), I will first give a rough sketch of this analysis.

3.1 Questions as Sets of Structured Propositions

In a nutshell, Reich (2002) proposes a hybrid approach to the semantics of questions and answers: on the one hand, it is argued, that focus/background-structures like the one in (17a) should be analysed as denoting structured

⁵Note that it isn't possible to simply require the answer to be an element of the question's denotation ($\llbracket A \rrbracket \in \llbracket Q \rrbracket$), and thus force the answer to trigger the relevant presupposition, since in answers to *which*-questions the restriction of the *which*-phrase usually isn't and can't be mentioned.

propositions, cf. (17b);

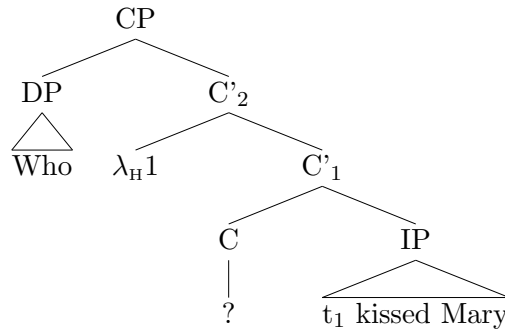
- (17) a. [John]_F kissed Mary.
 b. $\langle \text{John}, \lambda x. x \text{ kissed Mary} \rangle$

on the other hand, it is argued, that it is reasonable to stick to the propositional analysis of questions as proposed in Hamblin (1973), i.e., to conceive of questions as denoting the set of its possible direct answers. If Hamblin’s dictum is taken seriously and if focus/background-structures are analysed as denoting structured propositions, this is equivalent to say that *wh*-interrogatives denote sets of *structured* propositions, cf. (18).

- (18) a. Who kissed Mary?
 b. $\{ \langle x, \lambda y. y \text{ kissed Mary} \rangle; x \text{ is a person} \}$

Concerning the compositional semantics of *wh*-interrogatives, it is in principle possible to stick to the ‘traditional’ logical form of *wh*-interrogatives with an interrogativator ‘?’ in C lifting an open proposition *p* to the singleton set containing this proposition — cf. step 2 in table 1 — and with *wh*-phrases located in [Spec,C] or being adjoined to CP.

- (19) a. Who kissed Mary?
 b.



Having lifted the denotation of IP to the respective singleton set, the next step is to λ -abstract over the trace of the *wh*-phrase. At this step — cf. step 3 in table 1 — we want to bind the trace *within* the (singleton) set and build a (singleton) set of properties. Since common λ -abstraction results in

Step 1:	$\llbracket \text{IP} \rrbracket$	=	<i>that</i> x_1 <i>kissed Mary</i>
Step 2:	$\llbracket \text{C}'_1 \rrbracket$	=	$\{ \textit{that } x_1 \textit{ kissed Mary} \}$
Step 3:	$\llbracket \text{C}'_2 \rrbracket$	=	$\{ \lambda x_1. \textit{that } x_1 \textit{ kissed Mary} \}$
Step 4:	$\llbracket \text{CP} \rrbracket$	=	$\{ \langle x, \lambda x_1. \textit{that } x_1 \textit{ kissed Mary} \rangle; x \textit{ is a person} \}$

Table 1: bottom-up interpretation of (19b)

a function from individuals to sets of propositions rather than in a set of

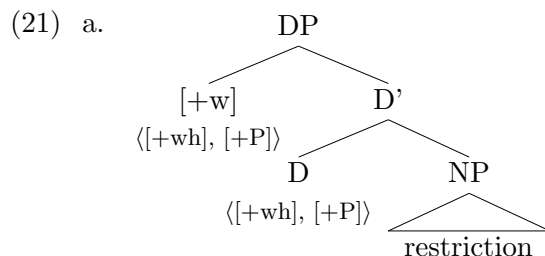
properties, one has to introduce another, though related kind of abstraction procedure which allows for common λ -abstraction *within* sets — this is the so-called ‘Hamblin-abstraction’, λ_H , an operation that is, as far as I know, first made use of in Hamblin (1973).⁶ In step 4, finally, this (singleton) set of properties is mapped to the respective set of structured propositions. As for question/answer congruence it is simply assumed that an utterance is a congruent direct answer iff it is an element of the question’s denotation.

3.2 Syntax and Semantics of Simple *wh*-Phrases

In step 4 of this derivation I presupposed a semantics for pronominal *wh*-phrases as stated in (20), i.e., *who* is modelled as mapping a set of (structured) properties \mathcal{Q} to the Cartesian product of the *wh*-phrase’s restriction and the set \mathcal{Q} .⁷

$$(20) \quad (who)' = \lambda \mathcal{Q} \lambda p \exists x \exists P [person(x) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$$

Consequently, a pronominal *wh*-phrase has to be conceived of as consisting of two parts: a functional part introducing the relevant structure and an indefinite part supplying for the *wh*-phrase’s restriction.



$$b. \quad ([+w])' = \lambda R \lambda \mathcal{Q} \lambda p \exists x \exists P [R(x) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$$

In fact it is possible and, I think, also reasonable to treat these two aspects of *wh*-phrases independently of each other — both syntactically and semantically, cf. the assumed internal structure of a pronominal *wh*-phrase like *who* in (21a): The internal structure of *who* is analysed as consisting of a DP whose complement is an NP supplying the indefinite restriction to persons, and whose specifier is a lexical interrogative item [+w] — which can be conceived of as the covert counterpart to overt *which* — encoding the functional part of the *wh*-pronominal. Basically following Trissler & Lutz (1992), I am assuming that the interrogative item [+w] introduces a phrasal *wh*-feature [+wh]^P, or more precisely, two features: a *wh*-feature [+wh] and a phrasal feature [+P]. These features license corresponding features in the head of DP — the parallel to the sentential domain is, I think, evident —, and thus

⁶For a definition of Hamblin-abstraction and possible alternatives, cf. Reich (2001).

⁷The function $(\cdot)'$ maps any natural language expression to its formal counterpart.

trigger the construction of simple interrogative *wh*-phrases like *who*, *what*, or *which book* via projection of these features. This way of looking at the syntax of interrogative *wh*-phrases has, by the way, rather interesting consequences for the analysis of non-interrogative *wh*-phrases like, for example, echo-*wh*-phrases, cf. Trissler & Lutz (1992) and Reis (1992) for discussion.

3.3 Syntax and Semantics of Complex *wh*-Phrases

So much for the syntactic and semantic analysis of *simple wh*-phrases. Concerning complex *wh*-phrases, I am assuming — again following in spirit Trissler & Lutz (1992) — that complex *wh*-phrases are constituted by *percolation* of the syntactic features [+wh] and [+P] rather than by *projection*. Percolation is modelled as a syntactic relation between two maximal projections and is basically restricted by two principles: first, feature percolation is allowed from complements to functional projections, cf. (22a), and, second, feature percolation is allowed from specifiers, if the head isn't already marked as [+wh], cf. (22b).

(22) *Percolation of [+wh], [+P] (in German)*

Suppose that XP and YP are maximal projections. [+wh] (and [+P]) percolates from XP to YP, if one of the following configurations holds:

- a. $[_{YP,[+wh]} [_{Spec,Y} [_{Y'} Y^{func} XP_{[+wh]}]]$, i.e., XP is a complement of Y and YP is a functional projection;
- b. $[_{YP,[+wh]} XP_{[+wh]} [_{Y'} Y_{[+wh]} \dots]]$, i.e., XP is the specifier of Y and Y isn't already marked as [+wh].

Given suitable assumptions about the syntactic structure of *wh*-phrases like *whose book*, *how tall*, *how many books* etc. these are all treated as complex *wh*-phrases relative to the percolation mechanism stated in (22), cf. (23).

(23) (Some) complex *wh*-phrases (percolation of [+wh], [+P]):

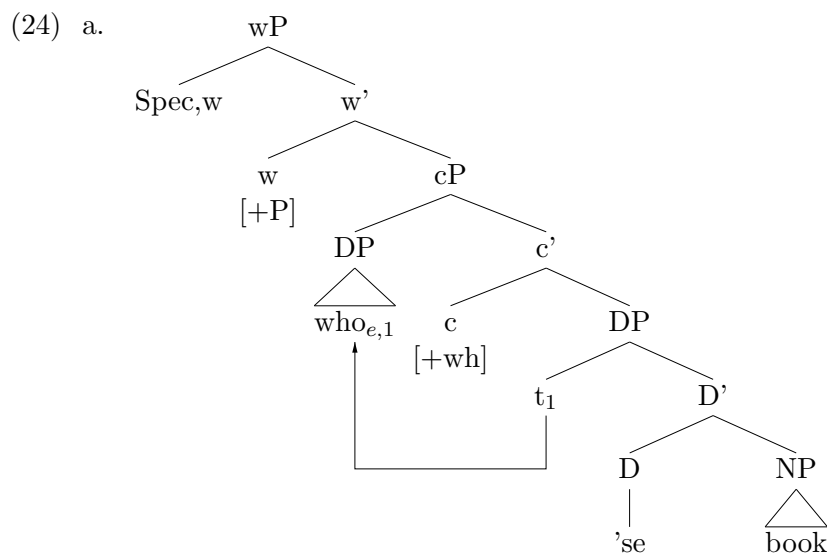
- a. *whose book*: $[_{DP} who [_{D'} POSS [_{NP} book]]]$
- b. *how tall*: $[_{AP} [_{DegP} how] [_{A'} tall]]]$
- c. *how many books*: $[_{DP} [_{D'} \emptyset [_{QP} [_{DegP} wie] [_{Q'} [_{Q} viele] [_{NP} Bücher]]]]]$

In the following, however, the discussion will mainly center around the analysis of the complex *wh*-phrase *whose book*.

The crucial point where I depart from the assumptions argued for in Trissler & Lutz (1992) concerns the exact syntactic shape of complex *wh*-phrases: contrary to Trissler & Lutz (1992), I assume that each of the features [+wh] and [+P] — which are responsible for the constitution of complex *wh*-phrases via feature percolation — projects a functional projection on top of the *wh*-phrase: the *wh*-feature [+wh] projects a 'small' cP corresponding syntactically as well as semantically to the 'large', sentential CP; and the phrasal feature [+P] projects another functional projection which I take to

be specific for complex *wh*-phrases and which I'd like to dub 'wP', which is simply short for '*wh*-phrase'. Of course, both the small cP and the wP need to be categorial transparent. Though I do not yet have any independent empirical evidence for the existence of such functional projections, their assumption is in fact forced in a transparent logical form by semantic interpretation as will be clear from the following discussion; furthermore it should be emphasized that these functional projections are not simply stipulated, but that they have its natural origin in the independently needed feature percolation mechanism introduced above.

Now, to be more concrete, let's have a closer look at the syntax and semantics of the complex *wh*-phrase *whose book*, in especially at the syntax and semantics of the head of the small cP — the feature [+wh] — and the head of wP — the feature [+P]. As I mentioned above, I take it that the small cP functions both syntactically and semantically absolutely parallel to the sentential CP: as far as its syntax is concerned, the *wh*-pronominal *who*, which is embedded in the complex *wh*-phrase, moves upwards to the specifier position of the small cP — its movement being covert since there's no independent *wh*-feature to license, cf. (24);



- b. $([+wh])' = \lambda y \lambda x [x = y]$ (generalized interrogativator)
- c. $([+P])' = \lambda \mathcal{R} \lambda \mathcal{Q} \lambda p \exists x \exists P [\mathcal{R}(x) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$ (*p*-type)
- d. $(\text{who}_e)' = \lambda \mathcal{Q} \lambda z \exists x \exists P [\text{person}(x) \wedge \mathcal{Q}(P) \wedge z = \langle x, P \rangle]$ (*e*-type)

as far as its semantic composition is concerned the interpretation of the small cP is again parallel to the interpretation of the sentential CP, however with one exception — this time the interpretation results in a set of structured *individuals* rather than a set of structured *propositions*. To see this, consider

step 1 to step 4 in table 2 (it may be instructive to compare this derivation to the interpretation of the *wh*-interrogative (19b) as stated in table 1): after *wh*-movement the DP denotes an ‘open’ individual, cf. step 1; as in

Step 1:	[[DP]]	=	x_1 ’s book
Step 2:	[[c’ ₁]]	=	$\{x_1$ ’s book $\}$
Step 3:	[[c’ ₂]]	=	$\{\lambda x_1.x_1$ ’s book $\}$
Step 4:	[[cP]]	=	$\{\langle x, \lambda x_1.x_1$ ’s book $\rangle; x$ is a person $\} := A$
Step 5:	[[wP]]	=	$\lambda Q\lambda p\exists x\exists P[A(x) \wedge Q(P) \wedge p = \langle x, P\rangle]$

Table 2: bottom-up interpretation of (24a)

the sentential domain the *wh*-feature [+wh] is interpreted as a type-shifter, lifting the individual to the singleton set containing this individual, cf. step 2; Hamblin-abstraction in step 3 results in the singleton set containing the property of ‘being x ’s book’; in step 4, finally, the pronominal *wh*-phrase *who* builds a set of structured individuals, namely the Cartesian product of the *wh*-phrase’s restriction and the denotation of small c ’.

Up to this point, the interpretation of the complex *wh*-phrase was in fact absolutely parallel to the one of *wh*-interrogatives. What distinguishes complex *wh*-phrases from *wh*-interrogatives, is the *wh*-phrase specific projection wP, in especially its head [+P]. If the feature [+P] is assigned exactly the same semantics as the lexical interrogative item [+w] or *which* in simple *wh*-phrases is — cf. (24c) —, then the layers wP and cP actually mimic the structure of simple *wh*-phrases: the feature [+P] is semantically equivalent to the interrogative expression *which* and the small cP simply serves as its restriction, cf. step 5 of the interpretational process.

In an interrogative like *Whose book did you read?* — cf. (25a) — this finally results in the set of structured propositions indicated in (25b) (cf. section 3.1 for the relevant steps):

- (25) a. Whose book did you read?
 b. $\{\langle a, \lambda y. \text{you read } y\rangle; a \in A\}$ or, more perspicuous,
 c. $\{\langle \langle x, \lambda z.z$ ’s book $\rangle, \lambda y. \text{you read } y\rangle; x$ is a person $\}$ or
 d. $\{\langle \langle \text{Thomas Mann}, \lambda z.z$ ’s book $\rangle, \lambda y. \text{you read } y\rangle, \dots \}$

On the assumption that (26a) — intended as an answer to (25a) — is assigned the focus/background-structure in (26b),⁸ and, second, that the focus/background-structure in (26b) is interpreted as the structured proposition given in (26c) — the focus *Thomas Mann* is adjoined to DP —, it is clear that (26a) is predicted to be a well-formed direct answer to (25a), since (26c) is an element of (25b).

⁸Cf. e.g. Reich (2001, 2002) and references therein for thorough discussion.

- (26) a. I read Thomas MANN’s book.
 b. I read [[Thomas Mann]_F’s book]_F
 c. $\langle\langle \textit{Thomas Mann}, \lambda z.z\textit{'s book}\rangle, \lambda y. \textit{you read } y\rangle$

Moreover, if (27a) is assigned the focus/background-structure in (27b) and (27b) is interpreted as the structured proposition given in (27c), it is likewise evident that (27a) isn’t a well-formed direct answer to (25a): (27c) simply isn’t an element of (25b). Taken together, this obviously solves the pied piping problem.

- (27) a. I read ‘Die BUddenbrooks’.
 b. I read [‘Die Buddenbrooks’]_F
 c. $\langle\langle \textit{‘Die Buddenbrooks’}, \lambda y. \textit{you read } y\rangle$

Before discussing the interpretation of multiple *wh*-phrases, let me mention that in Reich (2001) a choice function variant of this approach is proposed that in addition allows (i) to interpret the restriction of (complex) *wh*-phrases in situ, and (ii) to substitute focus binding for focus movement, thus avoiding violation of movement restrictions. For reasons of space and simplicity, however, I won’t discuss this variant here.

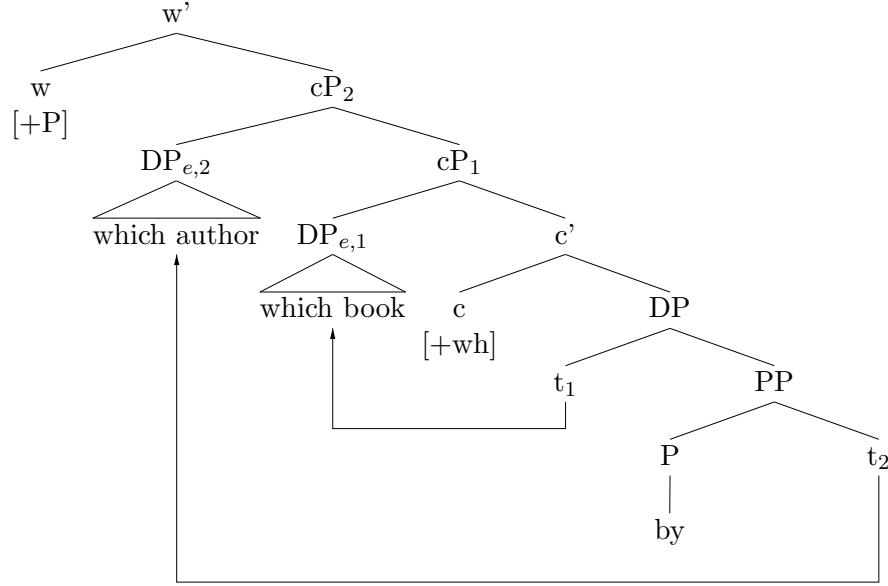
3.4 An Analysis of Multiple *wh*-Phrases

Since the main claim of the previous section was that the syntax and semantics of complex *wh*-phrases is — apart from the *wh*-phrase specific projection *wP* — completely parallel to the syntax and semantics of *wh*-interrogatives, it shouldn’t come as a surprise that cases of multiple *wh*-phrases can be treated in an absolutely straightforward way: multiple *wh*-phrases are analysed as ‘generalized’ multiple *wh*-interrogatives. To see this, let’s have a closer look at the multiple *wh*-phrase *which book by which author* in (28a). On the level of logical form the higher simple *wh*-phrase *which book* is moved to the specifier position of the small *cP* and the lower simple *wh*-phrase gets adjoined to the small *cP*.

Step 1:	[[DP]]	=	$x_1 \textit{ by } x_2$
Step 2:	[[c’]]	=	$\{x_1 \textit{ by } x_2\}$
Step 2’:	[[c’]]	=	$\{\lambda x_1.x_1 \textit{ by } x_2\}$
Step 3:	[[cP ₁]]	=	$\{\langle x, \lambda x_1.x_1 \textit{ by } x_2\rangle; x \textit{ a book}\}$
Step 3’:	[[cP ₁]]	=	$\{\lambda x_2.\langle x, \lambda x_1.x_1 \textit{ by } x_2\rangle; x \textit{ a book}\}$
Step 4:	[[cP ₂]]	=	$\{\langle y, \lambda x_2.\langle x, \lambda x_1.x_1 \textit{ by } x_2\rangle\rangle; x \textit{ a book}, y \textit{ an author}\}$ $=: A$
Step 5:	[[wP]]	=	$\lambda Q\lambda p\exists x\exists P[A(x) \wedge Q(P) \wedge p = \langle x, P\rangle]$

Table 3: bottom-up interpretation of (28b)

- (28) a. Which book by which author
 b. [...]



- c. $([+P])' = \lambda \mathcal{R} \lambda \mathcal{Q} \lambda p \exists x \exists P [\mathcal{R}(x) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$
 d. $([+wh])' = \lambda y \lambda x [x = y]$
 e. $(\text{which author})' = \lambda \mathcal{Q} \lambda z \exists x \exists P [\text{author}(x) \wedge \mathcal{Q}(P) \wedge z = \langle x, P \rangle]$
 f. $(\text{which book})' = \lambda \mathcal{Q} \lambda z \exists x \exists P [\text{book}(x) \wedge \mathcal{Q}(P) \wedge z = \langle x, P \rangle]$

After *wh*-movement, the DP denotes an ‘open’ individual; this time, however, an open individual that contains exactly two variables, cf. step 1 in table 3. Once again, interpretation of the *wh*-feature, Hamblin-abstraction and the interpretation of the simple *wh*-phrase *which book* results in a set of structured individuals, cf. steps 2 to 3; at this point, however, it is necessary to iterate the interpretation of adjoined simple *wh*-phrases. As steps 3' and 4 in table 3 show, this is absolutely straightforward — as it is in the sentential domain: the small cP denotes a set of a doubly structured individuals — cf. step 4 — that serves as the restriction of the semantic interpretation of the feature [+P], cf. step 5.

In an interrogative like *Which book by which author did you read?*, cf. (29a), this finally results in the set of structured propositions indicated in (29b) (cf. again section 3.1 for the relevant steps):

- (29) a. [Which book by which author] did you read?
 b. $\{ \langle \langle \text{Th. Mann}, \lambda x_2. \langle \text{‘Buddenbrooks’}, \lambda x_1.x_1 \text{ by } x_2 \rangle \rangle, \lambda y. I \text{ read } y \rangle, \langle \langle \text{H. Mann}, \lambda x_2. \langle \text{‘Der Untertan’}, \lambda x_1.x_1 \text{ by } x_2 \rangle \rangle, \lambda y. I \text{ read } y \rangle \dots \}$

Again, on the assumption that (30a) — intended as an answer to (29a) — is assigned the focus/background-structure in (30b) and that this focus/background-structure is interpreted as the structured proposition in (30c) (multiple focus movement within DP), then (30a) is predicted to be a well-formed answer to the question (29a), for (30c) is obviously an element of (29b).

- (30) a. I read ‘Die BUddenbrooks’ by Thomas MANN.
 b. I read [[‘Die Buddenbrooks’]_F by [Thomas Mann]_F]_F
 c. $\langle\langle Th. Mann, \lambda x_2. \langle ‘Die Buddenbrooks’, \lambda x_1. x_1 \text{ by } x_2 \rangle \rangle, \lambda y. I \text{ read } y \rangle$

This shows that multiple *wh*-phrases do not pose a major challenge in this approach. Nevertheless, there are some problems that should be mentioned here:

- In (28b) the PP *by which author* is adjoined to the DP *which book*. This enables one to move both *which*-phrases independently of each other to the cP-domain. If, however, the PP must be analysed as part of the restriction of the uppermost *which* for whatever reasons, then the pied piping problem obviously reoccurs within the multiple *wh*-phrase.
- If the relevant preposition is semantically empty (e.g., in case of relational nouns like *friend-of*) the restriction must be interpreted in situ for semantic reasons.

Both problems can be dealt with within the choice function variant of the approach proposed here, since the use of choice functions allows for an in situ interpretation of the *wh*-phrase’s restrictions (cf. Reich 2001).

4 Implications for *was...w*-Constructions

In the last part of this paper, I want to explore some possible consequences of the present approach for the analysis of so-called *was...w*-constructions in German, exemplified by (31a).

- (31) a. Was glaubst du, wen₁ Peter t₁ eingeladen hat?
 What believe you, who₁ Peter t₁ invited has
 ‘Who do you believe that Peter invited’
 b. Wen₁ glaubst du, t’₁ dass Peter t₁ eingeladen hat.
 ‘Who do you believe that Peter invited’

It is commonly assumed that *was...w*-constructions have at least the following properties (cf. Lutz et al. 2000 for an overview): (i) [Spec,C] of the matrix clause is always occupied by the *wh*-element *was*; (ii) the whole construction (31a) is a *wh*-interrogative (i.e., the superordinate C is marked as [+wh]), since it is semantically equivalent to the long *wh*-movement construction (31b); (iii) although introduced by a *wh*-phrase, the embedded *wh*-sentence

presumably isn't a *wh*-interrogative (i.e., the subordinate C isn't marked as [+wh]), since the embedding predicate — *glauben* ('believe') in (31a) — doesn't subcategorize for interrogatives.

Basically, there are two main approaches to the analysis of *was...w*-constructions (cf. again Lutz et al. 2000 for an overview), the so-called 'direct approach' and the so-called indirect approach.' Roughly speaking, the direct approach argues that in *was...w*-constructions the *wh*-phrase of the subordinated sentence is — contrary to long *wh*-movement constructions — only partially moved on the level of surface structure; the *wh*-element *was* is conceived of as an expletive element whose task it is to mark the semantic scope of the partially moved *wh*-phrase. The indirect approach, on the other hand, argues, first, that the *wh*-element *was* is in fact a 'real' *wh*-phrase, second, that the embedded *wh*-sentence is in fact a *wh*-interrogative, and, third, that this *wh*-interrogative is — at the level of deep structure — the syntactic complement of the *wh*-phrase *was*. It is further assumed that, on surface structure, the *wh*-interrogative adjoins to *was* and *was* moves to [Spec,C]; on logical form, then, the *wh*-interrogative is moved upwards and 'reconstructed' into the complement position of *was*, cf. (32a).

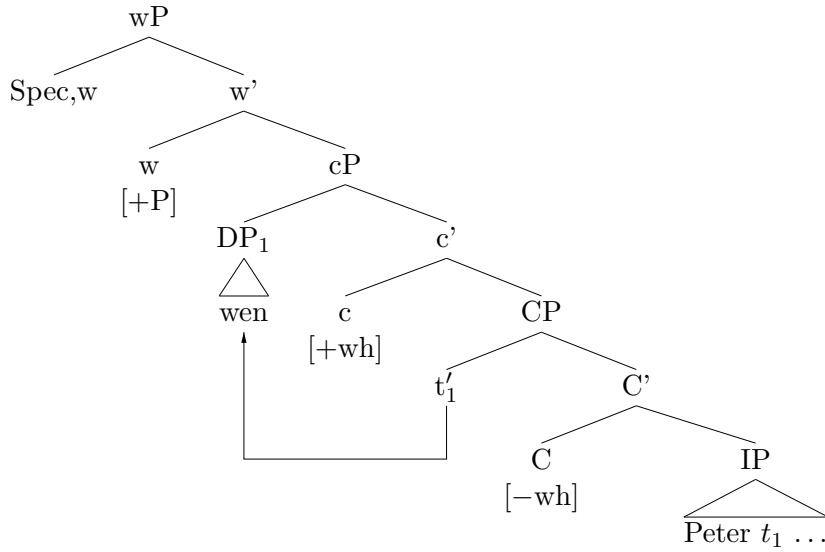
- (32) a. [was [wen₁ Peter t₁ eingeladen hat]]₂ ? [du glaubst t₂
 [what [who₁ Peter t₁ invited has]]₂ ? [you believe t₂]
 b. $\lambda p \exists q [(\lambda r \exists x [r = \textit{Peter invited } x])(q) \wedge p = \textit{you believe } q]$
 c. (was)' = $\lambda Q \lambda P \lambda p \exists q [Q(q) \wedge P(q)(p)]$

Actually, it turns out that the analysis for complex *wh*-phrases as proposed in the previous sections suggests an analysis of *was...w*-constructions that results in essentially the same logical form as the indirect approach does, but in a completely different way. The basic idea is, that the embedded *wh*-sentence is in fact a complex, though sentential *wh*-phrase. If it is assumed — contrary to the indirect approach — that the embedded *wh*-sentence isn't a *wh*-interrogative, i.e., that its complementizer position isn't marked as [+wh], then the percolation rules for [+wh] and [+P] predict that the features [+wh] and [+P] which are introduced by the *wh*-phrase *wen* percolate from SpecC to CP and project a small cP and a wP, respectively; i.e., the embedded *wh*-sentence is in fact to be analysed as a complex *wh*-phrase and it is assigned the structure in (33b).

Since the complementizer position of sentential CP isn't marked as [+wh], it doesn't contribute anything to the interpretation and the CP denotes — after LF-movement of the simple *wh*-phrase *wen* to the specifier-position of the small cP — an open proposition, cf. step 1; and since the CP denotes a proposition, the complete interpretational process up to the small cP generates a set of structured propositions — in fact exactly the same set of structured propositions that would have been generated if the sentential CP were analysed as a real *wh*-interrogative. Since we assumed, however, that

(33) a. wen₁ Peter t₁ eingeladen hat

b.



c. $([+wh])' = \lambda q \lambda p [p = q]$

d. $([+P])' = \lambda \mathcal{R} \lambda \mathcal{Q} \lambda p \exists q \exists P [\mathcal{R}(q) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$ (p -type)

e. $(\text{wen}) = \lambda \mathcal{Q} \lambda p \exists x \exists P [person(x) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$ (p -type)

the sentential CP doesn't have the semantic force of a *wh*-interrogative, the proposed analysis of complex *wh*-phrases predicts the presence of the functional projection wP; and it turns out, that the interpretation of its head, i.e., the interpretation of the feature [+P], is basically identical to the semantic interpretation of *was* in the so-called indirect approach.

Step 1:	$\llbracket \text{CP} \rrbracket$	=	<i>Peter invited</i> x_1
Step 2:	$\llbracket c' \rrbracket$	=	$\{ \textit{Peter invited } x_1 \}$
Step 2':	$\llbracket c' \rrbracket$	=	$\{ \lambda x_1. \textit{Peter invited } x_1 \}$
Step 3:	$\llbracket cP \rrbracket$	=	$\{ \langle x, \lambda x_1. \textit{Peter invited } x_1 \rangle; x \textit{ is a person} \} := A$
Step 5:	$\llbracket wP \rrbracket$	=	$\lambda \mathcal{Q} \lambda p \exists q \exists P [A(q) \wedge \mathcal{Q}(P) \wedge p = \langle x, P \rangle]$

Table 4: bottom-up interpretation of (33b)

To complete the picture, the interpretation of the logical form (34a) finally results in a set of structured propositions as indicated in (34b) (cf. once more section 3.1 for the relevant steps),

(34) a. $\llbracket [+P] [\textit{who}_1 [[+wh] [t'_1 \textit{Peter } t_1 \textit{ingel. hat}]]]_2 ? [\textit{du glaubst } t_2]$
 b. $\{ \langle \langle \textit{Mary}, \lambda x_1. \textit{Peter invited } x_1 \rangle, \lambda q. \textit{you believe } q \rangle, \dots \}$

and, consequently, (35b) is predicted to be a well-formed answer to (31a).

- (35) a. I believe that Peter invited MArY.
b. I believe [that Peter invited [MArY]_F]_F
c. $\langle\langle Mary, \lambda x_1. Peter\ invited\ x_1 \rangle, \lambda q. I\ believe\ q \rangle$

This is exactly the desired result. Now, what are the advantages of this approach, what are its disadvantages? First of all, it captures the intuition that the embedded *wh*-sentence isn't a *wh*-interrogative. Second, it accounts for the fact that *was...w*-constructions are impossible with *whether*-sentences, simply because *whether*-sentences always have to be analysed as *whether*-interrogatives; and last but not least this analysis follows completely from independent assumptions about the structure of complex *wh*-phrases, and thus subsumes the phenomenon of *was...w*-constructions under a much more general phenomenon, namely the one of complex *wh*-phrase.

Unfortunately, there still remain one or two problems. To enable the restriction to stay in situ, one has to assume — as in the indirect approach — that the small cP is adjoined to the wP and that the wP, which is phonologically realized as *was*, is moved overtly to [Spec,C]. This point is in fact rather unproblematic, since in the choice function variant of the approach pursued here, this stipulation can be avoided. What is more problematic, though, is the following: Even if the cP is interpreted in situ and if it is only the *wh*-part of the complex *wh*-phrase that moves overtly to [Spec,C], why isn't it possible to move the complete *wh*-phrase/*wh*-interrogative overtly to [Spec,C]? At the moment, I've got no really good answer to this question — but, to the best of my knowledge, the proponents of the indirect approach are in no better position.

5 Summary

In a first step, I evaluated three different approaches to the pied piping problem and showed that neither of them treats the problem in a really satisfiable way. In a second step, I developed a structured approach to the pied piping problem which is based on a semantic analysis of *wh*-interrogatives that models *wh*-interrogatives as denoting sets of structured propositions, rather than unstructured ones. The most central idea of this proposal is the assumption that all *wh*-constructions — i.e., *wh*-phrases and *wh*-interrogatives — should be analysed syntactically as well as semantically in the same way, with the only exception that (complex) *wh*-phrases are assigned an additional functional projection that — inter alia — accounts for the different behavior of complex *wh*-phrases and *wh*-interrogatives. In the last part of the paper, I finally sketched a new analysis of German *was...w*-constructions that subsumes this kind of construction under the general phenomenon of complex *wh*-phrases; if successful, this analysis may serve as further indirect evidence for the approach to complex *wh*-phrases proposed in this paper.

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