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The functional nature of multiple *wh*- free relative clauses*

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Abstract: Multiple *wh*- free relative clauses are not only less attested cross-linguistically and have been much less studied than other types of clauses, but are also particularly puzzling. Focusing on multiple *wh*- free relative clauses in Romanian, we show that, despite being true free relative clauses, standard semantic analyses of free relative clauses with just a single *wh*-phrase (Jacobson 1995; Dayal 1996; Caponigro 2003, 2004) cannot be straightforwardly extended to multiple *wh*- free relative clauses. We propose a solution to this puzzle by providing the first compositional analysis of multiple *wh*- free relative clauses, which builds on previous work on single *wh*- free relative clauses and functional readings in interrogative and relative clauses.

Keywords: free relatives, *wh*-clauses, functional *wh*-words

1 The puzzle

Multiple wh- clauses are *wh*-clauses containing more than one *wh-phrase.*[1] They are well-attested across languages and manifest themselves in different shapes, with various levels of productivity within a language and across languages. Multiple *wh*- interrogative clauses like those in (1) are widespread (see e.g., Dayal 2016 for a recent overview). A few languages also allow for multiple *wh*- correlative clauses like those in (2) (see Braşoveanu 2008, 2012; Citko 2009; Lipták 2009 a.o.) or multiple *wh*- "modal existential constructions" (MECs) like those in (3) (see Grosu

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[1] We use the term *wh-phrase* to refer to both a simple phrase that is made of just a *wh*-word (e.g., *who*, *where*) or a more complex phrase containing a *wh*-word together with other lexical material (e.g., *by means of which device*, *how many participants*).

2004 and Šimík 2011 a.o.). The non-English examples in this paper are all from Romanian unless otherwise indicated.

(1) Mă întreb /spune-mi [**cine ce** a făcut azi].
me wonder.1SG/tell.2SG-me who what has done today
'I wonder/tell me who has done what today.'

(2) [**Cine ce** şi-a luat], acela aia să mănânce.
who what CL.3SG-has taken that-one that SUBJ eat.3SG
Roughly: 'Everyone should eat whatever (food) they picked.'

(3) Nu are [**cine ce** să facă].
not has who what SUBJ do.3SG
'There's nothing anyone could do.'

On the other hand, all languages we are aware of ban the use of multiple *wh*-clauses to form headed relative clauses, probably as a consequence of the more general ban on headed relative clauses with multiple gaps.

(4) *Am mâncat prăjitura în momentul [**pe care când**
have.1SG eaten cake-the at moment-the ACC which when
mi-ai adus-o].
CL.1SG-have.2SG brought-it
Intended interpretation: 'I ate the cake you brought me when you brought it to me.'

There is another kind of multiple *wh*-construction, which has received little attention: **multiple *wh*- free relative clauses** (***multiple wh- FRs***). This is the construction we focus on in this paper. To our knowledge, multiple *wh*- FRs have only been found in a few languages so far, most of which are spoken in the Balkans (Bulgarian, Macedonian, Romanian, see Rudin 2007, 2008). Examples from Romanian with two and three *wh*-phrases are given in (5-8) and (9), respectively.[2]

(5) Am mâncat [**ce când** mi-ai adus].
have.1SG eaten what when CL.1SG-have.2SG brought
Roughly: 'I ate the thing/things you brought me to eat at the moment(s) appropriate for it/them.'

[2] Our ten consultants are all from Transylvania, a region from North-Western and Central Romania. Two anonymous conference abstract reviewers reported that in their (unspecified) variety of Romanian multiple *wh*- FRs are not allowed. On the other hand, Rudin (2007, 2008) provides examples of multiple *wh*- FRs from Romanian without further specifying which variety she is considering. From now on, whenever we use the label Romanian, we are specifically referring to the variety of Romanian spoken in Transylvania, unless otherwise mentioned.

(6) Am împachetat [**ce** **cui** dăm de Crăciun].
have.1 wrapped what who.DAT give.1PL for Christmas
Roughly: 'We wrapped the things to give to the appropriate people on Christmas.'

(7) Ți-am arătat [**ce** **cum** a fost instalat.]
CL2SG-have.1SG shown what how has been installed
Roughly: 'I showed you the thing(s) that were installed in the way(s) it/they were installed.'

(8) Azi am pregătit [**ce** **când** vei lua în următoarele zile.]
today have.1SG prepared what when will.2SG take in next-the days
Roughly: 'Today I prepared what you will take (at its appropriate time) in the next days.'

(9) Ți-am dat [**ce** **unde** **când** a trebuit instalat.]
CL2-have.1SG given what where when has needed installed
Roughly: 'I gave you the things that needed to be installed in the appropriate place at the appropriate time.'

It is not easy to find a fully satisfactory translation for multiple *wh*- FRs in languages lacking them because of the way the interpretation of the first (highest) *wh*-phrase affects the interpretation of the other *wh*-phrases. We return to this crucial feature of multiple *wh*- FRs in section 3.

Multiple *wh*- FRs have not only been little studied, but are also particularly puzzling. As far as their morpho-syntactic and semantic status is concerned, they are free relative clauses (FRs) rather than any other type of multiple *wh*- clauses, as we show in section 2. Still, standard semantic treatments of FRs with just a single *wh*-phrase (*single wh- FRs*) cannot straightforwardly extend to multiple *wh*- FRs, as we discuss in section 4. We propose a solution to this puzzle by providing the first compositional analysis of multiple *wh*- FRs, which builds on previous work on single *wh*- FRs and functional readings in interrogative and relative clauses. We focus on Romanian, a language that makes use of multiple *wh*- FRs productively and also displays all the other multiple *wh*- clauses listed above (e.g., Comorovski 1996; Grosu 2004; Braşoveanu 2008, 2012), a property that allows a better understanding of how the denotation of *wh*-words and the semantic composition varies and relates across constructions.

2 Multiple *wh*- FRs are free relative clauses

One of the questions raised by multiple *wh*- FRs is whether they can be reduced to one of the other multiple *wh*- constructions mentioned above. We argue that the answer is 'no': multiple *wh*- FRs differ from the kinds of multiple *wh*- clauses illustrated in (1-3) and constitute a distinct type of multiple *wh*- construction. As

we will see, multiple *wh*- FRs are both syntactically and semantically close to single *wh*- FRs. In this section, we present a series of arguments supporting our claim.

2.1 Multiple *wh*- FRs are not interrogative clauses

There are at least three properties indicating that multiple *wh*- FRs are not interrogative clauses. First, like single *wh*- FRs, they can occur as arguments of non-interrogative predicates like 'eat', 'prepare', 'wrap' or 'give', as shown above in (5) to (9), respectively. Second, they exhibit the same restrictions on *wh*- phrases as single *wh*- FRs. For instance, Romanian single *wh*- FRs allow for almost all *wh*-phrases that can occur in interrogative clauses (e.g., Grosu 2013; Caponigro & Fălăuș 2017), the complex *wh*-phrase *care+NP* 'which NP' being the only exception (10). *Care+NP* cannot occur in multiple *wh*- FRs either (11). In contrast, *care+NP* is perfectly acceptable in (matrix or embedded) multiple *wh*- interrogatives (12):

(10) * Am mâncat [**care mâncare** ai gătit-o].
have.1 eaten which food have.2SG cooked-it

(11) * Am mâncat [**care mâncare când** ai gătit-o].
have.1 eaten which food when have.2SG cooked-it

(12) (Mă întreb) [**care mâncare când** a fost gătită?].
me wonder.1SG which food when has been cooked
'(I wonder) which food was cooked when?'

Third, the interpretation of multiple *wh*- FRs does not resemble the interpretation of (single or multiple) *wh*- interrogative clauses. We discuss the semantic contribution of multiple *wh*- FRs in detail in section 4. Here it suffices to observe that, like single *wh*- FRs, multiple *wh*- FRs denote singular or plural individuals, as highlighted by the definite descriptions paraphrasing them. *Wh*- interrogative clauses, instead, denote a question, i.e., a set of propositions or some other semantic object different from individuals.

2.2 Multiple *wh*- FRs are not correlative clauses

Multiple *wh*- FRs are also different from correlatives. A well-known feature of correlative constructions, also illustrated in (2) above, is that they occur at the periphery of their matrix clause (e.g., Dayal 1996; Lipták 2009). In contrast, multiple *wh*- FRs occur in argument or adjunct positions within their matrix clauses (similarly to single *wh*- FRs), rather than dislocated. Furthermore, *wh*-phrases used in a correlative have a corresponding anaphoric (pronominal/demonstrative) marker in the matrix clause—one for each *wh*-phrase. Neither single *wh*- FRs nor

multiple *wh*- FRs have this property—their matrix clause does not contain anaphoric elements for the *wh*-phrases.

2.3 Multiple *wh*- FRs are not MECs

We conclude our comparative discussion by contrasting multiple *wh*- FRs with MECs. Grosu (2004, 2013) and Šimík (2011) clearly show that multiple *wh*- MECs are introduced by a limited class of matrix predicates, i.e., existential 'be' and 'have', as illustrated in (3). On the other hand, predicates like 'wrap', 'eat', and 'show' do not embed MECs.[3] Since these are exactly the matrix predicates introducing the multiple *wh*- clauses in (5-9), those embedded multiple *wh*- clauses cannot be MECs. The very same predicates can, however, introduce single *wh*-FRs (13-15), which further supports the claim that multiple *wh*- FRs are FRs.

(13) Am mâncat [**ce** ai fi mâncat şi tu].
have.1SG eaten what have.COND.2SG be eaten also you
'I ate what you would have eaten as well.'

(14) Ți-am arătat [**cum** trebuie instalat frigiderul].
CL.2SG.DAT-have.1SG shown how must installed fridge-the
'I showed you how/the way in which the fridge must be installed.'

(15) A împachetat cadouri [**cine** a avut timp].
has wrapped gifts who has had time
'(Those) who had time wrapped gifts.'

Another argument against a MEC analysis for the multiple *wh*- clauses we are investigating relates to the mood of MECs. Grosu (2004, 2013) and Šimík (2011) extensively argue that MECs require the subjunctive or the infinitive, as also exemplified in the Romanian sentences in (3). In contrast, multiple *wh*- FRs do not impose any mood restrictions: all our examples of multiple *wh*- FRs use the indicative, behaving like single *wh*- FRs in this respect as well.[4] Lastly, MECs and multiple *wh*- FRs differ in their interpretation. MECs have been argued to have the

[3] Predicates like 'give', 'send', 'choose', and 'get' can introduce single MECs cross-linguistically, but to our knowledge no multiple MECs have been discussed in the literature with predicates other than 'be' and 'have'.

[4] This does not mean that subjunctive is ruled out in FRs. As (i)-(ii) show, subjunctive mood is also possible in FRs, both single and multiple *wh*- ones (on the distribution of subjunctive mood in Romanian, see Farkas 1985, 1992):

(i) Am împachetat **ce** să iei cu tine.
have.1SG packed what SUBJ take.2SG with you
'I packed what you should take with you.'

(ii) Am împachetat **ce** **când** să iei cu tine.
have.1SG packed what when SUBJ take.2SG with you
'I packed what you should take with you when you should take it'.

meaning of existentially quantified expressions. As already suggested by the paraphrases above and discussed in the next section, this is unlike the semantic behavior of multiple *wh*- FRs, which we show to denote individuals. We therefore have both syntactic and semantic arguments against an analysis of multiple *wh*- FRs as MECs.

2.4 Multiple *wh*- FRs are free relative clauses

The discussion above has highlighted several differences between multiple *wh*- FRs and other constructions involving multiple *wh*-phrases. While pointing out these differences, we also argued that multiple *wh*-FRs exhibit the following commonalities with single *wh*- FRs:

(i) they both occur in argument or adjunct position within the matrix clause
(ii) they are introduced by the same (non-interrogative, non-existential) matrix predicates
(iii) they allow the use of almost all *wh*-phrases used in interrogatives, the only exception, for both single and multiple *wh*-FRs, being the complex *wh*-phrase *care+NP* 'which NP'
(iv) they do not impose any restrictions concerning mood
(v) they have the same meaning (see section 4)

We conclude that there is convincing syntactic and semantic evidence to distinguish the construction that we are investigating—multiple *wh*- FRs—from other kinds of multiple *wh*- clauses attested cross-linguistically, be they correlatives, interrogatives or MECs. We have seen that multiple *wh*- FRs behave, in all relevant respects, like single *wh*- FRs: they have the same distribution and, as we will discuss in detail in the following sections, they have the same meaning. The question then becomes: what is the interpretation of multiple *wh*- FRs, and how is it derived by a compositional procedure resembling the one of single *wh*- FRs?

3 Semantic properties of multiple *wh*- FRs

Multiple *wh*- FRs exhibit two main semantic properties. First, their overall meaning is the same as the meaning of single *wh*- FRs: they refer to a singular or plural individual, like definite descriptions. Second, the meaning of the leftmost *wh*-phrase in a multiple *wh*-FR affects the meaning of all the other *wh*-phrases. We discuss each property in turn in section 3.1 and section 3.2. Then, in section 4, we develop a compositional semantic analysis that accounts for both properties.

3.1 Multiple *wh*- FRs are referential

The evidence that multiple *wh*- FRs are referential comes not only from the fact that speakers agree with paraphrasing them by means of referential expressions like definite descriptions (see the paraphrases of multiple *wh*- FRs above), but also from the fact they exhibit the typical maximality properties of plural definite descriptions. For instance, in the situation in (16), the sentence with a (bracketed) multiple *wh*- FR in (16a) cannot be uttered felicitously. Here, Lia has smiled at only one woman, while Adrian smiled at the same woman plus four other people. Lia has to have smiled at all the five people Adrian did at the same time as Adrian did for (16a) to be judged felicitous. The same infelicity judgment holds for (16b), in which the multiple *wh*- FR in (16a) has been replaced with a (bracketed) single *wh*- FR, and for (16c), in which the multiple *wh*- FR has been replaced with a (bracketed) definite description, both of which are (rough) paraphrases of the multiple *wh*- FR in (16a). On the other hand, (16d) with an indefinite replacing the definite is judged acceptable and true in the given situation.

(16) SITUATION: *Lia smiled at one woman at the same time Adrian smiled at her. Adrian smiled at four more people, while Lia didn't smile at anybody* else.

a. # Lia a zâmbit [**când cui** i-a zâmbit Adrian].
Lia has smiled when who.DAT CL.3SG-has smiled Adrian
'Lia smiled at the people Adrian smiled at when he smiled at them.'

b. # Lia a zâmbit [**cui** i-a zâmbit Adrian] (în momentul
Lia has smiled who.DAT CL.3SG-has smiled Adrian in moment
când i-a zâmbit Adrian).
when CL.3SG-has smiled Adrian
'Lia smiled at the people Adrian smiled at (at the same time as he smiled at them).'

c. # Lia a zâmbit [persoanelor cărora le-a zâmbit
Lia has smiled people-the.DAT which.DAT.PL CL.3PL-has smiled
Adrian] în momentul când le-a zâmbit Adrian.
Adrian in moment-the when CL.3PL-has smiled Adrian
'Lia smiled at the people Adrian smiled at the same time as he smiled at them.'

d. Lia a zâmbit [unei persoane căreia i-a zâmbit
Lia has smiled a.DAT person which.DAT.SG CL.3SG-has smiled
Adrian] în momentul când i-a zâmbit Adrian.
Adrian in moment-the when CL.3SG-has smiled Adrian
'Lia smiled at a person Adrian smiled at at the same time as he smiled at her.'

The above test allows us to conclude that multiple *wh*- FRs, like single *wh*- FRs, do not behave like indefinites, i.e., existentially quantified expressions. The examples

in (17-20) below show that multiple *wh*- FRs do not behave like universally quantified expressions either. Definite descriptions can occur as the complement of *mare parte* 'a big part/most of' in a partitive construction (19). Single and multiple *wh*- FRs can occur in the very same position as well (17-18) while universally quantified expressions cannot (20).

(17) Am fabricat **mare parte din** [ce cui dăm de Crăciun].
have.1 made big part of what who.DAT give.1PL for Christmas
'We made most of the things to give to the people they were made for at Christmas.'

(18) Am fabricat **mare parte din** [ce dăm de Crăciun].
have.1PL made big part of what give.1PL for Christmas
'We made most of the things we give for Christmas.'

(19) Am fabricat **mare parte din** [lucrurile pe care le dăm
have.1PL made big part of things-the ACC which CL.3PL give.1PL
oamenilor de Crăciun].
people-the.DAT for Christmas
'We made most of the things to give to the people they were made for at Christmas.'

(20) ?? Am fabricat **mare parte din** [tot ce dăm
have.1PL made big part of everything what give.1PL
oamenilor de Crăciun].
people-the.DAT for Christmas
('We made most of everything to give to the people they were made for at Christmas.')

In conclusion, multiple *wh*- FRs share the same semantic properties as single *wh*- FRs: they do not behave like quantified expressions, but rather exhibit the same referential properties as definite descriptions.

3.2 The functional interpretation of *wh*-phrases in multiple *wh*- FRs

The other key semantic feature of multiple *wh*- FRs is the way their *wh*-phrases are interpreted. In particular, in all the multiple *wh*- FRs illustrated above, the first *wh*-phrase—the *wh*-phrase preceding and c-commanding all the others—behaves differently from the other *wh*-phrase(s), and its interpretation affects the interpretation of the other *wh*-phrase(s). To see this, let us return to example (8), repeated in (21):

(21) Azi am pregătit [**ce** **când** vei lua în următoarele zile].
today have.1SG prepared what when will.2SG take in next-the days
'Today I prepared what you'll take at the right time to take it in the next days.'

This sentence would be used in a context like the following: imagine you are getting worried about having a lot of medication to take, at different times of the day, and having it all mixed up. To put your mind at ease, I prepared your morning and evening medication for the next few days, dividing it into separate boxes so that you don't get confused. In this context, it is clear that for each medicine I prepared, there is an appropriate/unique time for it to be taken. Crucially, (21) cannot mean that today I prepared what you'll take at some random/non-unique time in the next days, with the *wh*-phrase *când* 'when' acting as an existentially quantified expression. Nor can it mean that today I prepared what you'll take at that specific time in the next days, with *când* acting as a free pronoun over instants whose reference is contextually determined. In other words, the time at which each medication has to be taken is functionally dependent on the specific medication: each medication is associated to a unique specific time.

This behavior is observed across all multiple *wh*- FRs we have discussed: the value that they assign to each of their *wh*-phrases always functionally depends on the value they assign to their left-most *wh*-phrase, i.e., the *wh*-phrase c-commanding all the others (with the trivial exception of the leftmost *wh*-word itself, of course). This kind of functional dependency is from an individual to another one, i.e. a Skolem function, as we discuss further in section 4.

4 Semantic analysis of multiple *wh*- FRs

In this section we develop a compositional semantic analysis for multiple *wh*- FRs that accounts for the two semantic properties discussed in section 3. We build on well-established semantic analyses of single *wh*- FRs by showing their limits for multiple *wh*- FRs and how they can be developed in order to account for multiple *wh*- FRs as well. The crucial novelty will be a flexible meaning of *wh*-words in FRs as licensing simple variables over individuals and complex functional variables.

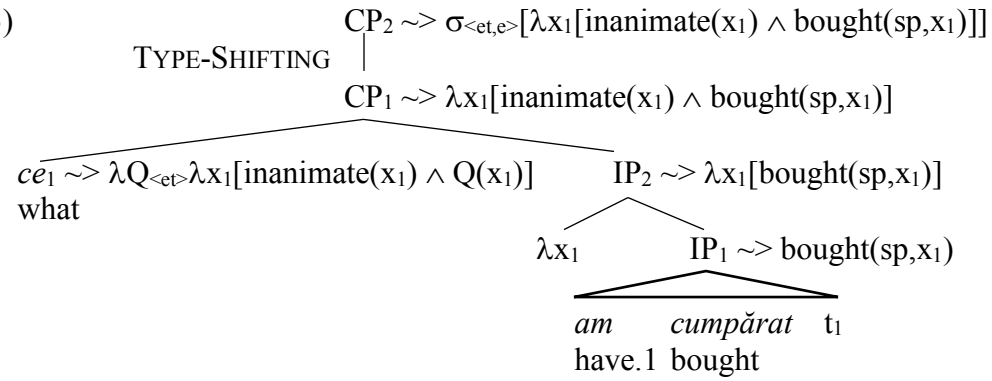
4.1 Semantics of single *wh*- FRs

The main idea behind standard analyses of single *wh*- FRs—details aside—is that the *wh*-phrase licenses a trace/variable over individuals over which lambda-abstraction applies, producing a set of individuals. A maximality operator or a type-shifting operation applies to this set returning the unique maximal member of the set—the same denotation as a definite description (Jacobson 1995; Dayal 1996; Caponigro 2003, 2004).

The sentence in (22) provides an example of a single *wh*- FR in brackets, while (23) gives the crucial steps of its semantic derivation according to the proposals mentioned above.

(22) Am împachetat [**ce** am cumpărat].
have.1 wrapped what have.1 bought
'I wrapped what I bought today.'

(23)



The *wh*-phrase leaves a trace t_1 in its base-generated position, which translates into a variable over individuals (x_1). IP_2 ends up denoting a set of individuals by lambda-abstraction over this variable: the set of all the singular and plural individuals that the speaker (sp) bought up to its unique maximal individual (i.e., the individual resulting from the sum of all the atomic individuals in the set). At this point, the *wh*-phrase is combined with the IP and semantically acts as a set restrictor: it applies to the set the IP denotes and returns the subset of all the non-human singular or plural individuals that the speaker (sp) bought as the denotation of CP_1. Finally, a default type-shifting operation applies, where the set CP_1 denotes is turned into its maximal individual via the maximality operator σ, which has been argued to be the semantic contribution of the definite determiner *the* in English and similar languages (Link 1983). Notice that such an operation is information-preserving: a set containing atomic individuals and all the plural individuals that can be formed out of the atomic ones up to the maximal one and its maximal one are in a one-to-one correspondence and it is always possible to go from one to the other.

Summarizing, this analysis of single *wh*- FRs accounts for their behavior as definite descriptions by assuming a silent version of the definite operator that applies by default, which crucially relies on a set of individuals which is the result of abstracting over a free variable over individuals. This is the same variable that is licensed by *wh*-phrases in *wh*- interrogative clauses. The meaning that is assumed for *wh*-phrases in single *wh*- FRs (24a) is close, but not identical to the meaning that is assigned to *wh*-phrases in common analyses of *wh*- interrogative clauses (24b) (Karttunen 1977):

(24) a. **wh-$_{FR}$** ~> $\lambda Q_{<et>}\lambda x_1[WH(x_1) \wedge Q(x_1)]$
b. **wh-$_{INTERR}$** ~> $\lambda Q_{<et>}\exists x_1[WH(x_1) \wedge Q(x_1)]$

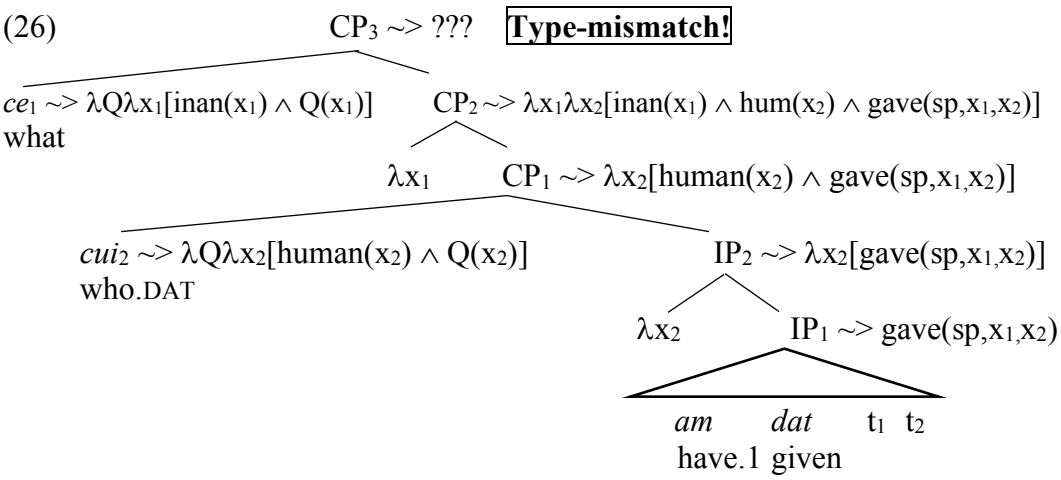
According to (24b), a *wh*-phrase in an interrogative clause (wh-$_{INTERR}$) behaves exactly like an existential generalized quantifier: for instance, *who* means exactly the same thing as *someone*. As we saw, the existential quantification over the variable licensed by the *wh*-phrase in a *wh*- interrogative clause is replaced by lambda-abstraction over the variable translating the *wh*-trace in a FR. The one-place predicate *WH* in (24a-b) stands for whatever semantic restriction the *wh*-phrase carries (human for 'who', location for 'where, etc.).

4.2 Problems with extending the semantics of single *wh*- FRs to multiple *wh*- FRs

The approach in section 4.1 cannot be straightforwardly applied to multiple *wh*- FRs. Let us briefly see why with an example, such as (25), which contains a multiple *wh*- FR in brackets. (26) attempts to provide its semantic derivation assuming that all *wh*-phrases license traces translating into variables over individuals and all *wh*-phrases behave as restrictors of sets of individuals.

(25) Am împachetat [**ce** **cui** am dat].
have.1 wrapped what who.DAT have.1 given
Roughly: 'We wrapped what we gave to the appropriate people.'

(26)



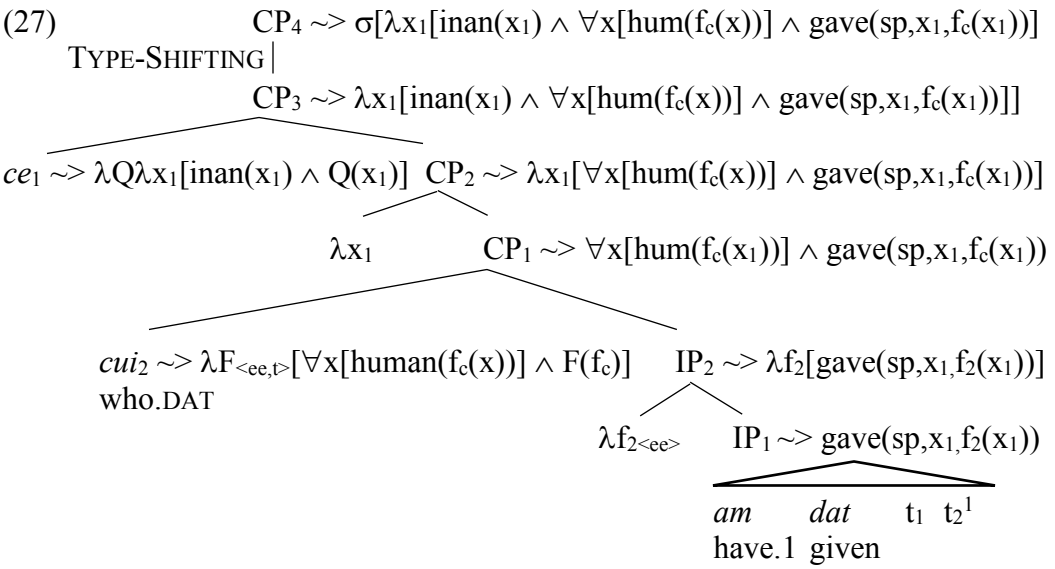
The translation of CP_1 in (26), i.e., the CP containing only the lowest *wh*-phrase and the remainder of the FR, is a set of individuals—the set of individuals to whom the speakers have given a certain object x_1. The problem becomes apparent in the next step. As usual, before a *wh*-phrase can combine with its clause, lambda-abstraction over the variable that is coindexed with the *wh*-word has to apply. Abstracting over x_1 produces the denotation of CP_2: a function from inanimate individuals x_1 to sets of human individuals x_2 such that the speakers gave x_1 to x_2, a semantic object of type <e,et>. On the other hand, its sister *wh*-word is a set restrictor, of type <et,et>.

Function application cannot apply, nor can any other known semantic rule. Therefore, CP_3 ends up without a denotation and the semantic derivation crashes. Even if we assumed an *ad hoc* semantic rule to combine the two meanings, it would not return the correct meaning for CP_3 and the whole FR, since no dependency would be established between the meaning of the lowest *wh*-phrase and the meaning of the highest *wh*-phrase, contrary to our conclusions in section 3.2.

4.3 Proposal: the semantics of multiple *wh*-FRs by means of functional *wh*-words

To overcome the problem we discussed in the previous section, we propose that the first/leftmost *wh*-phrase in a FR (i.e., the *wh*-word that c-commands all the others in a multiple *wh*- FR) licenses a variable over individuals (as it does in a single *wh*- FR), while each of the other *wh*-phrases licenses a complex functional variable. Let us discuss the details of our proposal by going back to (25) above and providing the new semantic derivation in (27).

(27)



There are two crucial differences between the successful semantic derivation in (27) and the one that crashes in (26). First, the lower *wh*-phrase *cui*$_2$ in (27) licenses the complex double-indexed trace t_2^1 in its base-generated position, rather than a simple trace t_2. The complex trace translates into the complex variable $f_2(x_1)$, with f_2 a variable over functions from individuals to individuals (Skolem function, type <e,e>) and x_1 a variable over individuals that is coindexed with the higher *wh*-word *ce*$_1$. Crucially, $f_2(x_1)$ denotes an individual (type <e>), but this is the result of the interplay between a Skolem function and a variable over individuals, rather than the direct assignment of an individual.

The second important difference relies on the actual denotation of the lower *wh*-phrase *cui*$_2$ in (27). It is now a function from a set of Skolem functions to 'true' if the contextually salient Skolem function f_c is a member of that set and outputs a human being as its value.

Let us now look at the main steps of the semantic derivation in (27) starting from the bottom. Lambda-abstraction applies to the variable over Skolem functions f_2 at the level of IP_1. As a result, IP_2 ends up denoting the set of all Skolem functions such that the speakers gave the individual x_1 to the individual that f_2 associates to x_1. The combination of *cui*$_2$ and IP_2 results in CP_1 denoting the proposition that everything that applies to a contextually given Skolem function f_c outputs a human being and that the speakers gave an individual x_1 to the human being that f_c associates to x_1. As usual, lambda-abstraction applies before the expression combines with a *wh*-phrase by abstracting over the variable that is coindexed with the *wh*-phrase. The result is that CP_2 denotes a set of individuals such that the speakers gave those individuals to the human beings that a contextually salient f_c associates to those individuals. This is the set the higher *wh*-phrase *ce*$_1$ applies to and restricts to the subset of inanimate things—the denotation of CP_3. Finally, the familiar type-shifting operation from single *wh*- FRs (see (23) and related discussion) can apply here as well, returning the maximal individual the multiple *wh*- FR refers to—the denotation of CP_4. In this way, the multiple *wh*- FR in (27) ends up denoting the unique maximal individual of the set of objects x_1 that the speakers gave to the people associated with x_1 according to the contextually salient function f_c from objects to humans. This interpretation captures speakers' intuitions and the semantic properties we discussed in section 3.

4.4 Proposal: elaborating on two core assumptions, and further support

The analysis of multiple *wh*- FRs we just presented crucially relies on two core assumptions. First, we are assuming that *wh*-phrases can license two kinds of traces that translate into two kinds of variables, as summarized in (28).

(28) a. **simple wh- trace**: $t_1 \rightsquigarrow x_1$ b. **functional wh-trace**: $t_2^1 \rightsquigarrow f_2(x_1)$

We have already commented on the differences between the two traces in (28) in the previous section. Here we provide further support for the assumption that *wh*-phrases can license functional traces by mentioning other *wh*-clauses whose *wh*-phrases have been argued to license the same kind of functional trace. We refer the interested reader to the relevant literature given below for further details.

Wh-phrases licensing functional traces were initially suggested to account for functional readings of single *wh*- interrogative clauses with universal quantifiers (Engdahl 1980, 1986; Chierchia 1991, 1993; Dayal 1996). For instance, the single *wh*- interrogative clause in (29a) allows for an answer like *His mother* (29b), which

doesn't refer to any individual in particular but rather to the function mapping every Italian male to a specific and unique female.

(29) a. QUESTION: [Which woman]$_2$ does [every Italian man]$_1$ love **t$_2$^{1}** the most?
b. ANSWER: His mother.

This approach was subsequently extended to account for headed relative clauses with a universal quantifier like (30) by assuming that their possibly null *wh*-operator (Op$_2$) licenses a functional trace (Jacobson 1995; Sharvit 1999a from which (30) is adapted):

(30) [The picture of herself]$_2$ [Op$_2$ [every famous actress]$_1$ hated **t$_2$^{1}**] sold fast.

Furthermore, Sharvit (1999b) argues that single *wh*- FRs with quantifiers like (31) also contain a functional trace licensed by the *wh*-phrase introducing the FR:

(31) [What$_2$ [every student]$_1$ **t$_2$^{1}** got] was a nuisance to him.

To this, we can add the fact that multiple *wh*- interrogative clauses have also been argued to license functional traces (e.g., Comorovski 1996; Dayal 1996: 117-118, 2016: 112-115). A multiple *wh*- interrogative clause like the one in (32a), which receives a functional answer like (32b) (both adapted from Comorovski 1996: p. 51, ex. 95), would license a functional trace at LF, as shown in (32c).

(32) a. QUESTION: Which student got back which paper?
b. ANSWER: Every student got back their syntax paper.
c. LF of a.: [[which paper]$_2$ [[which student]$_1$ [t$_1$ got back **t$_2$^{1}**]]]?

Finally, multiple *wh*- correlative clauses are another *wh*-construction for which functional traces have been invoked (Dayal 1996: 200-202). Adapting Dayal's analysis to Romanian (see also Brașoveanu 2012: 41), the higher *wh*-phrase in the multiple *wh*- correlative clause in (33) licenses an individual trace, while the lower *wh*-phrase licenses a functional trace.

(33) [Cine$_1$ [ce mâncare]$_2$ t$_1$ și-a adus **t$_2$^{1}**], pe aceea o
who what food REFL.DAT-has brought ACC DEM it.ACC
va mânca.
will.3SG eat
'Everyone will eat whatever food they brought with them.'

In conclusion, our core assumption that *wh*-phrases can license functional traces is independently supported by proposals made for several different constructions.

The second assumption at the center of our proposal is that *wh*-phrases can denote two kinds of set restrictors, as summarized in (34).

(34) a. $\mathbf{WH_{FR\text{-}simple}}$ ~> $\lambda Q_{<et>}\lambda x_1[WH(x_1) \wedge Q(x_1)]$
b. $\mathbf{WH_{FR\text{-}functional}}$ ~> $\lambda F_{<ee,t>}[\forall x[WH(f_c(x))] \wedge F(f_c)]$

The denotation in (34a) is the one that is assumed for *wh*-phrases in single *wh*- FRs like those we discussed in section 4.1: a *wh*-phrase acts as a set restrictor by applying to a set of individuals and returning a subset of it. The denotation in (34b), instead, is the true novelty of our proposal. According to it, a *wh*-phrase denotes a function that applies to a set of Skolem functions and returns 'true' if the contextually salient Skolem function f_c is a member of that set and f_c outputs individuals that satisfy the restriction/property the *wh*-phrase conveys (human, inanimate, place, time, etc.). If we compare our proposal for the meaning of functional *wh*-phrases in FRs in (34b) with the meaning that has been proposed for functional *wh*-phrases in interrogative clauses in (35) (Engdahl 1986; Chierchia 1991; Dayal 1996), the only difference is the one in bold in (35): the variable f_2 over Skolem functions is existentially bound in (35), while f_c is assigned a contextually salient function as its value in (34b).

(35) $\mathbf{WH_{INTERR\text{-}functional}}$ ~> $\lambda F_{<ee,t>}\mathbf{\exists f_{2<e,e>}}[\forall x[WH(f_2(x))] \wedge F(f_2)]$

A welcome prediction of our proposal is the one schematized in (36): wh_2, the *wh*-phrase that is c-commanded by the other (wh_1) has to receive a functional interpretation. Any other meaning combination of *wh*-phrases would make the semantic derivation crash (for essentially the same reasons we discussed in section 4.2). This matches speakers' intuitions, according to which the interpretation of the highest *wh*-phrase affects the interpretation of the other *wh*-phrase.

(36) [$_{FR}$ **wh-1**$_{FUNCTIONAL/INDIVIDUAL}$ ... **wh-2**$_{FUNCTIONAL/*INDIVIDUAL}$]

5 Conclusions and future research

We have shown that multiple *wh*- FRs exist and are productive, at least in Transylvanian Romanian, and have added them to the other kinds of multiple *wh*-clauses that are attested in the language (interrogative clauses, correlative clauses, and MECs). Multiple *wh*- FRs are FRs and their basic semantics is the same as the one of single *wh*- FRs: they are both referential and maximal. Our semantic analysis builds on two main components: (i) the assumption that *wh*-phrases can license functional traces, which has been independently argued for several other constructions, and (ii) a new functional meaning for *wh*-phrases, which is essentially a variant of the functional meaning of *wh*-phrases that has been independently proposed to account for functional *wh*- interrogative clauses.

In future work, we are planning to explore some outstanding issues that we briefly mention below. First, the constraint in (36) leaves wh_1 and its trace free between an individual and functional interpretation even if, in the examples we

have discussed, wh_1 always receives an individual interpretation. This choice is essentially due to functional single *wh*- FRs such as the one in (31) and multiple *wh*- FRs with a universal quantifier like (37).

(37) Infirmiera a pregătit [**ce** **când** să ia **fiecare** pacient].
nurse-the has prepared what when SUBJ take.3SG every patient
'The nurse prepared what every patient had to take at the appropriate time.'

In both cases, the universal quantifier affects the interpretation of all the *wh*-phrases, including wh_1. The investigation of multiple *wh*- FRs such as the one (37) is one of our next research goals.

Multiple *wh*- FRs can have more than two *wh*-phrases, as we showed in (9). Speakers have the intuition that for each thing, there is a unique mapping to a specific place and a specific time. We believe our analysis can be generalized to these cases as well, but we would like to show it in more detail in future work.

We would also like to investigate what *prima facie* may look like multiple *wh*- FRs, but, at the same time exhibit puzzling syntactic and semantic properties like (38) (from Rudin 2008: ex. 6b).

(38) Trăncăneşte [**cine** **ce** vrea].
blabs who what wants
'Everyone's blabbing whatever they want.'

The bracketed clause in (38) is a multiple *wh*- clause. It is unlikely to be an interrogative clause or MEC. It does not have the typical distribution (it is not left dislocated) or morpho-syntax of correlatives (its matrix clause bans demonstratives linked to the *wh*-phrases in the embedded clause). On the other hand, it does not behave like the multiple *wh*- FRs we have discussed so far either: its *wh*- clause seems to syntactically and semantically satisfy both arguments of the matrix predicate (the subject and the complement). Also, the *wh*- clause triggers a universal reading, which is different from the definite reading in multiple *wh*- FRs.[5]

Finally, we would like to address the issue of cross-linguistic variation among multiple *wh*- FRs. Rudin (2007, 2008) briefly mentions Bulgarian and Macedonian (in addition to Romanian), but we are not aware of any detailed investigation of multiple *wh*- FRs in either language. We have also found speakers of Franconian German (from Baden-Württemberg) and speakers of varieties American English (from Maryland and Georgia) who accept multiple *wh*- FRs like those in (39-40).

(39) Ich gebe dir, [was du wo hin legen musst].
I give you what you where down lay must
'I'll give you what to put at its appropriate place.'

[5] Braşoveanu (2012: ex. 38 and ex. 40) shows examples of multiple *wh*- correlative clauses exhibiting a similar semantic contrast between definite and universal readings.

(40) I'll prepare [what to give to who(m)].
'I'll prepare what we should give to the appropriate people.'

On the other hand, it is incontrovertible that multiple *wh-* FRs are less common across languages than single *wh-* FRs or other kinds of multiple *wh-* clauses. Even within our limited investigation, languages that have both single *wh-* FRs and multiple *wh-* interrogative clauses do not necessarily have multiple *wh-* FRs. Most varieties of American and Canadian English we are aware of do not allow for multiple *wh-* FRs, nor do most varieties of German we have checked. Also, we have not found any variety of Spanish or French that allows for multiple *wh-* FRs. We hope that further investigation will help us understand what aspects of multiple *wh-* FRs may be responsible for their rarity.

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