Exceptional-scope effects in Mandarin relative clauses

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1 Introduction

Mandarin is well-known for its scope rigidity in simple transitive clauses (Huang 1982; Lee 1986; Aoun and A. Li 1993; a.o.). Unlike English, Mandarin does not show scope interaction between subject and object quantificational phrases (QPs) in simple transitive clauses, as shown by the contrast in (1).

(1) a. Three students have read every book.
= 'There is a group of three students who read all books.' (Surface: $3 > \forall$)
= 'For every book x, there is a (possibly different) group of three students who read x.' (Inverse: $\forall > 3$)

b. san-ge xuesheng du-le mei-ben shu
three-CL student read-ASP every-CL book
'Three students have read every book.'
= 'There is a group of three students who read all books.' (Surface: $3 > \forall$)
≠'For every book x, there is a (possibly different) group of three students who read x.' (Inverse: $*\forall > 3$)

However, scope interaction in relative clauses (RCs) seems to be more flexible. As shown in (2), both an RC-embedded QP and an RC-external QP are able to take wide scope over the other (Huang 1982; Aoun and A. Li 1993, 2003).

(2) a. *Subject RC*:

wo jian-guo [$_{RC}$ ___ jiang **mei-zhong yuyan** de] **san-ge xuesheng**
1SG see-ASP speak every-CL language DE three-CL student

'I saw three students that speak every language.'
= 'I saw a group of three students who speak all languages.'[1] ($3 > \forall$)
= 'For each language x, I saw a (possibly different) group of three students who speak x.' ($\forall > 3$)

[1] A reading where 'three' takes wide scope is sometimes ambiguous itself: (i) There is a group of three students who collectively speak all languages, but each of them may not speak all languages; (ii) there is a group of three students and each of them speaks all languages. Crucially, (2a) is not ambiguous in this way; when 'three' takes wide scope, only the reading in (ii) is available for (2a). However, if an aspectual marker is present in the relative clause, the wide scope reading of 'three' becomes ambiguous in the way described above, as shown in the contrast below.

(iii) a. wo jian-guo [$_{RC}$ ___ yanjiu-le **mei-zhong yuyan** de] **san-ge xuesheng**
1SG see-ASP research-ASP every-CL language DE three-CL student
'I saw three students who have studied every language.'
(i) 'I saw a group of three students who collectively studied all languages.' ($3 > \forall$)
(ii) 'I saw a group of three students, each of whom has studied all languages.' ($3 > \forall$)

b. wo jian-guo [$_{RC}$ ___ yanjiu **mei-zhong yuyan** de] **san-ge xuesheng**
1SG see-ASP research every-CL language DE three-CL student
'I saw three students that study every language.'
(i) #'I saw a group of three students who collectively study all languages.' ($3 > \forall$)
(ii) 'I saw a group of three students, each of whom studies all languages.' ($3 > \forall$)

I will not discuss the ambiguity in this paper, since it is not the main focus here, and assume the reading where 'three' takes wide scope to be unambiguous henceforth.

b. *Object RC*:

wo du-guo [$_{RC}$ **mei-ge** **xuesheng** xihuan ___ de] **san-ben shu**
1SG read-ASP every-CL student like DE three-CL book

'I read three books that every student likes.'
= 'I read a group of three books liked by all students.' (3 > ∀)
= 'For each student x, I read a (possibly different) group of three books x likes.' (∀ > 3)

The scope ambiguity in Mandarin relative clauses, especially in subject RCs, is exceptional in two respects. First, in a subject RC, reconstruction of the RC head including the quantifier back into the relative clause is not sufficient to derive the scope ambiguity, given the scope rigidity between subject and object QPs in Mandarin simple transitive clauses. Furthermore, as a more scope-flexible language, English does not show the scope ambiguity in subject RCs but only in object RCs, as seen in (3). If the scope ambiguity in Mandarin subject RCs were derived by QR of the RC-embedded QP in the object position over the reconstructed RC head, the same ambiguity would be expected in the English counterpart (3a) as well, contrary to fact.

(3) a. *Subject RC*
I saw **three students** [$_{RC}$ who speak **every language**].
= 'I saw a group of three students who speak all languages.' (3 > ∀)
≠ 'For each language x, I saw a (possibly different) group of three students who speak x.' (*∀ > 3)

b. *Object RC*
I read **three books** [$_{RC}$ that **every student** likes].
= 'I read a group of three books liked by every student.' (3 > ∀)
= 'For each student x, I read a (possibly different) group of three books x likes.' (∀ > 3)

Hence, the relatively flexible scope relations in Mandarin relative clauses are puzzling and cannot be fully captured by reconstruction of the RC head and RC-internal QR. In this paper, I argue for a long QR approach to account for the exceptional-scope effects in Mandarin relative clauses. Specifically, I will show that the scope ambiguity seen in (2) is derived by long QR of a RC-embedded QP out of a relative clause to the edge of the containing DP, from where it can take scope over RC-external elements. Under a phase-based account of the clause-boundedness of QR (Cecchetto 2004), long QR out of Mandarin RCs does not violate any of the locality constraints, due to Mandarin RCs being prenominal.

I will also account for cases where long QR is impossible. Long QR fails to apply when the particle *dou* is present in a relative clause as a quantifier-distributor, or when the relative clause stands between the head noun and the numeral, i.e. in a [D RC N] order. In those cases, a relative clause embedded in a specificational-copula sentence may admit a reading similar to the exceptional-scope effect, but I will argue that it is not derived by scope interaction, but rather by analyzing the relative clause as containing a functional trace (Jacobson 1994; Sharvit 1999).

Section 2 presents more data unexpected under reconstruction of the RC head and thus need to be accounted for. Section 3 shows how long QR is able to capture most of the data. Section 4 discusses cases where *dou* blocks long QR. Section 5 shows how a functional RC analysis fills in the holes left by the long QR approach. Section 6 discusses alternative approaches, remaining issues and implications. Section 7 concludes the paper.

2 More exceptional-scope effects

This section presents three sets of new data related to scope relations within and across Mandarin relative clauses. First, a QP embedded in a relative clause can bind a matrix pronoun c-commanded by the DP containing the RC (**section 2.1**). Second, when the particle *dou* is present in the relative clause, the RC-embedded QP wide scope reading is absent in most cases, but not in cases where the relative clause is embedded in a specificational copula sentence (**section 2.2**). Last, subject RCs are more restricted in admitting the exceptional-scope effects than object RCs (**section 2.3**).

2.1 Binding out of DPs

Exceptional-scope effects are observed beyond relative clause boundaries. An RC-embedded QP is able to not only take scope over the RC-external QP, but also to bind a matrix pronoun c-commanded by the DP containing the relative clause. As shown in (4), the embedded QP *every man* in both subject and object RCs is able to bind the third person pronoun *ta* in the matrix clause c-commanded by the RC-containing DP. When binding the matrix pronoun, the RC-embedded QP obligatorily takes wide scope over the RC-external QP. Both sentences in (4) can only be understood as there being more than three women in total.

(4) *QPs inside RCs bind matrix pronouns*

a. *Subject RC*:

[$_{DP}$[$_{RC}$ ___ yaoqing [**mei-ge nanren**]$_1$ de] **san-ge nüren**] dou yongbao-le **ta**$_1$.
invite every-CL man DE three-CL woman DOU hug-ASP 3SG

'For every man x, a (possibly different) group of three women that have invited x hugged x.' ($\forall > 3$)

b. *Object RC*:

[$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ yaoqing ___ de] **san-ge nüren**] dou yongbao-le **ta**$_1$.
every-CL man invite DE three-CL woman DOU hug-ASP 3SG

'For every man x, a (possibly different) group of three women that x invited hugged x.' ($\forall > 3$)

RC-head reconstruction alone cannot account for the binding of matrix pronouns. If only the RC head reconstructs and the RC-embedded QP is interpreted in-situ, the embedded QP does not c-command the pronoun it binds at LF.

The possibility of the embedded QP binding out of the containing DP resembles inverse linking, as shown in (5) (May 1977; May 1985; a.o.). Under one of the analyses of inverse linking, the embedded QP undergoes QR and binds the matrix pronoun from the edge of DP (May 1985; Heim and Kratzer 1998; May and Bale 2006; a.o.).

(5) [$_{DP}$ A man from [every city]$_1$] hates it$_1$.

Different from inverse linking, however, scoping and binding out of relative clauses as seen in the Mandarin data crosses finite-clause boundaries, which is unexpected on standard story.

2.2 Blocking effects of *dou*

The exceptional-scope effects, i.e. a RC-embedded QP scoping and binding a pronoun out of the relative clause, are not available in a relative clause containing the quantifier-distributor *dou*. The Mandarin particle *dou* has multiple uses. When serving as a quantifier-distributor, it is associated with a non-atomic nominal expression, such as a QP with a universal distributive quantifier in (6), and has a meaning similar to the post-nominal *all* in English (Lin 1998; Giannakidou and Cheng 2006; M. Xiang 2008; Y. Xiang 2020; a.o.). The analysis of *dou* will be discussed in section 4.

It has been observed in previous literature that the presence of *dou* inside a relative clause blocks a RC-embedded QP from taking wide scope over a RC-external QP (Aoun and A. Li 1993, 2003). In comparison with RCs without *dou* in (2), repeated below as (7), RCs with *dou* shown in (6) are unambiguous in scope: the RC-embedded QPs, *every language* in (6a) and *every student* in (6b), are only able to take narrow scope; thus, the only available readings for (6a) and (6b) are that I saw three students in total, and I have read only three books in total, respectively.

(6) *Dou* present inside RCs[2]

a. *Subject RC*:

wo jian-guo [$_{RC}$ ___ **mei-zhong yuyan** dou jiang de] **san-ge xuesheng**
1SG see-ASP every-CL language DOU speak DE three-CL student

'I saw three students who speak every language.'
= 'I saw a group of three students who speak all languages.' (3 > ∀)
≠ 'For each language x, I saw a (possibly different) group of three students who speak x.' (*∀ > 3)

b. *Object RC*:

wo du-guo [$_{RC}$ **mei-ge xuesheng** dou xihuan ___ de] **san-ben shu**
1SG read-ASP every-CL student DOU like DE three-CL book

'I have read three books that every student likes.'
= 'I read a group of three books liked by all students' (3 > ∀)
≠ 'For each student x, I read a (possibly different) group of three books x likes.' (*∀ > 3)

(7) *Dou* not present inside RCs

a. *Subject RC*:

wo jian-guo [$_{RC}$ ___ jiang **mei-zhong yuyan** de] **san-ge xuesheng**
1SG see-ASP speak every-CL language DE three-CL student

'I saw three students who speak every language.'
= 'I saw a group of three students who speak all languages.' (3 > ∀)
= 'For each language x, I saw a (possibly different) group of three students who speak x.' (∀ > 3)

b. *Object RC*:

wo du-guo [$_{RC}$ **mei-ge xuesheng** xihuan ___ de] **san-ben shu**
1SG read-ASP every-CL student like DE three-CL book

[2]The object *mei-zhong yuyan* 'every language' in the subject RC has moved from a post-verbal position to a pre-verbal, pre-*dou* position as independently required by the presence of *dou*.

'I have read three books that every student likes.'
= 'I read a group of three books liked by all students' (3 > ∀)
= 'For each student x, I read a (possibly different) group of three books x likes.' (∀ > 3)

The RC-embedded QP in a relative clause containing *dou* also fails to bind a matrix pronoun c-commanded by the RC-containing DP, as shown in the contrast between (8) and (9) (adapted from (4)).[3] The matrix pronoun in (8) cannot covary with the RC-embedded QPs *every language* or *every man*; instead, the sentences are felicitous only when the matrix pronoun refers to an independent entity.

(8) *Dou* present inside RCs

a. *Subject RC*:

[DP[RC ___ [**mei-zhong yuyan**]$_1$ dou jiang de] **san-ge xuesheng**] (dou) reai
every-CL language DOU speak DE three-CL student DOU love
ta$_{2/*1}$.
3SG

'Three students who speak every language$_1$ love it$_{2/*1}$.'
#'For every language x, a (possibly different) group of three students who speak x love x.' (*∀ > 3)

b. *Object RC*:

[DP[RC [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **san-ge nüren**] (dou) yongbao-le
every-CL man DOU invite DE three-CL woman DOU hug-ASP
ta$_{2/*1}$.
3SG

'Three women that every man$_1$ invited hugged him$_{2/*1}$.'
'For every man x, a (possibly different) group of three women that x invited hugged x.' (*∀ > 3)

(9) *Dou* not present inside RCs

a. *Subject RC*:

[DP[RC ___ jiang [**mei-zhong yuyan**]$_1$ de] **san-ge xuesheng**] (dou) reai **ta**$_1$.
speak every-CL language DE three-CL student DOU like 3SG

'For every language x, a (possibly different) group of three students who speak x like x.' (∀ > 3)

b. *Object RC*:

[DP[RC [**mei-ge nanren**]$_1$ yaoqing ___ de] **san-ge nüren**] (dou) yongbao-le **ta**$_1$.
every-CL man invite DE three-CL woman DOU hug-ASP 3SG

'For every man x, a (possibly different) group of three women that x invited hugged x.' (∀ > 3)

[3]Note that the *dou* in the matrix clauses in (8) and (9) is optional and its presence does not affect the availability of the exceptional-scope effects.

At first sight, the contrasts with respect to the presence of *dou* inside RCs could be attributed to *dou* blocking reconstruction of the RC head, but as will be discussed in section 4.2, both empirical and theoretical evidence suggests that *dou* does not block reconstruction; in fact, *dou* should favor reconstruction instead. Hence, the absence of exceptional-scope effects in RCs containing *dou* is surprising if the scope ambiguity in RCs were derived from reconstruction of the RC head.

Dou's blocking effect is further complicated when the type of the matrix clause is taken into consideration. When a relative clause containing *dou* is embedded in a specificational-copula sentence, instead of a non-specificational sentence as seen above, it allows the RC-embedded QP to bind out of DPs again, and admits a multiple-individual reading, despite the singularity of the RC head.[4]

For example, (10a) has a reading that every man invited one or more women and for every man x, among the women that x invited, there must be a woman who is x's mom. The same relative clause embedded in a non-specificational sentence, as shown in (10b), does not allow binding out of the DP or the multiple-individual reading. The only possible interpretation for (10b) is that there is a woman that every man invited and she hugged someone else. The unavailability of the multiple-individual reading is further supported by the incompatibility of having another *dou* in the matrix clause, which requires its associate to be a non-atomic nominal expression. Similarly in (10c), where the predicate is intransitive, the multiple-individual reading is unavailable, as shown by the unacceptability of having *dou* in the matrix clause.

(10) *Object RC*

a. *In a specificational sentence*

[DP[RC [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge nüren**] shi **ta**$_1$ mama
every-CL man DOU invite DE one-CL woman be 3SG mom

'A woman that [every man]$_1$ invited is his$_1$ mom.' (✓multiple-individual reading)

b. *In a non-specificational sentence with transitive predicate*

[DP[RC [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge nüren**] (*dou) yongbao-le
every-CL man DOU invite DE one-CL woman DOU hug-ASP

ta$_{*1}$
3SG

'A woman that [every man]$_1$ invited hugged him$_{*1}$.' (#multiple-individual reading)

c. *In a non-specificational sentence with intransitive predicate*

[DP[RC [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge nüren**] (*dou) dao-le
every-CL man DOU invite DE one-CL woman DOU arrive-ASP

'A woman that [every man]$_1$ invited arrived.' (#multiple-individual reading)

However, the asymmetry with respect to the matrix clause type is only observed in object RCs, but not in subject RCs. Compared with object RCs in (10), subject RCs in (11) do not admit binding out of DPs or the multiple-individual reading regardless of the matrix clause type. The only available interpretation for (11a) is that there is a student who speaks every language and the student is a native speaker of a language salient in the context. Similarly, (11b) can only be

[4]The multiple-individual reading has a similar effect as the RC-embedded QP taking wide scope over the RC-external *one*, but the effect is not derived from scope taking but rather a functional interpretation of the gap, as will be discussed in detail in section 4.4 and section 5. Hence, I call it *multiple-individual reading* here, instead of RC-embedded QP wide scope or $\forall > \exists$ as in previous examples.

interpreted as there being a student who speaks every language and the student likes the culture of a contextually salient entity.

(11) *Subject RCs*

a. *In specificational sentence*

[$_{DP}$[$_{RC}$ ___ [**mei-zhong yuyan**]$_1$ dou jiang de] **yi-ge xuesheng**] shi **ta**$_{*1}$ de
every-CL language DOU speak DE one-CL student be 3SG DE
muyuzhe
native.speaker

'A student who speaks [every language]$_1$ is its$_{*1}$ native speaker.'
(#multiple-individual reading)

b. *In non-specificational sentence*

[$_{DP}$[$_{RC}$ ___ [**mei-zhong yuyan**]$_1$ dou jiang de] **yi-ge xuesheng**] reai **ta**$_{*1}$ de
every-CL language DOU speak DE one-CL student love 3SG DE
wenhua
culture

'A student who speaks [every language]$_1$ loves its$_{*1}$ culture.'
(#multiple-individual reading)

The same subject-object asymmetry is not observed in relative clauses without *dou*. As seen in (2) and (4), both subject and object relative clauses allow the RC-embedded QPs to scope and bind out of RCs, regardless of the matrix clause type.

To summarize, this section presented puzzling effects brought by the presence of *dou* in relative clauses: i) the impossibility of the RC-embedded QP wide scope when the relative clause contains the particle *dou*, ii) the asymmetry with respect to matrix clause type observed in object RCs containing *dou*, and iii) the absence of such an asymmetry in subject RCs containing *dou*.

2.3 Restrictions on subject RCs

Subject and object RCs exhibit several other differences in admitting exceptional-scope effects. First, a subject RC allows the exceptional-scope effects only when the embedded verb is in its bare form. When an aspectual marker or a modal is present in a subject RC, a RC-embedded QP is no longer able to take wide scope over a RC-external QP or bind a matrix pronoun. The contrast is shown in (12) for scope taking and in (13) for binding out of DPs.

Unlike the scopally ambiguous (12a) (repeated from (2a)), (12b) and (12c) are unambiguous in scope, with the only possible reading being that I saw a group of three students who have learned (12b) or will learn (12c) every language.

(12) *Scope taking in subject RCs*

a. *Bare verb*

wo jian-guo [$_{DP}$[$_{RC}$ ___ jiang **mei-zhong yuyan** de] **san-ge xuesheng**]
1SG see-ASP speak every-CL language DE three-CL student

'I saw three students who speak every language.'
= 'I saw a group of three students who speak all languages.' (3 > ∀)
= 'For each language x, I saw a (possibly different) group of three students who speak x.' (∀ > 3)

b. *With aspectual marker*

wo jian-guo [$_{DP}$[$_{RC}$ ___ xue -le/guo **mei-zhong yuyan** de] **san-ge xuesheng**]
1SG see-ASP learn -ASP every-CL language DE one-CL student

'I saw three students who have learned every language.'
= 'I saw a group of three students who have learned all languages.' (3 > ∀)
≠ 'For each language x, I saw a (possibly different) group of three students who have learned x.' (*∀ > 3)

c. *With modal*

wo jian-guo [$_{DP}$[$_{RC}$ ___ yao xue **mei-zhong yuyan** de] **san-ge xuesheng**]
1SG see-ASP will learn every-CL language DE three-CL student

'I saw three student who will learn every language.'
= 'I saw a group of three students who will learn all languages.' (3 > ∀)
≠ 'For each language x, I saw a (possibly different) group of three students who will learn x.' (*∀ > 3)

Similarly in (13), a RC-embedded QP is able to bind a matrix pronoun c-commanded by the containing DP only when the embedded verb is bare, but not when an aspectual marker or a modal is present. The matrix pronoun in (13b) and (13c) can only refer to some other third-person individual salient in the context, instead of covarying with the RC-embedded QP.

(13) *Binding out of subject RCs*

a. *Bare verb*

[$_{DP}$[$_{RC}$ ___ yaoqing [**mei-ge nanren**]$_1$ de] **san-ge nüren**] dou yongbao-le **ta**$_1$.
invite every-CL man DE three-CL woman DOU hug-ASP 3SG

'For every man x, a (possibly different) group of three women who invite x hugged x.' (∀ > 3)

b. *With aspectual marker*

[$_{DP}$[$_{RC}$ ___ yaoqing -le [**mei-ge nanren**]$_1$ de] **san-ge nüren**] dou yongbao-le
invite -ASP every-CL man DE three-CL woman DOU hug-ASP

ta$_{2/*1}$.
3SG

'Three women that invited [every man]$_1$ hugged him$_{2/*1}$.
#'For every man x, a (possibly different) group of three women who have invited x hugged x.' (*∀ > 3)

c. *With modal*

[$_{DP}$[$_{RC}$ ___ yao yaoqing [**mei-ge nanren**]$_1$ de] **san-ge nüren**] dou yongbao-le
will invite every-CL man DE three-CL woman DOU hug-ASP

ta$_{2/*1}$.
3SG

'Three women that will invite [every man]$_1$ hugged him$_{2/*1}$.
#'For every man x, a (possibly different) group of three women who will invite x hugged x.' (*∀ > 3)

However, the same contrast is not seen in object RCs. No matter whether an aspectual marker or a modal is present in an object RC, a RC-embedded QP is able to take wide scope over a RC-external QP or bind a matrix pronoun, as shown in (14).

(14) *Object RCs*

a. *Bare verb*

[DP[RC [**mei-ge nanren**]$_1$ yaoqing ___ de] **san-ge nüren**] dou yongbao-le **ta**$_1$.
every-CL man invite DE three-CL woman DOU hug-ASP 3SG

'For every man x, a (possibly different) group of three women that x invites hugged x.' ($\forall > 3$)

b. *With aspectual marker*

[DP[RC [**mei-ge nanren**]$_1$ yaoqing -le ___ de] **san-ge nüren**] dou yongbao-le
every-CL man invite -ASP DE three-CL woman DOU hug-ASP
ta$_1$.
3SG

'For every man x, a (possibly different) group of three women that x has invited hugged x.' ($\forall > 3$)

c. *With modal*

[DP[RC [**mei-ge nanren**]$_1$ yao yaoqing ___ de] **san-ge nüren**] dou yongbao-le
every-CL man will invite DE three-CL woman DOU hug-ASP
ta$_1$.
3SG

'For every man x, a (possibly different) group of three women that x will invite hugged x.' ($\forall > 3$)

Another distinction between subject and object RCs is in the types of quantifiers compatible with exceptional-scope effects. The exceptional-scope effects observed above seem to be less natural when a RC-embedded QP is headed by a quantifier other than the universal distributive *mei* 'every', as shown in (15) with *most* and *at least two* as examples. However, even though the wide scope of a RC-embedded QP headed by a non-*mei* quantifier is less natural in an object RC, compared to the narrow scope reading of the RC-embedded QP, as indicated by "?"in (15b), the intended reading is much harder to obtain in a subject RC, if not entirely impossible, as indicated with "?*"in (15b).

For the subject RC in (15a), the most salient reading is that I saw a group of three students who speak most languages (in the world) or at least two languages, which may not be the same set of languages. Now imagine a world with ten languages in total, and a conference inviting at least three speakers of each language. (15a) is not natural in a context where for each of eight languages among the ten, I have seen three students who speak it but have not seen any speaker of the other two languages, nor in a context where for each of at least two languages, say four languages among the ten, I have seen three students who speak it, but have not seen speakers of the other six languages.

On the other hand, the wide scope reading of a RC-embedded QP in an object RC (15b) is felicitous given specific contexts, even though it is less natural than the narrow scope reading of the RC-embedded QP. For example, imagine I asked each of the 10 students in my class to recommend three books they like to me; (15b) is felicitous in a situation where I have read eight students' recommended books, i.e. 24 books, but have not read the other two students' recommended books,

or I have read at least two students' recommended books, say three students' recommended books and nine books in total, but have not read the rest.

(15) *Scope taking with **most** and **at least two** inside RCs*

a. *Subject RC*

wo jian-guo [$_{DP}$[$_{RC}$ ___ jiang { **daduoshu** / **zhishao liang-zhong** } **yuyan** de]
1SG see-ASP speak most at.least two-CL language DE
san-ge **xuesheng**]
three-CL student

'I saw three students who speak most languages/at least two languages.'
(3 > most/at least 2)
(?*most/at least 2 > 3)

b. *Object RC*

wo du-guo [$_{DP}$[$_{RC}$ { **daduoshu** / **zhishao liang-ge** } **xuesheng** xihuan ___ de]
1SG read-ASP most at.least two-CL student like DE
san-ben shu]
three-CL book

'I have read three books that most/at least two students like.'
(3 > most/at least 2)
(?most/at least 2 > 3)

The distinctions between subject and object RCs presented in this section might be gradient, but the presence of the contrasts between subject and object RCs suggests that subject RCs are more restrictive with respect to the exceptional-scope effects. The presence of aspectual markers and modals, as well as quantifier types, seem to have greater effect on the availability of exceptional scope in subject RCs than in object RCs.

2.4 Summary of data

This section introduced novel data on exceptional-scope effects in Mandarin relative clauses. RC-embedded QPs are able to not only take wide scope over RC-external QPs, but also to bind matrix pronouns c-commanded by the containing DPs. However, the exceptional-scope effects are not free of restrictions. Asymmetries between subject and object RCs have been observed with respect to the presence of *dou*, the matrix clause type, the presence of aspectual markers and modals, as well as quantifier types, as summarized in the table below.

RC types	Baseline: *every*-QP embedded + bareV in RC	Presence of Asp/Modal in RC	Non-*every*-QP embedded in RC	RC containing *dou* in... specificational clause	non-spec. clause
subject RC	✔	✘	?✘	✘	✘
object RC	✔	✔	?	✔	✘

Table 1: The availability of exceptional-scope effects in subject and object RCs

The RC-embedded QP taking wide scope and binding out of RCs in baseline cases (column 2 in the table) will be accounted for in **sections 3.2 and 3.3**, the restrictions on subject RCs (column 3) will be discussed in **section 3.4**, *dou* effects (columns 5 and 6) will be discussed in **sections 4 and 5**. The restrictions on quantifier types will be discussed in **section 6** as an open question for future research.

3 Long QR without violating locality constraints

In this section, I will argue that the exceptional-scope effects in Mandarin RCs, i.e. the RC-embedded QP taking wide scope and binding matrix pronouns, are able to be derived by QRing the RC-embedded QP to the edge of the containing DP, from where the QP takes wide scope over the RC-external QP and binds the matrix pronoun. Section 3.1 introduces a phase-based account for the clause-boundedness of QR (Cecchetto 2004), which reduces the clause-boundedness to the Phase Impenetrability Condition (PIC) and Scope Economy. Section 3.2 shows how long QR out of Mandarin relative clauses does not violate the two locality constraints, due to the pre-nominal and pre-D position of Mandarin RCs. Section 3.3 shows detailed derivation of scope taking and binding out of the containing DP at the DP edge. Section 3.4 discusses the restriction on subject RCs with respect to the presence of aspectual markers and modals.

3.1 The clause-boundness of QR revisited

As covert $\overline{\text{A}}$-movement, quantifier raising (QR) differs from its overt counterparts in that QR seems to be unable to cross finite clause boundaries (Fodor and Sag 1982; Fox 1995; Fox 2000; a.o.), as shown by the unavailability of the embedded QP *every plane* taking wide scope over the matrix subject QP *a technician* in (16a). However, exceptions to the clause-boundedness have also been observed. For example, as shown in the antecedent-contained deletion (ACD) configuration in (16b), to get the reading where the matrix VP, not the embedded VP, serves as the antecedent for the elided VP, the embedded QP including the ACD site, *every committee that Bill did*, has to QR across a finite clause boundary.

(16) a. (Cecchetto 2004)
A technician said that John inspected **every plane**. (*$\forall > \exists$)

b. (Wilder 1997)
John said [$_{\text{CP}}$ that you were on **every committee** that Bill did <say that you were on>]. (✓ Matrix reading of ACD)

To account for this locality constraint, which is not shared by overt $\overline{\text{A}}$-movement, as well as its exceptions, Cecchetto (2004) proposes that QR, like overt movement, obeys the *Phase Impenetrability Condition* (PIC), as defined in (17), and that vP and CP are phases (Chomsky 2000; Chomsky 2001; Chomsky 2008).

(17) *The (Weak) Phase Impenetrability Condition (PIC)*[5]
The complement of a phase α is not accessible to operations at the level of the next highest phase β; only the head and the edge of α are.

According to the weaker version of the PIC, elements in the complement of a phase head become inaccessible only when the next highest phase is reached. In other words, a single step of movement cannot cross two or more phase heads.

In addition, QR also obeys Scope Economy to avoid semantically vacuous covert movement. Following Fox (2000), Cecchetto (2004) adopts the strong version of Scope Economy, as defined in

[5]The PIC adopted here is the weaker version (Chomsky 2001), as opposed to the strong version proposed in Chomsky (2000):

(i) *The Phase Impenetrability Condition (strong version)*
In a phase α with head H, the domain of H is not accessible to operations outside of α, only H and its edge are accessible to such operations.

(18). It requires each step of successive-cyclic QR to be independently motivated, such as resolving a type-mismatch, changing scope relations, or resolving ACD. Simply facilitating a further step of QR is not an independent motivation.

(18) *(Strong) Scope Economy*
In successive-cyclic QR, each step needs a motivation other than allowing further movement of the QP.

Hence, the clause-boundedness of QR can then be reduced to the combination of a more general locality constraint on movement (the PIC) and an economy constraint on covert movement (Scope Economy). The contrast in (16) can then be explained.

In (16a), since QR of the embedded object QP over the matrix subject QP would violate either the PIC or Scope Economy, as illustrated by two hypothetical operations of QR in (19), the unavailability of the inverse scope is expected. After type-driven QR to the edge of the embedded vP, if the embedded object QP were to undergo one step of QR to the matrix [Spec, vP], as shown in (19a), the PIC would be violated, since two phase heads, the underlined v and C, would be crossed by a single step of movement. If the embedded object QP stops at some point between the embedded CP and the matrix vP before reaching the matrix [Spec, vP], as in (19b)[6], the PIC is obeyed at the cost of violating Scope Economy, since the first step from the embedded [Spec, vP] to [Spec, VP] is not independently motivated.

(19) (Adapted from Cecchetto 2004)

a. *Violation of the PIC*
*[$_{TP}$ A technician [$_{vP}$ <**every plane**> [$_{vP}$ <a technician> [$_{v'}$ <u>v</u> [$_{VP}$ said [$_{CP}$ <u>that</u> [$_{TP}$ John [$_{T'}$ T [$_{vP}$ <**every plane**> [$_{vP}$ <u>v</u> [$_{VP}$ inspected **every plane**]]]]]]]]]]

b. *Violation of Scope Economy*
*[$_{TP}$ A technician [$_{vP}$ <**every plane**> [$_{vP}$ <a technician> [$_{v'}$ <u>v</u> [$_{VP}$ <**every plane**> [$_{VP}$ said [$_{CP}$ <u>that</u> [$_{TP}$ John [$_{T'}$ T [$_{vP}$ <**every plane**> [$_{vP}$ <u>v</u> [$_{VP}$ inspected **every plane**]]]]]]]]]]]

By contrast, in (16b), QR of the embedded object QP containing an ACD site can cross a finite clause boundary without violating either the PIC or Scope Economy. As shown in (20), the embedded object QP only needs to adjoin to the matrix VP to resolve ACD, which could be achieved in one step of well-motivated QR without crossing two or more phase heads.

(20) *No violation of the PIC or Scope Economy*
[$_{TP}$ John [$_{vP}$ <John> [$_{v'}$ <u>v</u> [$_{VP}$ <**every committee that Bill did**> [$_{VP}$ said [$_{CP}$ <u>that</u> [$_{TP}$ you [$_{T'}$ T [$_{vP}$ <**every committee that Bill did**> [$_{vP}$ <u>v</u> [$_{VP}$ were on **every committee that Bill did**]]]]]]]]]]]

Adopting Cecchetto's (2004) analysis, I will show in section 3.2 that long QR out of Mandarin prenominal pre-D relative clauses is allowed, because it does not violate either the PIC or Scope Economy.

3.2 Long QR out of prenominal object RCs

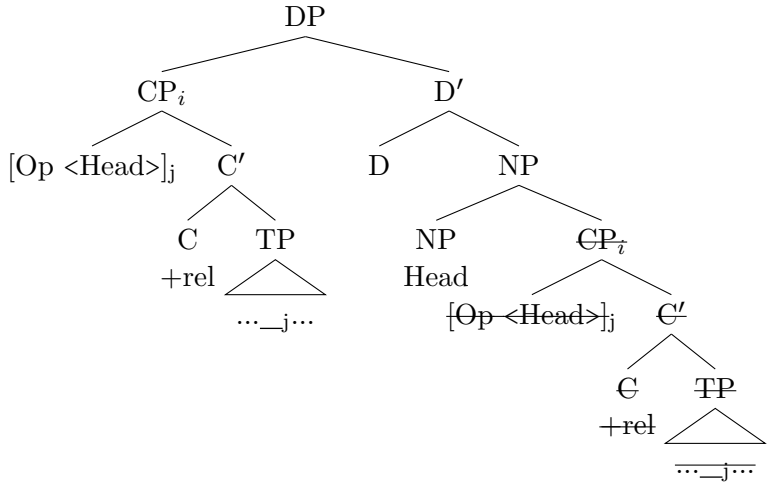
Since Mandarin is an SVO language, prenominal pre-D relative clauses are derived by moving the relative CP from a postnominal position to [Spec, DP] (de Vries 2002)[7]. The structure is shown in

[6] Cecchetto (2004) does not specify the intermediate landing site, only mentioning that QR is widely assumed to not target CP area. Since these steps of QR are bad due to other violations, I posit the intermediate site at [Spec, VP] simply for illustration.

[7] Kayne (1994) proposes that prenominal RCs are all TPs moved from a postnominal position to [Spec, DP], leaving the RC head and relative operator stranded. de Vries (2002) provides extensive arguments against movement of only

(21), where the external head is base-generated externally and associated with the internal head via matching (Sauerland 1998, 2000; a.o.). I assume that the higher copy of the moved CP is interpreted at LF, leaving a trace of type $\langle e,t\rangle$ in its base position[8].

(21)



An object RC in Mandarin (22a), for example, can then be represented by the bracket structure in (22b).

(22) a. *Object RC*

[$_{DP}$[$_{RC}$ **mei-ge** **xuesheng** xihuan ___ de] **san-ben shu**]
every-CL student like DE three-CL book

'Three books that every student likes'

b. [$_{DP}$ [$_{CP}$ [Op <book>]$_j$ [$_{C'}$ C [$_{TP}$ **every student** like ___$_j$]]] [$_{D'}$ [$_D$ **three-cl**] [$_{NP}$ book ___$_{CP}$]]]]

Note that the numeral in the RC-external QP, *three*-CL, is located in the D head, instead of being part of the RC head NP. Mandarin nominal expressions have independently been argued to have the structure in (23) (Tang 1990; A. Li 1998, 1999; Aoun and A. Li 2003; Huang, A. Li, and Y. Li 2009; a.o.). As discussed in Huang et. al. (2009: chapter 8), a DP projection is present in Mandarin nominals and the D head is null in an individual-denoting nominal expression of the form [Num + Cl + N]. Adopting this structure for Mandarin nominal expressions, I collapse all projections above NP into the DP area and depict the numeral-with-classifier in the D head for ease of presentation, but the following analysis will work just as well if a full fledged DP structure is assumed. Section 4 will present independent evidence in favor of treating numerals as heading a projection higher than NP in Mandarin.

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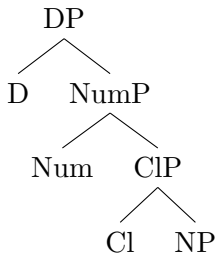
the TP in a relative clause to derive a prenominal word order. Whether prenominal RCs are TPs or CPs does not affect the arguments at hand, and I will assume CP movement for simplicity.

[8]Head raising is available for Mandarin RCs as well, as discussed in Aoun and Li (2003: ch 5). In cases that force head raising, the structure will look roughly the same as (21) except that the external head will be coindexed with the internal head, as it is raised out of the relative CP instead of being base-generated externally (Bhatt 2002), and the lower copy of the moved CP needs to be interpreted to avoid unbound traces. Since cases forcing head raising are not in the scope of the current paper, I will not elaborate on the head raising structure in detail and assume the structure in (21) henceforth, but the analysis is compatible with a head raising structure as well.

(23)



Now let us return to QR. Following Cecchetto (2004), I assume that covert movement such as QR takes place after spell-out (Nissenbaum 2001), and that access to LF, unlike access to PF, is not successive cyclic, but rather a one-step operation that takes place at the end of the derivation. However, despite the non-successive-cyclic access to LF, covert movement, like overt movement, still needs to obey the PIC.[9] Furthermore, Despite being an article-less language, Mandarin has been argued to have DP projections (Huang, A. Li, and Y. Li 2009: chapter 8), and in addition to CPs and vPs, DPs are also phases (Giorgi and Longobardi 1991; Szabolcsi 1994; Gavruseva 2000; Citko 2014; Aravind 2021; a.o.). Hence, (RC-embedded) v, C and D are the phase heads relevant to the locality constraints on QR out of relative clauses in English and Mandarin.

As illustrated in (24), the movement of the relative CP to get the prenominal pre-D linear order allows the relative CP to land in a position higher than the phase head D. The RC-embedded QP is then able to QR out of the relative CP to the edge of the containing DP. This step of QR does not violate the PIC, since only one phase head (the underlined C) is crossed, and it obeys Scope Economy as it changes scope relations by allowing the RC-embedded QP to take wide scope over the RC-external QP.

(24) ✓ *Long QR out of prenominal RCs*
[$_{DP}$ <**every student**> [$_{DP}$ [$_{CP}$ [Op <book>]$_j$ [$_{C'}$ <u>C</u> [$_{TP}$ **every student** like ___$_j$]]] [$_{D'}$ [$_{D}$ <u>three-CL</u>] [$_{NP}$ book ___$_{CP}$]]]]

By contrast, long QR out of relative clauses in a post-D position would violate at least one of the locality constraints on QR. Consider postnominal RCs in English first. As shown in (25a), the embedded QP *every student* undergoing one step of QR to [Spec, DP] would violate the PIC, as it

[9] According to Cecchetto (2004), the main motivation for assuming the non-cyclic access to LF comes from the LF phenomena that are sensitive to long-distance c-command at LF, such as Condition C, as shown in (i). If LF is accessed successive-cyclically, then when the embedded CP is reached, the embedded vP will be sent to LF, which only contains the R-expression but not its binder. In order to obtain a complete LF representation where Condition C is violated, one needs to assume either that the syntactic objects are reassembled at LF or that each phase shipped to LF stores the information that it contains an R-expression. These treatments according to Cecchetto (2004) are either redundant or require ad hoc mechanism for R-expressions. Instead, accessing LF in a one-step manner avoids the postulations.

(i) *He$_1$ [$_{vP}$ thinks [$_{CP}$ that Mary [$_{vP}$ saw John$_1$]]].

Cecchetto (2004) further assumes that even though covert movement takes place after Spell-out and access to LF is non-successive-cyclic, it still obeys the PIC. It is natural to assume that as an instance of the operation (Move), covert movement also obeys the general restrictions as overt movement does. Furthermore, since the PIC was motivated to reduce the computational burden of the derivation, it should be obeyed by covert movement as well if computational burden is a real issue.

Hence, it seems that the PIC for covert movement adopted in Cecchetto (2004) is similar to Subjacency, where only the number of phase heads crossed in one instance of movement matters, and the complement of each phase head will not become invisible at LF when the next phase head is reached. Following Cecchetto (2004), I adopt this version of the PIC for QR, but it is unclear why covert movement still needs to obey the PIC if access to LF is not successive-cyclic, and the reasons given by Cecchetto (2004) still seem stipulative. I will leave the question open for future research.

crosses two phase heads, D and C. Since QR is assumed to not target the CP area, as mentioned in Cecchetto (2004), the specifier position of the embedded CP is unable to serve as an intermediate landing site. Since NPs are widely assumed to lack specifiers (Bošković 2014; Sichel 2018; a.o.), successive-cyclic movement through [Spec, CP] or [Spec, NP] to obey the PIC, as shown in (25b), is not available either.

(25) ✗ *Long QR out postnominal RCs*
[$_{DP}$ the **three books** [$_{RC}$ that **every student** likes]]

a. *Violation of the PIC*
*[$_{DP}$ <**every student**> [$_{DP}$ the [$_{NP}$ [$_{NP}$ three books]$_i$ [$_{CP}$ [Op <three books>$_i$]$_j$ [$_{C'}$ C [$_{TP}$ **every student** likes ___$_j$]]]]]]

b. *Lack of an intermediate landing site*
*[$_{DP}$ <**every student**> [$_{DP}$ the [$_{NP}$ <**every student**> [$_{NP}$ [$_{NP}$ three books]$_i$ [$_{CP}$ [Op <three books>$_i$]$_j$ [$_{C'}$ C [$_{TP}$ **every student** likes ___$_j$]]]]]]]

Instead, the wide-scope reading of *every student* in (25) above is a consequence of reconstructing the RC head *three books*. When reconstruction of *three* is not possible, *every student* is predicted to not be able to take wide scope over *three books*, which is borne out, as shown in (26). As discussed in Bhatt (2002), when a definite determiner is present, numerals and quantificational adjectives, such as *few* and *many*, are adjectival and reconstruct as part of the RC head NP, but they cannot reconstruct when the definite determiner is absent, since they need to be in the D head instead of being adjectives of the NP. As shown in (26a), where *three* occupies the D head and cannot reconstruct with the RC head NP, the embedded QP *every student* is no longer able to take wide scope, compared with the availability of the embedded QP wide scope after reconstruction of *three books* in (26b).

(26) a. I read [$_{DP}$ **three** [$_{Head\ NP}$ **books**] [$_{CP}$ that **every student** likes ___]]. (*∀ > 3)

b. I read [$_{DP}$ the [$_{Head\ NP}$ **three books**] [$_{CP}$ that **every student** likes ___]]. (∀ > 3)

Further support for the long QR analysis comes from the inability to long QR out of post-D RCs in Mandarin. As shown in (27), when the Mandarin relative clause stands between the numeral and the head NP, i.e. in a [D/Num-RC-N] order, the RC-embedded QP *every student* fails to have a wide-scope reading. The absence of the target reading follows directly from the locality constraints on QR and the inability of numerals to reconstruct in Mandarin. The post-D relative clause moves to a position [Spec, XP] between D and N from its postnominal base position (see de Vries 2002 p.135 for discussion on deriving [D-RC-N] order in SVO languages). Crucially, as discussed in Bhatt (2006), only subject RCs, but not object RCs, can be reduced, and thus, object RCs are always CPs. Since the moved CP is still within the DP phase, QR of the embedded QP via one step to [Spec, DP], as shown in (27a), would cross both C and D heads and thus violate the PIC. If the functional projection XP only has one specifier position, then the intermediate landing site in (27b) is not available either; if it allows multiple specifiers, the first step of QR would still be ruled out, since it is not independently motivated, violating Scope Economy.

(27) ✗ *Long QR out prenominal post-D RCs*

wo	du-guo	[$_{DP}$ **san-ben**	[$_{RC}$ **mei-ge**	**xuesheng**	xihuan	_ de]	[$_{Head}$ shu]]
1SG	read-ASP	three-CL	every-CL	student	like	DE	book

'I have read three books that every student likes.' (3 > ∀/*∀ > 3)

a. *Violation of the PIC*
[$_{DP}$ <**every student**> [$_{DP}$ [$_{D'}$ three-CL [$_{XP}$ [$_{CP}$ [Op <book>]$_j$ [$_{C'}$ C [$_{TP}$ **every student** like ___$_j$]]] [$_{X'}$ X [$_{NP}$ book ___$_{CP}$]]]]]

b. *Lack of an intermediate landing site or violation of Scope Economy*
[$_{DP}$ <**every student**> [$_{DP}$ [$_{D'}$ three-CL [$_{XP}$ <**every student**> [$_{XP}$ [$_{CP}$ [Op <book>]$_j$ [$_{C'}$ C [$_{TP}$ **every student** like ___$_j$]]] [$_{X'}$ X [$_{NP}$ book ___$_{CP}$]]]]]]

By comparing the possibility of long QR out of relative clauses in different positions, this subsection has argued that it is the prenominal pre-D position of Mandarin relative clauses that allows the RC-embedded QP to undergo QR to [Spec, DP] without violating the PIC and Scope Economy. Details of how this derivation yields the RC-embedded QP wide-scope reading and allows binding of a matrix pronoun from [Spec, DP] will be shown in the next subsection.

3.3 Deriving the exceptional-scope effects

As in inverse linking and possessive constructions with quantificational possessors, the QP undergoing QR out of a relative clause needs to compose with the rest of the DP at the edge of DP. A type-shifting rule, *Argument Saturation*, proposed in Büring (2004) allows the QP to take wide scope from that position.

(28) *Argument Saturation* (Büring 2004)
For any DP, any type T, and any $[\![\text{Z }]\!]^g \in D_{\langle e,\langle T,t\rangle\rangle}$,
$[\![\text{DP Z}]\!]^g = [\![\text{Z DP}]\!]^g = \lambda\psi \in D_T.[\![\text{DP}]\!]^g(\lambda x.[\![\text{Z}]\!]^g(x)(\psi))$.

The LF for the subject DP in sentence (29a) with a reading where the RC-embedded QP takes wide scope is shown in (29b). The RC-embedded QP *every man* is interpreted at the edge of DP and composes with the rest of the DP via Argument Saturation. The higher copy of the relative CP (③) is interpreted under the *Predicate Abstraction* rule defined in Heim and Kratzer (1998), as shown in (29c), while the lower copy is interpreted as a trace of type $\langle e,t\rangle$. After the step-by-step derivation shown in (29d), the RC-embedded QP *every man* is able to take wide scope over *three women*.[10]

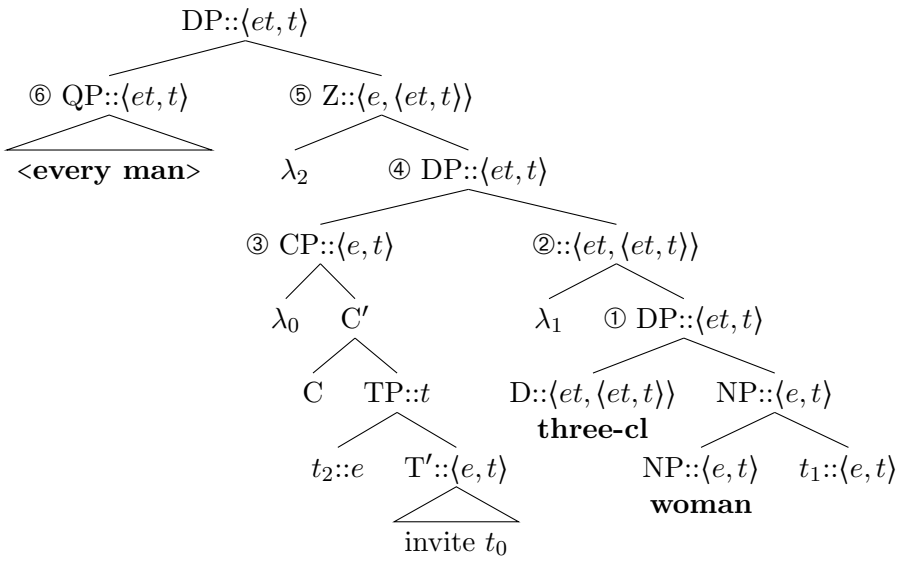
(29) a. *Object RC*

[$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ yaoqing ___ de] **san-ge** nüren] dou yongbao-le **ta**$_1$
every-CL man invite DE three-CL woman DOU hug-ASP 3SG

'Three women that every man$_1$ invited hugged him$_1$'. ($\forall > 3$)

[10]The definition of the quantifier *every* is presuppositional, i.e. $[\![\text{every}]\!] = \lambda Q_{et}.\lambda P_{et} : \exists x \in D_e\,[P(x)].\,\forall x[P(x) \rightarrow Q(x)]$. For example, the QP *every man* presupposes that there exists at least one man. I will leave out the presupposition part in the derivation henceforth for simplicity.

b. *LF*:



c. *Predicate abstraction* (*PA*) (Heim and Kratzer 1998)
Let α be a branching node with daughters ζ and γ, where ζ dominates only λi (where i is a numerical index). Then, for any variable assignment a, $[\![\alpha]\!]^a = \lambda x \in D.[\![\gamma]\!]^{a^{x/i}}$.

d. *Derivation*

i) $[\![\text{D}]\!] = \lambda Q_{et}.\lambda P_{et}.\exists x\,[|x| = 3 \wedge Q(x) \wedge P(x)]$

ii) $[\![①]\!]^g = \lambda P_{et}.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge [g(1)](x) \wedge P(x)]$

iii) $[\![②]\!]^g = \lambda Q_{et}.\lambda P_{et}.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge Q(x) \wedge P(x)]$ (By *PA*)

iv) $[\![③]\!]^g = \lambda x.\,\textsc{invite}(g(2), x)$ (By *PA*)

v) $[\![④]\!]^g = \lambda P_{et}.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(g(2), x) \wedge P(x)]$

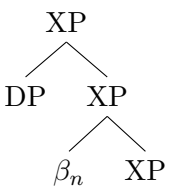
vi) $[\![⑤]\!]^g = \lambda y.\lambda P_{et}.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(y, x) \wedge P(x)]$ (By *PA*)

vii) $[\![⑥]\!]^g = \lambda Q_{et}.\forall z\,[\textsc{man}(z) \rightarrow Q(z)]$

viii) $[\![\text{DP}]\!]^g = \lambda R_{et}.[\![⑥]\!]^g(\lambda u.[\![⑤]\!]^g(u)(R))$ (By *Argument Saturation*)
$= \lambda R_{et}.\,[\lambda Q_{et}.\forall z\,[\textsc{man}(z) \rightarrow Q(z)]](\lambda u.[\lambda y.\lambda P_{et}.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(y, x) \wedge P(x)]](u)(R))$
$= \lambda R_{et}.\,[\lambda Q_{et}.\forall z\,[\textsc{man}(z) \rightarrow Q(z)]](\lambda u.[\lambda P_{et}.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(u, x) \wedge P(x)]](R))$
$= \lambda R_{et}.\,[\lambda Q_{et}.\forall z\,[\textsc{man}(z) \rightarrow Q(z)]](\lambda u.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(u, x) \wedge R(x)])$
$= \lambda R_{et}.\,\forall z\,[\textsc{man}(z) \rightarrow (\lambda u.\exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(u, x) \wedge R(x)])(z)]$
$= \lambda R_{et}.\,\forall z\,[\textsc{man}(z) \rightarrow \exists x\,[|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(z, x) \wedge R(x)]]$

Even though the RC-embedded QP is at the edge of DP, it does not c-command the matrix pronoun. In order for it to bind the matrix pronoun, I adopt the β-operator for pronoun binding proposed in Büring (2004), as defined in (30), and the matrix pronoun is analyzed as an E-type pronoun (Evans 1980; Heim 1990; Heim and Kratzer 1998; Chierchia 1995, a.o.).

(30) a. *Pronoun Binding*



where n is an index, DP occupies an A-position

b. $[\![\beta_n \text{ XP}]\!]^g = \lambda x.[[\![\text{XP}]\!]^{g[n \to x]}(x)]$

According to the E-type analysis, the pronoun is interpreted as consisting of a definite article THE and a predicate containing two variables: R of type $\langle e, \langle e, t\rangle\rangle$, and a variable x (or *pro* in Heim and Kratzer (1998)) of type e, which is bound by the β-operator according to Büring (2004). The variable R stays free and denotes a 2-place relation supplied by the context. For example, the pronoun *it* in a donkey sentence (31a) can be analyzed as [THE $R(x_2)$], as seen in (31b), where R is contextually assigned the 'donkey of' function, as shown in the interpretation in (31c). The contextual assignment for R is ensured by the *Appropriateness Condition* in (32).

(31) (Büring 2004: (7))

a. Every farmer who owns a donkey beats it.

b. LF: [every farmer who owns a donkey] [β_2 [beats [THE $R(x_2)$]]]

c. *every farmer who owns a donkey* beats **the donkey *he* owns**

(32) *Appropriateness Condition* (Heim and Kratzer 1998: p.293)
A context c is *appropriate* for an LF ϕ only if c determines a variable assignment g_c whose domain includes every index which has a free occurrence in ϕ.

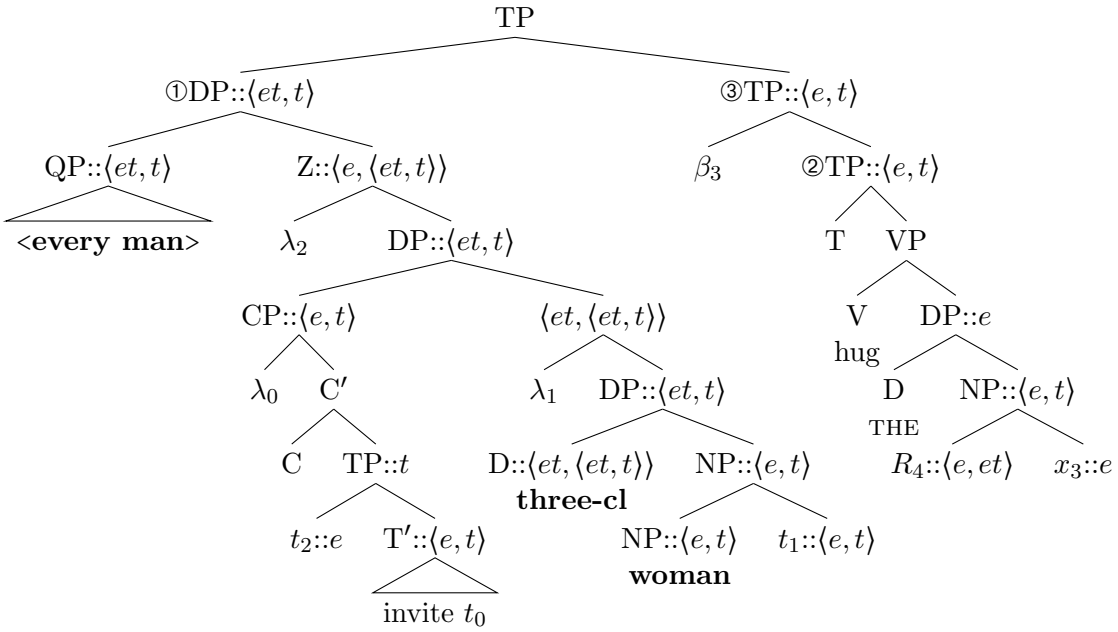
The matrix pronoun in the Mandarin sentence (29a) (repeated below as (33a)) can covary with the RC-embedded QP in a similar manner. As shown in the LF in (33b), the matrix pronoun is analyzed as a definite article THE taking the contextually supplied two-place relation R_4, whose argument x_3 is bound by β_3. Specifically, R_4 receives the interpretation in (33c-ii). Then after the step-by-step derivation, we get the intended truth condition shown in (33c-vi).

(33) a. *Object RC*

[DP[RC [**mei-ge nanren**]$_1$ yaoqing ___ de] **san-ge** nüren] dou yongbao-le **ta**$_1$
every-CL man invite DE three-CL woman DOU hug-ASP 3SG

'Three women that every man$_1$ invited hugged him$_1$'. ($\forall > 3$)

b. *LF*: [three women that every man invited] [β_3 [hugged [THE $R_4(x_3)$]]]



c. *Derivation*:

i) $[\![①]\!]^g = \lambda K_{et}.\, \forall z\, [\textsc{man}(z) \rightarrow \exists x\, [|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(z, x) \wedge K(x)]]$

ii) $[\![R_4]\!]^g = \lambda x_e.\lambda y_e.$ MAN-THAT-INVITED-x (y).

iii) $[\![x_3]\!]^g = g(3)$

iv) $[\![②]\!]^g = \lambda y.\, \textsc{hug}(y, \textsc{the}\, [\![R_4]\!]^g(g(3)))$

v) $[\![③]\!]^g = \lambda u.[\![②]\!]^{g[3\rightarrow u]}(u)$ (By *Pronoun Binding*)
$= \lambda u.[\lambda y.\, \textsc{hug}(y, \textsc{the}\, [\![R_4]\!]^g(u))](u)$
$= \lambda u.\, \textsc{hug}(u, \textsc{the}\, [\![R_4]\!]^g(u))$

vi) $[\![\text{TP}]\!]^g = [\![①]\!]^g([\![③]\!]^g)$
$= \lambda K_{et}.\, \forall z\, [\textsc{man}(z) \rightarrow \exists x\, [|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(z, x) \wedge K(x)]]$
$(\lambda u.\, \textsc{hug}(u, \textsc{the}\, [\![R_4]\!]^g(u)))$
$= 1$ iff $\forall z\, [\textsc{man}(z) \rightarrow \exists x\, [|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(z, x) \wedge$
$(\lambda u.\, \textsc{hug}(u, \textsc{the}\, [\![R_4]\!]^g(u)))(x)]]$
$= 1$ iff $\forall z\, [\textsc{man}(z) \rightarrow \exists x\, [|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(z, x) \wedge$
$\textsc{hug}(x, \textsc{the}\, [\![R_4]\!]^g(x))]]$
$= 1$ iff $\forall z\, [\textsc{man}(z) \rightarrow \exists x\, [|x| = 3 \wedge \textsc{woman}(x) \wedge \textsc{invite}(z, x) \wedge$
$\textsc{hug}(x, \iota y.\text{MAN-THAT-INVITED-}x(y))]]$

With two additional semantic operations, Argument Saturation and the β-operator for pronoun binding, we can get the intended reading where the RC-embedded QP, after long QR out of the relative clause, takes wide scope over the RC-external QP and binds the matrix pronoun at the edge of DP. Thus, the basic pattern of the exceptional-scope effects has been explained by long QR. The following sections will discuss the complications and restrictions on the exceptional-scope effects.

3.4 Long QR out of prenominal subject RCs

As introduced in section 2.3, subject RCs show more restrictions than object RCs in admitting exceptional scope effects. Only subject RCs with bare verbs allow the embedded QP to take wide scope. When aspectual markers or modals are present, the RC-external QP unambiguously takes wide scope. The contrast with respect to the presence of modals and aspectual markers is not present in object RCs. In this section, I propose that the restriction can be attributed to the difference in RC sizes: A full-sized subject RC requires the RC-embedded object QP to undergo more steps of QR out of the relative clause, which may either create processing difficulty or be syntactically impossible.

Due to a projection requied for aspects or modals, a subject RC with an aspectual marker or modal as shown in (34a) cannot be reduced, but rather has to stay as a full CP. A subject RC without any aspectual marker or modal shown in (35b), on the other hand, can be treated as a reduced RC containing only a *PrtP* (Bhatt 2006), a projection smaller than TP. The additional CP layer in a full-sized subject RC, as compared to a reduced subject RC, creates an additional phase, and thus requires the RC-embedded QP to undergo one more step of QR out of the relative clause. The steps of QR taken by the RC-embedded QP are illustrated in (34b) and (35b) for full-sized and reduced subject RCs respectively.

In a full-sized subject RC shown in (34), the RC-embedded QP needs to QR to [Spec, vP] first before further QRing out of the relative CP, as illustrated in (34b-i); otherwise, the PIC would be violated by a single instance of QR crossing two phase heads, as shown in (34b-ii). However, since a reduced subject RC does not have the CP phase, the RC-embedded object QP can undergo one step of QR out of the relative clause to [Spec, DP], as shown in (35b), without stopping at [Spec, vP] to avoid violating the PIC.

(34) a. *Full subject RC*

wo renshi [$_{DP}$[$_{RC}$ __ {xue-guo/yao xue} **mei-zhong yuyan** de] **san-ge**
1SG know learn-ASP/will learn every-CL language DE three-CL
xuesheng]
student

'I know three students who have learned/will learn every language.' (*∀ > 3)

b. i) *Two steps of QR*:
...[$_{DP}$ <**every language**> [$_{DP}$ [$_{CP}$ [Op <student>]$_j$ [$_{C'}$ C [$_{TP}$ ___$_j$ T [$_{vP}$ <**every language**> [$_{vP}$ v [$_{VP}$ learn **every language**]]]]]] [$_{D'}$ three-CL [$_{NP}$ student ___$_{CP}$]]]]

ii) *One step of QR → violation of the PIC*
*...[$_{DP}$ <**every language**> [$_{DP}$ [$_{CP}$ [Op <student>]$_j$ [$_{C'}$ C [$_{TP}$ ___$_j$ T [$_{vP}$ v [$_{VP}$ learn **every language**]]]]] [$_{D'}$ three-CL [$_{NP}$ student ___$_{CP}$]]]]

(35) a. *Reduced subject RC*

wo renshi [$_{DP}$[$_{RC}$ __ jiang **mei-zhong yuyan** de] **san-ge** xuesheng]
1SG know speak every-CL language DE three-CL student

'I know three students who speak every language.' (∀ > 3)

b. *One step of QR*:
...[$_{DP}$ <**every language**> [$_{DP}$ [$_{PrtP}$ ___$_i$ [$_{Prt'}$ Prt [$_{vP}$ v [$_{VP}$ learn **every language**]]]] [$_{D'}$ three-CL [$_{NP}$ student$_i$ ___$_{CP}$]]]]

There are two potential accounts for the degradation brought by an additional step of QR in a full-sized subject RC. First, the step of QR from the base position of an RC-embedded object QP to [Spec, vP] may not be well motivated, violating Scope Economy (a *syntactic approach*). Alternatively, two steps of QR create more processing costs than one step of QR (a *processing approach*). I will discuss the two possibilities in turn.

The first possibility, where the step of QR is prohibited due to the lack of independent motivation, seems surprising at first sight, given the conventional view that to resolve the type-mismatch between the object QP (type $\langle et, t\rangle$) and the predicate ($\langle e, t\rangle$) is a sufficient motivation for the object QP to undergo QR to [Spec, vP]. However, Blok (2017) provides a different perspective on QR to [Spec, vP]: Since object quantifiers are ambiguous (Montague 1973; Partee and Rooth 1983; Hendrinks 1993) and can be interpreted in-situ, as shown in (36), QR to [Spec, vP] is not driven by resolving type-mismatch; instead, QR to [Spec, vP] applies in order for the object QP to take inverse scope over the reconstructed subject QP (Hornstein 1995; Johnson and Tomioka 1997; Sauerland and Elbourne 2002; a.o.).

(36) (Blok 2017)

a. $[\![\text{every}_1]\!] = \lambda P_{et}\lambda Q_{et}.\forall x\,[P(x) \rightarrow Q(x)]$

b. $[\![\text{every}_2]\!] = \lambda P_{et}\lambda R_{\langle e,et\rangle}\lambda y.\forall x\,[P(x) \rightarrow R(x)(y)]$

Since type-driven QR is no longer necessary, a step of QR is motivated only if it creates a new scope relation. This proposal would predict a violation of Scope Economy in (34b-i): The step of QR to [Spec, vP] does not create any new scope relations, and thus is not well-motivated. Since the RC-embedded object QP cannot undergo one step of QR out of the full subject RC, as shown in (34b-ii), it is syntactically impossible for the RC-embedded QP to take wide scope when the subject RC is a full-sized CP.

However, a problem of this analysis is that the matrix reading of an ACD, as shown in (20) and repeated in (37) below, where the QP containing the ACD site undergoes long QR across a finite clause boundary, becomes unexpected. Without type-driven QR, the first step of QR to the embedded [Spec, vP] seen in (37b) would be unmotivated, since it does not create any new scope relations, but this step is required by the PIC.

(37) *Matrix reading of ACD*

a. John said that you were on every committee that Bill did <say that you were on>.

b. [$_{IP}$ John [$_{vP}$ <John> [$_{v'}$ v [$_{VP}$ <**every committee that Bill did**> [$_{VP}$ said [$_{CP}$ that [$_{TP}$ you [$_{T'}$ T [$_{vP}$ <**every committee that Bill did**> [$_{vP}$ v [$_{VP}$ were on **every committee that Bill did**]]]]]]]]]]]]

I have no concrete answer yet for this dilemma, but one possibility is that QR for ACD is of a different kind from QR for scope taking and thus subject to different locality constraints. As mentioned in Overfelt (2020), the restricted distribution of sloppy pronouns in ACD constructions suggests that the QR for resolving ACD, as a syntactic operation, cannot be licensed by postsyntactic conditions. It seems to be at odds with the conventional understanding of QR, which is licensed only when it can create distinctions in interpretation. Since QR for ACD has a more structural than interpretive motivation, it is possible that QR for ACD does not need to obey the same semantic constraints as QR for scope taking, namely Scope Economy.

Alternatively, the degradation of a RC-embedded QP taking wide scope in a full-sized subject RC compared to that in a reduced subject RC could be attributed to processing. The additional step of QR in a full-sized subject RC is syntactically possible, but creates higher processing cost. In fact, the subject-object asymmetry with respect to scope taking is not unique to Mandarin relative clauses. As observed by Cecchetto (2004), the subject QP in an ECM clause in Italian more easily takes inverse scope than the object QP in an ECM clause.

(38) (Cecchetto (2004): 368-369)

a. *Object QP in ECM*
Almeno un giornalista ha visto il commissario picchiare ognuno dei pacifisti.
'At least one journalist has seen the police officer beating **each of the pacifists**.'
(??∀ > ∃)

b. *Subject QP in ECM*
Almeno un pacifista ha visto ognuno dei poliziotti tirare una pietra.
'At least one pacifist has seen **each of the policemen** throwing a stone.' (?∀ > ∃)

Based on the *Processing Scope Economy* proposed in Anderson (2004) and experimental evidence on processing costs of QR (Syrett and Lidz 2011; Tanaka 2015; a.o.), Wurmbrand (2018) argues that QR is not always clause-bounded; rather, the processing cost of QR increases as more steps of QR are required by the inverse scope, leading to the degradation of cross-sentential QR. A potential source of the processing cost of QR, as discussed in Wurmbrand (2018), is the process of *Trace Conversion* (Fox 2003), which each lower copy of the moved QP along the QR chain needs to undergo at LF.

(39) *Trace Conversion* (Fox 2003: 111, (50))

a. Variable Insertion: (Det) Pred ⇒ (Det) [Pred $\lambda y(y = \text{him}_n)$] (n is the index of the moved QP)

b. Determiner Replacement: (Det) [Pred $\lambda y(y = \text{him}_n)$] ⇒ the [Pred $\lambda y(y = \text{him}_n)$]

As shown in (34), QR out of a full-sized subject RC takes two steps, while QR out of a reduced subject RC in (35), or an object RC as shown in (24) and repeated below as (40) only requires one step. According to Wurmbrand's version of *Processing Scope Economy*, the RC-embedded QP taking a wide scope reading in a full-sized subject RC is expected to be more costly and thus less acceptable than that in a reduced subject RC or an object RC.

(40) *One step of QR out of a prenominal object RC*
[$_{DP}$ <**every student**> [$_{DP}$ [$_{CP}$Op <book>]$_j$ [$_{C'}$ C [$_{TP}$ **every student** like ___$_j$]]] [$_{D'}$ [$_{D}$ three-CL] [$_{NP}$ book ___$_{CP}$]]]]

To summarize, the restriction on Mandarin subject RCs with respect to admitting the exceptional scope effects can be attributed to the additional step of QR required in a full-sized subject RC, as compared to a reduced subject RC or an object RC. The additional step of QR is either syntactically impossible due to the lack of independent motivation or costly in processing. I leave the choice between the two options open for future research.

4 The blocking effect of *dou*

This section explains the blocking effect of *dou* shown in section 2.2, where the RC-embedded QP is unable to take wide scope or bind matrix pronouns when *dou* is present in RCs. I will first introduce the analysis of *dou* in Y. Xiang (2020) and show why it blocks long QR, followed by discussion of why it cannot be the case that *dou* blocks reconstruction of the head. The cases where RCs containing *dou* are embedded in specificational sentences will be discussed in section 5.

4.1 Semantics of *dou* and long QR

The Mandarin particle *dou* is well-known for its multiple functions: It can be used as a quantifier-distributor, a free choice item licensor, and a scalar operator (Lin 1998; Giannakidou and Cheng 2006; M. Xiang 2008; Y. Xiang 2020; a.o.). I will focus on the quantifier-distributor use of *dou* for the current concern. Similar to the postnominal *all* in English, *dou* universally distributes over its associate, a nominal expression to its left. It has been observed to have three requirements. (i) *Maximality requirement*: The predicate denoted by the VP applies to all members in the set denoted by *dou*'s associate, as shown in (41a) (M. Xiang 2008). (ii) *Distributivity requirement*: *Dou* forces a distributive reading of the sentence, as shown in (41b) (Lin 1998). (iii) *Plurality requirement*: The associate of *dou* has to be non-atomic, such as *every time* in (41c) when the subject nominal is not atomic (Y. Xiang 2020).

(41) (Y. Xiang 2020)

a. *Maximality requirement*
(Scenario: *A large group of children, with one or two exceptions, went to the park.*)

[Haizimen] (#**dou**) qu-le gongyuan.
children DOU go-PERF park

'The children (#all) went to the park.'

b. *Distributivity requirement*
(Scenario: *The considered individuals all together bought only one house.*)

[Tamen] (#dou) mai-le fangzi.
they DOU buy-PERF house

'They (#all) bought house(s).'

c. *Plurality requirement*

Yuehan [*(mei-ci)] **dou** qu de Beijing.
John every-time DOU go DE Beijing

'Every time, the place that John went to was Beijing.'

Y. Xiang (2020) proposes a unified denotation of *dou* for its three uses, as shown in (42). *Dou* presupposes that the prejacent clause of *dou* has at least one sub-alternative, which is a weaker alternative asymmetrically entailed by the prejacent clause of *dou*, as defined in (43). The non-vacuity presupposition derives the distributivity and plurality requirements seen in (41b) and (41c). *Dou* then asserts that the prejacent clause is true and the exhaustification of each sub-alternative, achieved by the O-operator defined in (44), is false. The prejacent assertion and anti-exhaustification together derive the maximality effect seen in (41a).

(42) **Definition of *dou***
$[\![dou_C]\!] = \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).\, p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C)[O_C(q)(w) = 0]$

a. Non-vacuity presupposition: The prejacent has at least one sub-alternative

b. Prejacent assertion: The prejacent is true.

c. Anti-exhaustification: Exhaustification of each sub-alternative is false.

(43) **Sub-alternatives as weaker alternatives**
$\textsc{Sub}(p, C) = (C - \textsc{Excl}(p, C)) - \{p\} = \{q | p \subset q, q \in C\}$,
where $\textsc{Excl}(p, C) = \{q | p \nsubseteq q \wedge q \in C\}$

(44) **The O-operator** (Chierchia, Fox, and Spector 2012)
$O_C = \lambda p \lambda w : p(w) = 1 \wedge \forall q \in \textsc{Excl}(p, C)[q(w) = 0]$

For example, when *dou* is present in a sentence shown in (45), where the focus associate of *dou* is non-atomic, *dou* takes the TP *John and Mary arrived* as its argument at LF, as seen in (45a), which has the denotation shown in (45b).[11] In the domain of *dou*, as defined in (45c), there are two alternatives asymmetrically entailed by the prejacent clause, as shown in the set of contextually relevant sub-alternatives of the prejacent clause in (45d). Hence, by the definition of *dou* in (42), the denotation of the entire sentence is shown in (45e).

(45) [John and Mary] **dou** arrived. (Y. Xiang 2020)

a. LF: $\textbf{dou}_C[_S[\text{John and Mary}]_{[+F]}$ arrived]

b. $[\![S]\!] = \textsc{arrive}(j \oplus m)$

c. C= $\{\textsc{arrive}(x) \mid x_e \text{ is a relevant individual}\}$

d. $\textsc{Sub}([\![S]\!], C) = \{\textsc{arrive}(j), \textsc{arrive}(m)\}$

e. $[\![dou_C(S)]\!] = \textsc{arrive}(j \oplus m) \wedge \neg O[\textsc{arrive}(j)] \wedge \neg O[\textsc{arrive}(m)] = \textsc{arrive}(j \oplus m)$

However, *dou* is incompatible with an atomic associate, as shown in (46). The prejacent clause of *dou*, as shown in (46b), does not asymmetrically entail anything in the domain defined in (46c). The non-vacuity presupposition of *dou* is thus unsatisfied.

[11] Following Y. Xiang (2020), I will call the TP taken by *dou* 'S', so it is clearer that this is the prejacent clause of *dou*.

(46) *[John] **dou** arrived. (Y. Xiang 2020)

a. LF: $\mathbf{dou}_{\mathrm{C}}[_{\mathrm{S}}[\mathrm{John}]_{[+\mathrm{F}]}$ arrived]

b. $[\![\mathrm{S}]\!]$ = ARRIVE(j)

c. C= {ARRIVE(x) | x_e is a relevant individual}

d. SUB($[\![\mathrm{S}]\!]$, C) = $\varnothing$

I now show that the non-vacuity presupposition blocks long QR out of relative clauses containing *dou*. First, when a RC-embedded QP, *every student*, is interpreted inside the relative clause containing *dou*, as shown in (47), the non-vacuity presupposition of *dou* can be satisfied, and the relative clause is interpretable, as proved in (48). The LF of the relative clause in (47) and its denotation according to the definition of *dou* in (42) are shown in (48a) and (48b) respectively. The relative clause containing *dou* is interpretable, because there is at least one assignment g such that for any y, with the denotations of the prejacent clause and the set of contexually relevant alternatives shown in (48c-i) and (48c-ii), the set of contextually relevant sub-alternatives asymmetrically entailed by the prejacent clause of *dou* $[\![\mathrm{S}]\!]^{g[1\to y]}$ is not empty, as shown in (48c-iii), satisfying the non-vacuity presupposition of *dou*.

(47) *RC containing <u>dou</u> without long QR*

wo du-guo [$_{\mathrm{DP}}$[$_{\mathrm{RC}}$ **mei-ge** **xuesheng** <u>dou</u> xihuan _ de] **san-ben** shu]
1SG read-ASP every-CL student DOU like DE three-CL book

'I have read three books that every student likes.' (3 > ∀)/(*∀ > 3)

(48) There is at least one g such that DOM($[\![\mathrm{RC}]\!]^g$) ≠ $\varnothing$ because,

a. RC = [1 [$\mathbf{dou}_{\text{C-}pro1}$ [$_{\mathrm{S}}$ [every student]$_{[+\mathrm{F}]}$ likes ___$_1$]]]

b. $[\![\mathrm{RC}]\!]^g = \lambda y : [\![dou_{\text{C-}pro1}(\mathrm{S})]\!]^{g[1\to y]}$ is defined. $[\![dou_{\text{C-}pro1}(\mathrm{S})]\!]^{g[1\to y]}$
$= \lambda y : \mathrm{SUB}([\![\mathrm{S}]\!]^{g[1\to y]}, \mathrm{C}(y)) \neq \varnothing. [\![\mathrm{S}]\!]^{g[1\to y]} = 1 \wedge \forall q \in \mathrm{SUB}([\![\mathrm{S}]\!]^{g[1\to y]}, \mathrm{C}(y))[O(q) = 0]$

c. For any y,

i. $[\![\mathrm{S}]\!]^{g[1\to y]} = 1$ iff $\forall x[\mathrm{STUDENT}(x) \to \mathrm{LIKE}(x, y)]$

ii. $\mathrm{C}(y) = \{Q_{ett}(\lambda x.\mathrm{LIKE}(x, y)) \mid Q_{ett}$ is a relevant quantificational expression$\}$

iii. $\mathrm{SUB}([\![\mathrm{S}]\!]^{g[1\to y]}, \mathrm{C}(y)) \subseteq \{[\![$some students$]\!](\lambda x.\mathrm{LIKE}(x, y)),$
$[\![$most students$]\!](\lambda x.\mathrm{LIKE}(x, y)),$
$[\![$at least one student$]\!](\lambda x.\mathrm{LIKE}(x, y)), ...$
$[\![$more than half of the students$]\!](\lambda x.\mathrm{LIKE}(x, y)), ...\}$

However, if the RC-embedded QP undergoes long QR out of the relative clause, as schematized in (49), the non-vacuity presupposition of *dou* would fail, assuming *dou* does not move, following Y. Xiang (2020). QR leaves an individual-denoting gap at the position for the associate of *dou*, as shown in (50a). The denotation of the relative clause containing *dou* is shown in (50b) according to the definition of *dou*. For any assignment g, the domain of $[\![\mathrm{RC}]\!]^g$ is always empty, and the relative clause is uninterpretable. For any y, the prejacent clause $[\![\mathrm{S}]\!]^{g[1\to y]}$ of *dou* shown in (50c-i), where the associate of *dou*, i.e. $g(2)$, is atomic, does not asymmetrically entail anything. Hence, the set of contextually salient sub-alternatives of the prejacent clause is empty, as shown in (50c-iii), and the non-vacuity presupposition of *dou* is unsatisfied.

(49) *RC containing dou after long QR*
*I read [$_{DP}$ <**every student**> [$_{DP}$ [$_{RC}$ [Op <book>]$_j$ [$_{TP}$ **every student** dou like ___$_j$ DE]] [$_{D'}$ three [$_{NP}$ book$_j$ ___$_{RC}$]]]]

(50) For any g, assuming $[\![C]\!]^g$ =C, $\textsc{Dom}([\![RC]\!]^g) = \varnothing$, because,

a. RC = [1 [**dou**$_{C\text{-}pro1}$ [$_S$ [___$_2$]$_{[+F]}$ likes ___$_1$]]]

b. $[\![RC]\!]^g = \lambda y : [\![dou_{C\text{-}pro1}(S)]\!]^{g[1\to y]}$ is defined. $[\![dou_{C\text{-}pro1}(S)]\!]^{g[1\to y]}$
$= \lambda y : \textsc{Sub}([\![S]\!]^{g[1\to y]}, C(y)) \neq \varnothing. [\![S]\!]^{g[1\to y]} = 1 \wedge \forall q \in \textsc{Sub}([\![S]\!]^{g[1\to y]}, C(y))[O(q) = 0]$

c. For any y,

i. $[\![S]\!]^{g[1\to y]} = 1$ iff $\textsc{like}(g(2), y)$

ii. $C(y) = \{\textsc{like}(x, y) \mid x_e \text{ is a relevant individual}\}$

iii. $\textsc{Sub}([\![S]\!]^{g[1\to y]}, C(y)) = \varnothing$

To summarize, the non-vacuity presupposition of *dou* blocks long QR of the RC-embedded QP. The absence of both the wide-scope reading of a RC-embedded QP and binding out of the containing DP when *dou* is present in a relative clause is thus expected under the long QR analysis. The next subsection will discuss why it cannot be the case that *dou* blocks reconstruction, as briefly mentioned in section 2.2.

4.2 *Dou* and RC head reconstruction

From a theoretical perspective, none of the three components in the definition of *dou* in (42) would block reconstruction. The assertions that the prejacent clause is true (42b) and that the exhaustification of each sub-alternative of the prejacent clause is false (42c) are irrelevant to the potential of blocking reconstruction. The non-vacuity presupposition in (42a), on the other hand, predicts the opposite: Instead of blocking reconstruction, *dou* should prefer reconstruction where reconstruction is needed to preserve the prejacent clause of *dou* intact, ensuring that the prejacent clause has at least one sub-alternative. Hence, *dou* blocking reconstruction does not directly follow from the current analysis of *dou*. Empirical evidence provides further support that *dou* does not block reconstruction.

First, binding of an anaphor in the RC head is observed in relative clauses containing *dou*. As shown in the baseline sentence in (51a), the anaphor *ta.ziji* external to the relative clause can only be bound by a RC-internal R-expression c-commanding the gap, i.e. *Zhang's mom* in (51a), but not *Zhang*, despite both R-expressions linearly preceding the anaphor. The baseline sentence shows that it is not the linear order, but rather the ability to reconstruct the RC-head that allows anaphora binding. When *dou* is present in a relative clause, as shown in (51b), a similar pattern in observed: The anaphor *tamen.ziji* in the RC head can be bound by *Zhang and Li's friends*, which c-commands the gap, but not the more deeply embedded *Zhang and Li*. Hence, (51a) and (51b) together suggest that *dou* does not block reconstruction of the RC head.

(51) a. *Baseline*:

wo renshi [$_{DP}$[$_{RC}$ [**Zhang**$_1$ de mama]$_2$ yaoqing ___$_i$ de] [**ta.ziji**$_{2/*1}$ de xuesheng]$_i$
1SG know Zhang DE mom invite DE 3SG.self DE student

'I know the student of herself$_{2/*1}$ that [Zhang$_1$'s mom]$_2$ has helped.'

b. *Presence of dou in RC*

wo renshi [$_{DP}$[$_{RC}$ [[**Zhang he Li**]$_1$ de pengyou-men]$_2$ dou bangzhu-guo ___$_i$ de] [
1SG know Zhang and Li DE friend-PL DOU help-ASP DE
tamen.ziji$_{2/*1}$ de xuesheng]$_i$
3PL.self DE student

'I know the student of themselves$_{2/*1}$ that [[Zhang and Li]$_1$'s friends]$_2$ have helped.'

Another piece of evidence for the compatibility of reconstruction and *dou* comes from the scope interaction between a RC-embedded QP and a QP in an adjectival modifier of the RC head, as discussed in Aoun and A. Li (2003). When the numeral *three* is not directly quantifying the RC head, but rather embedded in a possessive modifying the RC head NP, as shown in (52a), the RC-embedded QP *every person* is able to take wide scope over *three author*, despite the presence of *dou* inside the relative clause. This is in contrast with (52b), where the numeral *three*-CL is not embedded in an adjectival modifier of the head NP *author*. If *dou* blocks reconstruction for scope, then the RC-embedded QP wide scope is expected to be unavailable in both (52a) and (52b), contrary to fact.

(52) a. (Aoun and A. Li (2003): 138 (11))

[$_{DP}$[$_{RC}$ **mei-ge ren** dou xihuan _ de] [$_{NP}$ [**san-ge zuojia** (xie) de] shu]]
every-CL person DOU like DE three-CL author write DE book

'the books written by three authors that everyone likes.' ($\forall > 3$)

b. [$_{DP}$[$_{RC}$ **mei-ge ren** dou xihuan _ de] **san-ge** [$_{NP}$ **zuojia**]]
every-CL person DOU like DE three-CL author

'three authors that everyone likes.' (*$\forall > 3$)

The contrast seen in (52) suggests that it is not *dou* that blocks reconstruction for scope; instead, only adjectival modifiers, such as possessives or relative clauses, but not numerals, are part of the RC head NP and thus can reconstruct. The distinction between numerals and adjectival modifiers with respect to reconstruction in Mandarin is further supported by evidence independent of *dou*.

Bhatt (2002, 2006) observes that adjectival modifiers of RC head NPs, such as *first*, *only*, and *longest*, can have both high and low readings, as shown in (53). The low reading (53b) is only available if the RC head NP including the adjectival modifier reconstructs.

(53) the [first book]$_i$ [$_{CP}$ *first book*$_i$ that [John said [$_{CP}$ *first book*$_i$ that [Tolstoy had written *first book*$_i$]]]] ((23) in Bhatt (2002))

a. *High reading*:
(Scenario: In 1990, John said that Tolstoy had written *Anna Karenina*; in 1991, John said that Tolstoy had written *War and Peace*. Hence the NP is *Anna Karenina*.)
the λx first [book, x] [John said that Tolstoy had written x]
$\approx$ the first book about which John said that Tolstoy had written it

b. *Low reading*:
(Scenario: John said that the first book that Tolstoy had written was *War and Peace*. Hence the NP is *War and Peace*.)
the λx [John said that [first [Tolstoy had written [book x]]]]
$\approx$ the x s.t. John said that the first book that Tolstoy had written was x

Similarly, numerals and quantificational adjectives in English, such as *few* and *many*, also allow the low reading, only when a definite determiner is present, as shown in (54a). Without a definite determiner, a numeral or quantificational adjective has to be in the D head, instead of serving as an adjectival modifier, and thus, the low reading of the numeral or quantificational adjective is no longer available, as shown in (54b). The contrast seen in (54) with respect to the availability of the low reading suggests that only NP, but not DP, reconstructs, and numerals and quantificational adjectives in English can be either adjectival modifiers or determiners.

(54) ((52) and (54) in Bhatt (2002))

a. I have read the two books that John said that Tolstoy had finished.

i. ✓ *High reading*:
(Scenario: John pointed to two books and said that Tolstoy had finished them. I have read those books.)
the λx two [book x] [John said that Tolstoy had finished x]
≈ the two books about which John said that Tolstoy had finished them

ii. ✓ *Low reading*:
(Scenario: In an opaque box are books that Tolstoy had finished and John said there are two books, but in fact there are four. I have read those books.)
the λx [John said that [Tolstoy had finished [two books x]]]
≈ the x s.t. John said that Tolstoy had finished the two books x

b. I have read two books that John said that Tolstoy had finished.

i. ✓ *High reading*
two λx [book x] [John said that Tolstoy had finished x]
≈ two books about which John said that Tolstoy had finished them

ii. ✗ *Low reading*
(Intended) the x s.t. John said that Tolstoy had finished [two books x]

Numerals in Mandarin, unlike their counterparts in English, are unable to serve as adjectival modifiers, as shown by the contrast between a numeral *two*-CL and a real adjectival modifier *longest* with respect to the availability of the low reading in (55). The adjectival modifier *longest* is compatible with the low reading, as shown in (55a), while the numeral *two*-CL is not, as shown in (55b). The pattern observed in (55) suggests that Mandarin numerals are like those English numerals in the D head due to the absence of a definite determiner, as seen in (54b), and different from (quantificational) adjectival modifiers that are part of the head NP.

(55) a. *Adjectival modifier of NP*

wo mai-le [$_{RC}$ Zhang shuo-guo Tuoersitai du-wan _ de] [$_{NP}$ **zui-chang de** shu]
1SG buy-ASP Zhang say-ASP Tolstoy finish DE most-long DE book

'I bought the longest book that Zhang said Tolstoy had finished.'
✓ *Low reading*: the x s.t. Zhang said that the longest book that Tolstoy had finished was x.
✓ *High reading*: the longest book(s) about which Zhang said that Tolstoy had finished them.

b. *Numeral*

wo mai-le [$_{RC}$ Zhang shuo-guo Tuoersitai du-wan _ de] **liang-ben** [$_{NP}$ shu]
1SG buy-ASP Zhang say-ASP Tolstoy finish DE two-CL book

'I bought two books that Zhang said Tolstoy had finished.'
✗ *Low reading*: the x s.t. Zhang said that Tolstoy had finished the two books x.
✓ *High reading*: two books about which Zhang said that Tolstoy had finished them.

The unavailability of the low reading for numerals in Mandarin further supports that Mandarin, like English, only allows NPs to reconstruct into relative clauses, but unlike English numerals, which are ambiguous between serving as a determiner or an adjectival modifier, Mandarin numerals are unambiguously determiners. They are always in a projection higher than NP, different from real adjectival modifiers, and thus cannot reconstruct with the RC head NP.

4.3 Interim Summary

Section 4.1 discussed the inability of a RC-embedded QP to take wide scope and bind out of the containing DP when *dou* is present in the relative clause, and attributed it to the non-vacuity presupposition of *dou*, which blocks long QR. Section 4.2 has shown that *dou* does not block reconstruction; instead, numerals in Mandarin do not reconstruct into relative clauses, unlike their counterparts in English, as well as adjectival modifiers in Mandarin, . However, as mentioned at the end of section 2.2 (column 6 in Table 1), the exceptional-scope effects are not always missing in relative clauses containing *dou*. Section 5 will discuss this issue in detail.

5 Functional reading of relative clauses

As shown in (10) in section 2.2 and repeated below in (56), an object RC containing *dou* allows the RC-embedded QP to "take wide scope"and bind a matrix pronoun when it is embedded in a specificational sentence, but not when it is embedded in a non-specificational clause. Furthermore, such an asymmetry with respect to matrix clause type is not observed in a subject RC, as shown in (11) and repeated below in (57).

(56) *Object RCs*

a. *In a specificational sentence*

[$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge nüren**] shi **ta**$_1$ mama
every-CL man DOU invite DE one-CL woman be 3SG mom

'A woman that [every man]$_1$ invited is his$_1$ mom.' (✓multiple-individual reading)

b. *In a non-specificational sentence*

[$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge nüren**] yongbao-le **ta**$_{*1}$
every-CL man DOU invite DE one-CL woman hug-ASP 3SG

'A woman that [every man]$_1$ invited hugged him$_{*1}$.' (#multiple-individual reading)

(57) *Subject RCs*

a. *In specificational sentence*

[$_{DP}$[$_{RC}$ ___ [**mei-zhong yuyan**]$_1$ dou jiang de] **yi-ge xuesheng**] shi **ta**$_{*1}$ de
every-CL language DOU speak DE one-CL student be 3SG DE
muyuzhe
native.speaker

'A student that speak [every language]$_1$ is its$_{*1}$ native speaker.'
(#multiple-individual reading)

b. *In non-specificational sentence*

[$_{DP}$[$_{RC}$ ___ [**mei-zhong yuyan**]$_1$ dou jiang de] **yi-ge xuesheng**] reai **ta**$_{*11}$ de wenhua
every-CL language DOU speak DE one-CL student love 3SG DE culture

'A student that speak [every language]$_1$ loves its$_{*1}$ culture.'
(#multiple-individual reading)

In this section, I will argue that the reading where the RC-embedded QP seems to take wide scope, which I call the *multiple-individual reading*, is not derived from scope taking, but rather a consequence of interpreting the relative clause as containing a functional trace. The functional analysis of RCs is able to capture the asymmetry with respect to matrix clause type in object RCs containing *dou*, as well as the lack of such asymmetry in subject RCs. Section 5.1 briefly introduces the functional analysis. Section 5.2 then shows that *dou* does not block the functional reading of an object RC embedded in a specificational sentence. Last, section 5.3 discusses cases where the functional reading is not available.

5.1 Natural function and pair-list

Questions with quantifiers have been observed to have both a natural-function reading and a pair-list reading, as shown in (58) (Engdahl 1980, 1986; Groenendijk and Stokhof 1984; a.o.).

(58) Which woman does every man love?

a. Natural-function answer: His mother.

b. Pair-list answer: John, Mary; Bill, Sally; Tom, Kate...

Chierchia (1993) among others (Dayal 1996; Bittner 1998) interprets both the natural-function and pair-list readings as a functional reading, where the gap of the *wh*-phrase is interpreted as a functional trace bearing two indices that need to be bound. The two readings then only differ in the kind of functions they denote: the former denotes a natural function, e.g. a *mother-of* function in (58a), while the latter denotes a pair-list function, mapping each man to the woman he likes as shown in (58b).

Parallel to questions, relative clauses have been shown to have both a natural-function reading (Jacobson 1994; von Stechow 1990), and a pair-list reading (Sharvit 1999). Sharvit (1999) extends Chierchia (1993)'s analysis of natural-function and pair-list questions to relative clauses, where a functional trace underlies both types of functional relative clauses.

As shown in (59), the gap in the relative clause denotes a natural function that maps every man to the woman he is hugging, and the the post-copular part of the sentence asserts that the natural function is a *mother-of* function. The pair-list RC, as shown in (60), also denotes a function, but instead of being a natural function, the function whose domain is restricted by the subject QP pairs each man x with the woman he hugged, i.e. $f(x)$, and the matrix clause states that the woman $f(x)$ pinched x.

(59) *Natural function RC* (Jacobson 1994; Sharvit 1999)
[$_{DP}$The **woman** [$_{RC}$ **every man** is hugging ___]] is his mother.

a. $\iota f[\text{NAT}(f) \,\&\, \forall x[x \in \text{DOM}(f) \rightarrow \text{WOMAN}(f(x))] \,\&\, \forall x[\text{MAN}(x) \rightarrow \text{HUG}(x, f(x))]]$
$= \lambda x \iota z[\text{MOTHER-OF}(z, x)]$

b. 'The unique natural function which maps every man to the woman he is hugging is the 'mother-of' function.'

(60) *Pair-list RC (Hebrew)* (Sharvit 1999)

[$_{\text{DP}}$ **ha-iSa** [$_{\text{RC}}$ Se [**kol** **gever**]$_1$ xibek ___]] cavta oto$_1$
the-woman that every man hugged pinched him

'For every man x, the woman x hugged pinched x.

a. $\exists A[W([\text{every man}], A) \wedge \forall x \in A[\text{PINCH}(\iota g[\text{DOM}(g) = A \wedge \forall y \in A [\text{WOMAN}(g(y)) \wedge \text{HUG}(y, g(y))]](x), x)]]$, where W is a unique witness set.

b. 'For every man x, $f(x)$ pinched x, where f is the unique function from men to the women they hugged.'

The main motivation for treating both natural-function and pair-list readings as containing a functional trace, as in Chierchia (1993) and Sharvit (1999), is to account for the subject-object asymmetry observed in both readings. As shown by the contrast between (58) where the QP is in the subject position, and (61) where the QP is in the object position, both natural-function and pair-list readings are unavailable when the QP is base generated in a position c-commanded by the *wh*-trace.

(61) Which woman loves every man? (Chierchia 1993)

a. *Natural functional answer: His mother

b. *Pair-list answer: John, Mary; Bill, Sally; Tom, Kate...

A similar contrast is observed in relative clauses. When the QP is in the embedded object position and the gap of the relative head is in the subject position, as shown in (62), neither the natural-function nor the pair-list reading is available.

(62) a. *Natural function RC (Hebrew)*: (Sharvit 1999)

*[$_{\text{DP}}$ **ha-iSa** [$_{\text{RC}}$ Se ___ mexabeket [**kol** **gever**]$_1$]] hi im-o$_1$.
the-woman that is.hugging every man is mother-his

Intended: 'The unique natural function which maps every man to the woman who is hugging him is the *mother-of* function.'

b. *Pair-list RC (Hebrew)*: (Sharvit 1999)

*[$_{\text{DP}}$ **ha-iSa** [$_{\text{RC}}$ Se ___ mexabeket [**kol** **gever**]$_1$]] covetet oto$_1$.
the-woman that is.hugging every man is.pinching him

Intended: 'For every man x, $f(x)$ is pinching x, where f is the unique function from men to the women who hugged them.'

Positing a layered functional trace in both natural-function and pair-list readings provides a unified account for the subject-object asymmetry: The incompatibility of a functional trace in the subject position is due to the weak crossover effect (WCO) caused by moving the c-commanded QP over the functional trace in order to bind the trace. As shown in (63), the functional index f of the functional trace is bound by the *wh*-phrase, while the other index needs to be bound by

a QP c-commanding the functional trace. A QP base-generated in the subject position, as shown in (63a), directly binds the functional trace, but an object QP needs to move over the functional trace to a position c-commanding it, as shown in (63b), which causes WCO according to Chierchia (1993). Hence, the WCO blocks both natural-function and pair-list readings in questions and RCs with a gap in the subject position.

(63) *Subject-object asymmetry* (Chierchia 1993)

a. [which woman]$_f$ [every man]$_a$ [t_a loves t^a_f]

b. *[which woman]$_f$ [every man]$_a$ [t^a_f loves t_a]

Despite the similarity between natural-function and pair-list RCs with respect to the subject-object asymmetry, they are different in several aspects, as discussed in Sharvit (1999). I will present two differences that are relevant here: i) Natural-function RCs are only compatible with specificational copula sentences, and ii) natural-function RCs only presuppose the uniqueness of a specific natural function, but not the uniqueness of individuals.

First, natural-function RCs can only be embedded in specificational copula sentences, while pair-list RCs are admitted in non-specificational sentences as well. The incompatibility of natural-function RCs with non-specificational sentences can be attributed to type-mismatch. Since the specificational copula *be* and the definite determiner are cross-categorial, they are free to admit any type of argument, but a non-specificational predicate of type $\langle e,t\rangle$ cannot combine with a subject DP containing a natural-function RC, which is of type $\langle e,e\rangle$.

The composition of a DP containing a pair-list RC with a non-specificational predicate is facilitated by an *Absorption* rule, as defined in (64a). *Absorption* allows the RC-embedded QP to be absorbed into the relative operator, as shown in (64a). Then another type-shifting operation shown in (64b) allows the bundle of the relative operator and QP to first combine with the rest of the relative clause (K), then the head noun (P), the determiner (T), and finally the matrix TP (R). A matrix predicate of type $\langle e,t\rangle$ is thus compatible with a pair-list RC.

(64) a. *Absorption*
$...[_{\text{DP}}\ ...[_{\text{RC}}\ \text{Op}_f\ [_{\text{TP}}\ \text{QP}_a...]]]... \rightarrow ...[_{\text{DP}}\ ...[_{\text{RC}}\ [\text{Op}_f\ \text{QP}_a]...]]^a_f...$

b. $[\![\text{Op QP}]\!] \rightarrow \lambda K\lambda P\lambda T\lambda R\exists A[W([\text{QP}],A) \wedge \forall x \in A[R(T(\lambda g[\text{Dom}(g) = A \wedge \forall y \in A[P(g(y)) \wedge K(g,y)]])(x),x)]]$

Second, natural-function and pair-list RCs also differ in their uniqueness presuppositions. As observed by Jacobson (1994), a natural-function RC such as (65a) does not presuppose that every man only hugged one woman, because the definite determiner takes a natural function, instead of an individual, as its argument. The uniqueness presupposition of the definite determiner is satisfied as long as among all the women each men hugged, there is a woman who is his mother, and there is no other contextually-relevant relation between each man and the women he hugged. Hence, a natural-function RC is felicitous in a context where some men might have hugged other women in addition to his mother, as shown in (65a). By contrast, a pair-list RC, shown in (65b), presupposes that for each man there is a unique woman that he hugged and is infelicitous in the given context. Since the definite determiner takes a pair-list function which pairs each man x with a woman y he hugged, it presupposes the pair-list function to be unique, i.e. there is no other contextually relevant pair-list function, and thus the woman hugged by each man also has to be unique.

(65) Context: John hugged Sarah and his mother, Bill hugged Mary and his mother, Sam hugged his mother, ...

a. Natural-function RC:
The woman every man hugged was his mother.

b. Pair-list RC (Hebrew):

#[$_{\text{Head}}$ **ha-iSa**] [$_{\text{RC}}$ Se **kol** **gever** xibek ___] cavta oto
the-woman that every man hugged pinched him

'For every man x, the woman x hugged pinched x.

The next subsection shows empirical evidence that Mandarin object RCs containing *dou* pattern with natural-function RCs, but not with pair-list RCs, which is expected under the analysis of *dou*.

5.2 Natural-function RCs with *dou*

As shown in (56) and repeated below as (66), the multiple-individual reading of an object RC containing *dou* is only available when the RC is embedded in a specificational sentence, as in (66a), but not when it is embedded in a non-specificational sentence, as in (66b). The pattern seen here resembles the distribution of natural-function RCs, which are only admitted in specificational sentences.

(66) *Object RCs*

a. *In a specificational sentence*

[$_{\text{DP}}$[$_{\text{RC}}$ [**mei-ge** **nanren**]$_1$ dou yaoqing ___ de] **yi-ge** **nüren**] shi **ta**$_1$ mama
every-CL man DOU invite DE one-CL woman be 3SG mom

'A woman that [every man]$_1$ invited is his$_1$ mom.' (✓multiple-individual reading)

b. *In a non-specificational sentence*

[$_{\text{DP}}$[$_{\text{RC}}$ [**mei-ge** **nanren**]$_1$ dou yaoqing ___ de] **yi-ge** **nüren**] yongbao-le **ta**$_{2/*1}$
every-CL man DOU invite DE one-CL woman hug-ASP 3SG

'A woman that [every man]$_1$ invited hugged him$_{2/*1}$.' (#multiple-individual reading)

Furthermore, the object RC containing *dou* in (67a) does not presuppose that every man only invited one woman. Note that there is no overt counterpart of *the* in (67), but only an numeral *one*. I assume that *one* imposes a uniqueness requirement, but I am not going to formalize it here. Despite *one* being present in both (67a) and (67b), a sharp contrast with respect to uniqueness is still observed between them.

(67a) is felicitous in a context where some men might invite more than one women as long as they all invited their mom among the women they invited. In comparison, a non-specificational sentence in (67b), which does not license natural-function RCs, is infelicitous in the same context, since the presupposition that every man invited only one woman fails. (67b), if it is not evaluated in the given context, can still have a multiple-individual reading, i.e. there were multiple women invited in total, but it is derived from the RC-embedded QP taking wide scope after long QR, as discussed in section 3, instead of being a functional reading as in (67a).[12] Note that *dou* in the

[12]When the same relative clause without *dou* in (67b) is embedded in a specificational sentence, as shown in (i) below, a natural-functional reading is expected and it should be as felicitous as (67a) in the given context, but a few native speakers I consulted with considered it to be less natural, if not entirely impossible, in the context. I do not have an answer for the contrast between (67a) in the main text and (i) below, but one possibility is that long QR is always preferred over the natural-functional analysis whenever long QR is possible, as in the case below where *dou* is not present and nothing blocks long QR out of the relative clause.

relative clause in (67b) is not compatible with the RC-embedded QP taking wide scope and binding a matrix pronoun. This is expected, since *dou* blocks long QR as discussed in section 4 and a natural-function RC is not admitted in a non-specificational sentence like (67b).

(67) Context: John invited his mother and Sally, Bill invited his mother and Zoe, Jack invited his mother...

a. [$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge** nüren]] shi **ta**$_1$ mama
every-CL man DOU invite DE one-CL woman be 3SG mom
'A woman that [every man]$_1$ invited was his$_1$ mother.' (✓multiple-individual reading)

b. #[$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ (*dou) yaoqing ___ de] **yi-ge** nüren]] yongbao-le **ta**$_1$
every-CL man DOU invite DE one-CL woman hug-ASP 3SG
'A woman [every man]$_1$ invited hugged him$_1$.' ($\forall > \exists$)

The two pieces of data above show that object RCs containing *dou* pattern with natural-function RCs, but not with pair-list RCs, in their distribution. This pattern can be explained under the denotation of *dou* in Y. Xiang (2020): The non-vacuity presupposition of *dou* would block the Absorption rule required for interpreting pair-list RCs, but nothing in the relative clause blocks the natural-function readings. The derivation details are shown below.

For the relative clause containing *dou* shown in (66) and repeated below as (68), *dou* is interpreted above TP and its prejacent clause contains a functional trace, as shown in the LF in (69a). The interpretation of the natural-functional RC is shown in (69b), where the RC is defined only if the prejacent clause of *dou* has at least one sub-alternative according to the definition of *dou*. Then as shown in (69c), the natural-functional RC containing *dou* is well-defined. With the denotations of the prejacent clause and the set of contextually relevant alternatives shown in (69c-i) and (69c-ii) respectively, the set of contextually relevant sub-alternatives asymmetrically entailed by the prejacent clause of *dou* is not empty, as shown in (69c-iii), satisfying the non-vacuity presupposition of *dou*.

(68) [$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ dou invite ___ de] **yi-ge** **nüren**]] shi **ta**$_1$ mama
every-CL man DOU yaoqing DE one-CL woman be 3SG mom
'A woman that every man invited is his mom.' (✓ Multiple individual reading)

(69) There is at least one g such that $\textsc{Dom}([\![\text{RC}]\!]^g) \neq \varnothing$ because,

a. RC = [1 [**dou**$_{\text{C-}pro1}$ [$_S$ [every student]$^2_{[+F]}$ $\_\__2$ likes $\_\_^2_1$]]]

b. $[\![\text{RC}]\!]^g = \lambda f_{ee} : [\![dou_{\text{C-}pro1}(\text{S})]\!]^{g[1\to f_{ee}]}$ is defined. $\textsc{Nat}(f_{ee}) \wedge [\![dou_{\text{C-}pro1}(\text{S})]\!]^{g[1\to f_{ee}]}$
$= \lambda f_{ee} : \textsc{Sub}([\![\text{S}]\!]^{g[1\to f_{ee}]}, \text{C}(f)) \neq \varnothing. \textsc{Nat}(f_{ee}) \wedge ([\![\text{S}]\!]^{g[1\to f_{ee}]} = 1) \wedge$
$\forall q \in \textsc{Sub}([\![\text{S}]\!]^{g[1\to f_{ee}]}, \text{C}(f))[O(q) = 0]$

c. For any f_{ee},

i. $[\![\text{S}]\!]^{g[1\to f]} = 1$ iff $\forall x[\textsc{student}(x) \to \textsc{like}(x, f(x))]$

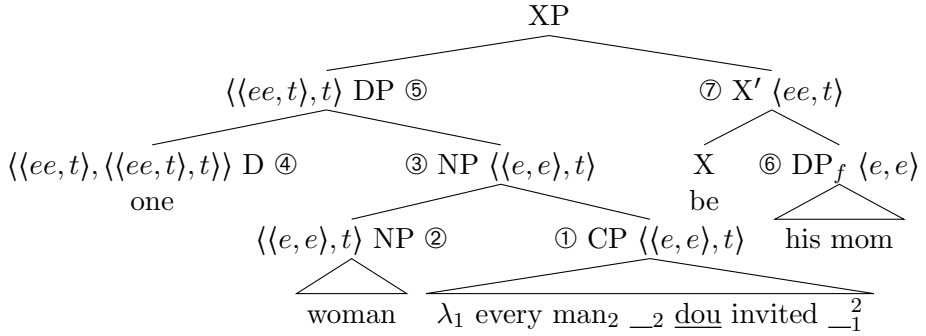
ii. $\text{C}(f) = \{Q_{ett}(\lambda x.\textsc{like}(x, f(x))) \mid Q_{ett}$ is a relevant quantificational expression$\}$

(i) ?#[$_{RC}$ mei-ge nanren yaoqing __ de] yi-ge [$_{Head}$ nüren] shi ta mama
every-CL man invite DE one-CL woman be 3SG mom
'A woman every man invited was his mother.'
(It seems to presuppose that every man hugged only one woman.)

iii. $\textsc{Sub}([\![\text{S}]\!]^{g[1\to f]},\text{C}(f)) \subseteq \{$[[some students]]$(\lambda x.\textsc{like}(x, f(x))),$
[[most students]]$(\lambda x.\textsc{like}(x, f(x))),$
[[at least one student]]$(\lambda x.\textsc{like}(x, f(x))), ...$
[[more than half of the students]]$(\lambda x.\textsc{like}(x, f(x))), ...\}$

To compose the natural-functional RC with the rest of the clause, I assume that nouns and generalized quantifiers have functional interpretations as well. The LF and derivations for (68) are shown in (70) and (71).

(70)



(71) a. $[\![①]\!] = \lambda f.\textsc{Nat}(f) \wedge \forall x[\textsc{man}(x) \to \textsc{invite}(x, f(x))]$

b. $[\![②]\!] = \lambda f.\forall x \in \textsc{Dom}(f) \to \textsc{woman}(f(x))$

c. $[\![③]\!] = \lambda f.\textsc{Nat}(f) \wedge \forall x \in \textsc{Dom}(f)[\textsc{woman}(f(x))] \wedge \forall x[\textsc{man}(x) \to \textsc{invite}(x, f(x))]$
$= \lambda f.\textsc{Nat}(f) \wedge \forall x \in \textsc{Dom}(f)[\textsc{woman}(f(x)) \wedge \textsc{man}(x) \to (\textsc{invite}(x, f(x)))]$

d. $[\![④]\!] = \lambda P_{<ee,t>}.\lambda Q_{<ee,t>}.\exists g.P(g) \wedge Q(g)$

e. $[\![⑤]\!] = \lambda Q.\exists g.\textsc{Nat}(g) \wedge \forall x \in \textsc{Dom}(g)[\textsc{woman}(g(x)) \wedge$
$(\textsc{man}(x) \to \textsc{invite}(x, g(x)))] \wedge Q(g)$

f. $[\![⑥]\!] = \lambda x\imath y.\textsc{mother-of}(y, x)$

g. $[\![\text{X}]\!] = \lambda h\lambda h'.h' = h$ (cross-categorial *be*)

h. $[\![⑦]\!] = \lambda h'.h' = \lambda x\imath y.\textsc{mother-of}(y, x)$

i. $[\![\text{XP}]\!] = 1$ iff $\exists g.\textsc{Nat}(g) \wedge \forall x \in \textsc{Dom}(g)[\textsc{woman}(g(x)) \wedge (\textsc{man}(x) \to \textsc{invite}(x, g(x)))]$
$\wedge (\lambda h'.h' = \lambda x\imath y.\textsc{mother-of}(y, x))(g)$
$= 1$ iff $\exists g.\textsc{Nat}(g) \wedge \forall x \in \textsc{Dom}(g)[\textsc{woman}(g(x)) \wedge (\textsc{man}(x) \to \textsc{invite}(x, g(x)))]$
$\wedge g = \lambda x\imath y.\textsc{mother-of}(y, x)$

To summarize, object RCs containing *dou* are compatible with a natural-functional reading: A multiple-individual reading is available when they are embedded in specificational sentences, and they do not presuppose that each man only invited one woman as seen in (67). The next subsection discusses why object RCs containing *dou* cannot be pair-list RCs, and why subject RCs containing *dou* are not compatible with either type of functional reading.

5.3 Pair-list RCs and subject RCs with *dou*

As shown in the English and Hebrew data in section 5.1, non-specificational sentences only admit pair-list RCs, but not natural-function RCs, due to a type-mismatch. Mandarin object RCs containing *dou* pattern with natural-function RCs and are not compatible with non-specificational sentences, as shown in (66b) and repeated below in (72). The unavailability of the multiple-individual reading suggests that the relative clause containing *dou* in (72) cannot be interpreted as a pair-list RC.

(72) *Object RC in a non-specificational sentence*

[$_{DP}$[$_{RC}$ [**mei-ge nanren**]$_1$ dou yaoqing ___ de] **yi-ge nüren**] yongbao-le **ta**$_{*1}$
every-CL man DOU invite DE one-CL woman hug-ASP 3SG

'A woman that [every man]$_1$ invited hugged him$_{*1}$.' (#multiple-individual reading)

The incompatibility of *dou* with pair-list RCs can be attributed to that Mandarin, unlike English and Hebrew, does not use Absorption at all and thus Mandarin RCs can never be analyzed as pair-list RCs, which requires Absorption. As discussed in section 3, since long QR of an embedded QP is possible out of a Mandarin pre-D relative clause, there is no need to resort to the pair-list analysis to derive the same scoping effects, as in English and Hebrew where postnominal RCs do not allow long QR out of relative clauses.

A piece of empirical evidence further suggests that Mandarin may not have pair-list RCs. As mentioned in section 3.2, long QR correctly predicts that the in a prenominal post-D RC, the RC embedded QP is no longer able to take wide scope, as shown in (27) and repeated below in (73). If pair-list RCs were available in Mandarin, then the RC-embedded QP would be able to take wide scope, as in postnominal pair-list RCs in English and Hebrew, contrary to fact.

(73) wo du-guo [$_{DP}$ **san-ben** [$_{RC}$ **mei-ge xuesheng** xihuan _ de] [$_{Head}$ shu]]
1SG read-ASP three-CL every-CL student like DE book
'I have read three books that every student likes.'
3 > ∀: three books in total
*∀ > 3: more than three books in total

However, why pair-list RCs and Absorption are not available in Mandarin still needs to be explained. Absorption was proposed first to account for the subject-object asymmetry in questions containing quantifiers. According to Chierchia (1993), the unavailability of the pair-list reading in a question containing a QP in the object position, such as (74a), as opposed to (74b), can be attributed to that the object QP cannot undergo Absorption into the *wh*-operator, since it would cross over the functional gap, causing a WCO. As in English, Mandarin questions also show a subject-object asymmetry, as seen in (75). If Absorption is not used in Mandarin, the absence of the pair-list reading in (75b) needs to be attributed to a WCO caused by QR of the object QP over the *wh*-phrase, or to the impossibility to QR an object QP over the subject in Mandarin.

(74) English questions containing quantifiers

a. *QP in subject*
Who did **every man** invite ___? (✓Pair-list)

b. *QP in object*
Who ___ invited **every man**? (*Pair-list)

(75) Mandarin questions containing quantifiers

a. *QP in subject*

mei-ge nanren yaoqing-le **shui**?
every-CL man invite-ASP who

'Who did every man invite? (✓ Pair-list)

b. *QP in object*

shui yaoqing-le **mei-ge nanren**?
who invite-ASP every-CL man

'Who invited every man?' (*Pair-list)

I leave the difference between Mandarin and English with respect to Absorption open for future research, but even if Absorption and pair-list RCs were available in Mandarin, *dou* would block Absorption, and the incompatibility of *dou* with pair-list RCs shown in (72) would still be expected.

As shown in (64a) and repeated below in (76), Absorption requires the subject QP to be absorbed into the relative operator at [Spec, CP]. The LF of the relative clause after Absorption is shown in (77a), where the associate of *dou* is an individual denoting gap left by Absorption. Then the rest of the relative clause including *dou*, labeled as S′, has the denotation shown in(77b) according to the definition of *dou*. The non-vacuity presupposition of *dou* is not satisfied, because there is no assignment g such that for any f and x, the prejacent clause of *dou* $[\![\mathrm{S}]\!]^{g[1\to f,2\to x]}$, as shown in (77c-i), always has sub-alternatives given the set of contextually relevant alternatives (77c-ii). For example, when x is substituted with an atomic entity, $[\![\mathrm{S}]\!]^{g[1\to f,2\to x]}$ does not asymmetrically entail anything, and thus the set of contextually relevant sub-alternatives is empty, as shown in (77c-iii); the prejacent clause of *dou* has sub-alternatives only when x is substituted with non-atomic expressions. Hence, the non-vacuity presupposition of *dou* is not always satisfied after Absorption applies.

(76) *Absorption*
...[DP ...[RC Op_f [TP QP_a...]]]... → ...[DP ...[RC [Op_f QP_a]...]]^a_f...

(77) After Absorption, there is no g such that for any f and x, assuming $[\![\mathrm{C}]\!]^{g[1\to f,2\to x]}$ =C, $\textsc{Dom}([\![\mathrm{S}']\!]^{g[1\to f,2\to x]}) \neq \varnothing$, because

a. RC = [[Op_1 [every man]$_2$] [S′ **dou**$_{\text{C-}pro1}$ [S [$\_\__2$]$_{[+\mathrm{F}]}$ likes $\_\_^2_1$]]]

b. (Following Sharvit (1999): Appendix B.(71).3)
$[\![\mathrm{S}']\!]^g = \lambda x_e.\lambda f_{ee} : [\![dou_{\text{C-}pro1}(\mathrm{S})]\!]^{g[1\to f,2\to x]}$ is defined. $[\![dou_{\text{C-}pro1}(\mathrm{S})]\!]^{g[1\to f,2\to x]}$
$= \lambda x_e.\lambda f_{ee} : \textsc{Sub}([\![\mathrm{S}]\!]^{g[1\to f,2\to x]}, \mathrm{C}(f)) \neq \varnothing. [\![\mathrm{S}]\!]^{g[1\to f,2\to x]} = 1 \wedge$
$\forall q \in \textsc{Sub}([\![\mathrm{S}]\!]^{g[1\to f,2\to x]}, \mathrm{C}(f))[O(q) = 0]$

c. Suppose a random function f and an **atomic** entity x,
(i) $[\![\mathrm{S}]\!]^{g[1\to f,2\to x]} = 1$ iff $\textsc{like}(x, f(x))$
(ii) $\mathrm{C}(f) = \{\textsc{like}(y, f(y)) \mid y_e \text{ is a relevant individual}\}$
(iii) $\textsc{Sub}([\![\mathrm{S}]\!]^{g[1\to f,2\to x]}, \mathrm{C}(f)) = \varnothing$

Since the non-vacuity presupposition of *dou* would fail if Absorption were to apply, object RCs containing *dou* are not compatible with pair-list RCs and thus are unable to be embedded in non-specificational clauses, which only admit pair-lsit RCs. The asymmetry with respect to matrix clause type in object RCs is explained.

Finally, the absence of the multiple-individual reading in Mandarin subject RCs containing regardless of the matrix clause type is also expected. As discussed in section 5.1, a functional trace underlies both natural-function and pair-list RCs. If the functional trace is in the subject position, as in a subject relative clause, the object QP needs to cross over the functional trace, in order scope over it in a natural-function RC or bind the double-layered trace in a pair-list RC, which would lead to WCO. Hence, Mandarin subject RCs containing *dou* cannot be analyzed as either natural-function or pair-list RCs, and the multiple-individual reading is missing regardless of the matrix clause type.

5.4 Summary

To summarize, section 4 and section 5 together account for the special effects of *dou* in Mandarin relative clauses. The non-vacuity presupposition of *dou* blocks long QR and Absorption, as shown in section 4 and section 5.3, but not the natural-functional reading, as shown in section 5.2. Hence, the patterns observed with relative clauses containing *dou* (column 5 and 6 in Table 1) are explained: When a relative clause containing *dou* is embedded in a non-specificational sentence, no exceptional-scope effect is observed, but when it is embedded in a specificational sentence, the exceptional-scope effects seem to reappear, but they are in fact a consequence of natural-functional readings, instead of scope taking.

6 Remaining issues

6.1 Alternative approaches

Wu and Larson (2019) propose a novel analysis to account for the distinction between relative clauses and simple transitive clauses with respect to scope interactions in Mandarin. They attribute the distinction to the presence of an additional TopP for subjects (distinguished from the TopP for topicalization) above TP in Mandarin simple transitive clauses, whose [iTOP] feature requires the subject DP to move from [Spec, TP] to [Spec, TopP]. By contrast, Mandarin RCs do not have any additional projection above TP, since their left peripheries are shown to be reduced; therefore, as in English simple transitive clauses, the subject stays in [Spec, TP].

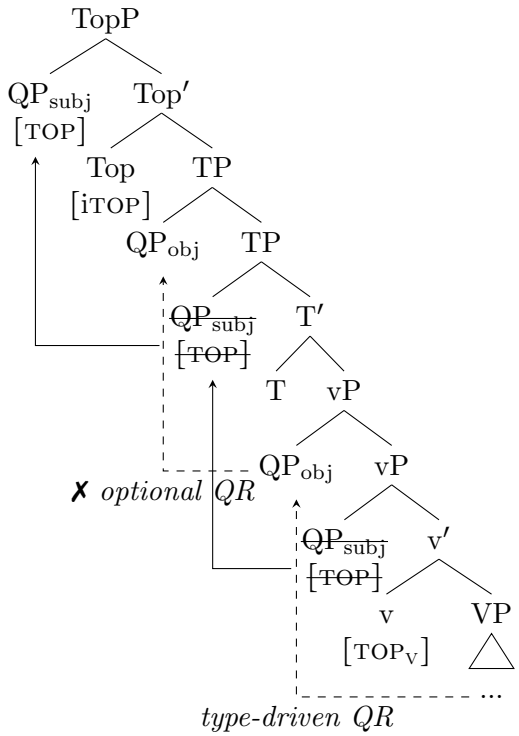
Assuming successive cyclic QR and strong Scope Economy, they show in (78) that optional QR of the object QP in Mandarin simple transitive clauses is not allowed, because the first step of the optional QR from [Spec, vP] to [Spec, TP] does not create any semantic effect, violating Scope Economy. In Mandarin RCs, on the other hand, since the left periphery has been reduced and a subject QP stays in [Spec, TP], the step of QR from [Spec, vP] to [Spec, TP] creates a new scope relation, as shown in (79), and thus obeys Scope Economy.

Their analysis offers a novel insight to the scope rigidity in Mandarin simple transitive clauses, in comparison to English's relatively flexible scope relations. However, there are several theoretical and empirical shortcomings with the analysis. First, they seem to assume that QR is a postsyntactic operation, which can occur after reconstruction, and that despite being postsyntactic, QR is successive cyclic. The assumptions of the timing and successive-cyclicity of QR are similar to ones assumed in Cecchetto (2004) and this paper. However, it is unclear why the successive-cyclicity forces QR to stop at [Spec, TP] before moving to [Spec, TopP] as shown in (78), since TP is not a phase.

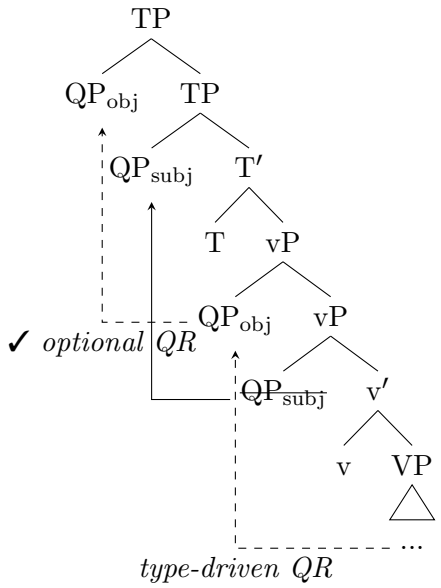
Second, their analysis for the scope flexibility in Mandarin relative clauses is unable to capture the *dou* effects. To account for the absence of the wide-scope reading of the RC-embedded QP in object RCs containing *dou*, they are forced to say that *dou* blocks reconstruction of the RC head, but as seen in section 4, there does not seem to be any direct argument for such a restriction imposed by *dou* both theoretically and empirically. Lastly, it predicts no asymmetry between object and subject RCs, even in postnominal RCs in English and other languages, but the prediction that English subject RCs allow the RC-embedded object QP to take wide scope over the RC head does not seem to be borne out.

Since scope rigidity of Mandarin matrix clauses is not the focus of the current paper, the analysis I am arguing for does not provide a direct solution for it. However, one possibility is that Mandarin subject QPs never reconstruct for scope. As argued for in Hornstein (1995), Johnson and Tomioka (1997), Sauerland and Elbourne (2002) among others, the English scope ambiguity

(78)



(79)



between subject and object QPs can only be derived from reconstruction of subject QPs into vP. It is possible that Mandarin subject QPs never reconstruct back into vP for scope. I have no concrete answer for why subject reconstruction for scope is impossible in Mandarin, but the scope interaction between a subject QP and negation, shown in (80), provides some promising evidence. Unlike an English subject QP in (80a), the Mandarin one in (80b) cannot be interpreted as taking narrow scope relative to negation. The absence of the scope interaction in (80b) supports the possibility that a subject QP in Mandarin does not reconstruct for scope.

(80) a. Every boy didn't arrive. $(\forall > \neg)$
$(\neg > \forall)$

b. **mei-ge nanhai** dou **mei** dao.
every-CL boy DOU not arrive
'Every boy didn't arrive.' $(\forall > \neg)$
$(*\neg > \forall)$

6.2 Quantifier-types restriction

Not all kinds of quantifiers admit the exceptional-scope effects in Mandarin RCs. As discussed in section 2.3, it is hard for quantifiers other than *every* in the RC-embedded QPs to take wide scope and bind matrix pronouns, and the restriction is much stronger in subject RCs than in object RCs.

The restriction on quantifier types is puzzling, but not surprising, since it is not unique to Mandarin relative clauses. For example, telescoping as shown in (81) also seems to be restricted to universal distributive quantifiers (Roberts 1987; Roberts 1989; Keshet 2008). Only the quantifier *each*, but not *only one*, is able to "telescope"into the second clause, binding the pronouns *he* and *his*. More specifically, (81b) is true only when there is only one candidate who walked to the stage and that candidate accepted his diploma, in contrast with (81a) where there are multiple candidates and

the pronouns covary with the QP *each candidate*, or (81c) where there can be multiple candidates who waled to the stage but only one of them accepted his diploma.

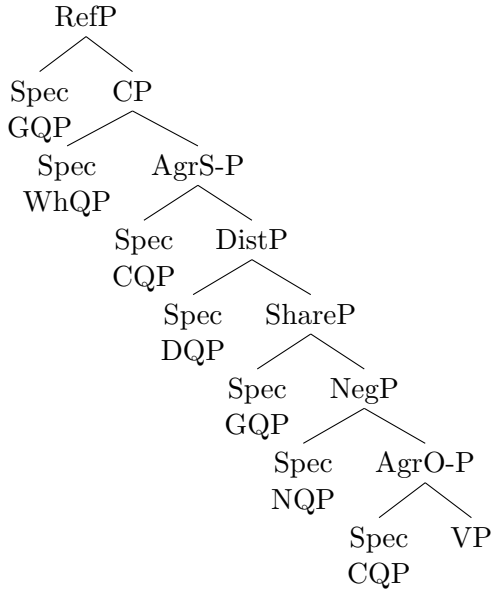
(81) a. Each degree candidate walked to the stage. He took his diploma from the Dean and returned to his seat (Roberts 1987).

b. #Only one degree candidate walked to the stage. He accepted his diploma.

c. Only one degree candidate walked to the stage and accepted his diploma.

As suggested in Keshet (2008), the restriction on quantifier type is attributed to independent reasons related to the hierarchical structure for different quantifiers proposed in Beghelli and Stowell (1997). Similarly, the restriction on quantifier types in Mandarin relative clauses, especially subject relative clauses, with respect to exceptional-scope taking might also be due to the different positions of different quantifiers in the hierarchical structure. As shown in (82), counting quantifier phrases (CQPs) such as *at least two* and *most* in object positions are in a lower position, i.e. AgrO-P, in comparison to distributive QPs (DQPs) in DistP.

(82)



It is possible that quantifiers lower than DistP can only QR to DistP and do not have further independent motivation to QR beyond, while those in positions higher than DistP, including DistP, can undergo QR to a higher position. It is then expected that a RC-embedded object QP headed by a non-distributive quantifier in a Mandarin subject RC is unable to take wide scope over the RC-external QP. However, it is unclear why DistP would be a boundary for further QR, and I will leave the puzzle on quantifier-type restriction open for future research.

7 Conclusion

In this paper, I have proposed that the exceptional-scope effects in Mandarin prenominal pre-D relative clauses, where the RC-embedded QP is able to scope and bind pronouns out of the RC, are derived by a long QR of the RC-embedded QP out of the relative clause to the edge of the containing DP. In addition to accounting for the presence of the exceptional-scope effects, this analysis also captures the cases where the exceptional-scope effects are absent. When the particle *dou* is present in a relative clause, or when a relative clause is in a prenominal post-D position, long QR fails to apply. Furthermore, when long QR fails to apply, a functional RC analysis may be resorted to

to fill the hole, which accounts for the multiple-individual reading of an object RC containing *dou* embedded in a specificational sentence.

A long QR approach to the Mandarin puzzle provides further support that it is not a finite clause boundary, but rather a phase boundary and lack of motivation to QR successive-cyclically through the phase boundary that create the locality constraint on QR. Once a phase head can be circumvented by an independent movement, such as the movement of relative clauses to a prenominal pre-D position to derive the right linear order in Mandarin, QR can take place across a finite relative clause boundary without violating any locality constraints on QR. However, the Complex NP Constraint for overt movement will not be relaxed in Mandarin in the same manner, since overt movement might be subject to additional constraints, such as cyclic linearization (Fox and Pesetsky 2005), and lack of an escape hatch at the edge of CP might still block overt movement out of complex NP islands.

A prediction of the long QR approach is that other languages with prenominal pre-D relative clauses are expected to allow long QR out of relative clauses as well. Cross-linguistic data are needed to test whether the prediction is borne out. Another question left open for future research is the asymmetry between Mandarin subject RCs and object RCs in the availability of the exceptional-scope effects. Subject RCs are more restrictive than object RCs with respect to the size of a relative clause and the type of the RC-embedded quantifier. I discussed potential syntactic and processing accounts for the asymmetry, but further research into the nature of QR and quantifiers is needed before reaching a conclusive answer.

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