Appendices — 'Relative measurement and scope in Mandarin' (published in *Glossa*)

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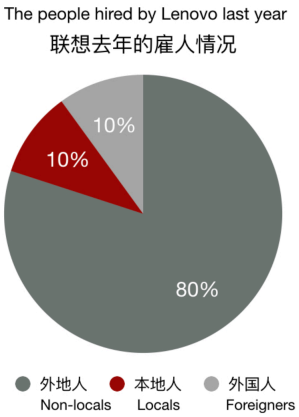
Appendix A: An online survey of non-conservative readings

An online survey was conducted to collect native Mandarin speakers' judgments on the non-conservative reading of a relative measurement construction (RM construction, for short). The result of the survey confirmed the availability of non-conservative readings.

Materials There were eight test items in Task I: four targets and four controls. Each target item presented participants with a 'proportion' diagram. The participants were asked to evaluate, based on the diagram, the acceptability of sentences with relative measure phrases (RM phrase, for short). A sample target task is given in Figure 1a. In this task, the diagram represented the people that Lenovo hired last year. A participant needed to judge whether the test sentence was acceptable based on the diagram. A 7-point Likert scale was used for the task. The minimum point on the scale was '0' (completely unacceptable), and the maximum was '6' (completely acceptable). A participant was free to choose any point between 0 and 6 down to a decimal place. The intermediate point 3 was labeled 'marginally acceptable'.

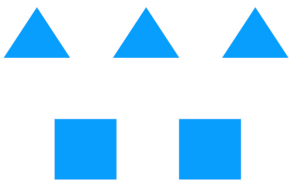
Figure 1: Target items and control items



Is the following sentence acceptable based on the diagram?

Qunian, Lianxiang gu-le 10% de bendiren.
last.year Lenovo hire-Asp 10% DE locals

(a) A sample target item



Is the following sentence acceptable based on the diagram?

Shangtu zhishao you san-ge zhengfangxing.
last.picture at.least have three-CL square

(b) A sample control item

If a participant could interpret the sentence as the non-conservative reading, i.e., 'Lenovo hired 10% locals', s/he would assign a higher score to the sentence. Since the total number of the locals was not given, the partitive reading, i.e., 'Lenovo hired 10% of the locals', was uninterpretable. If a participant only interpreted the test sentence as the conservative reading, s/he would assign a low score to the item.

The four control items involved RM phrases and were uncontroversially unacceptable given the diagrams, as shown in Figure 1b. The responses to the control items were used to compare with the responses to the target items and also served to check whether participants paid enough attention during the experiment. All the items were pseudo-randomized, and were presented in Simplified Chinese characters, on the online survey platform Qualtrics.

Participants A total of 63 persons participated in this study. They were mostly college students studying in various universities in Mainland China, recruited with the generous help of their course instructors. A small number of the participants might be personal friends of these instructors and hence might not be college students. Since the survey was anonymous, these participants could not be told apart. All of the participants volunteered to participate in the survey and received no compensation.

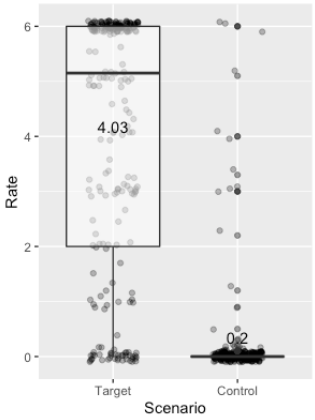


Figure 2: Results

Results A total of 63 online surveys were collected. There was a participant who failed more than one control items, so their data were excluded. The results are summarized in Figure 2. The mean judgment rating of target items is 4.05, while the mean judgment rating of the control items is just 0.2. The difference between the target items and the control items is statistically significant ($\beta = -3.8331$, $\text{SE} = 0.2067$, $t = 18.55$,$p < 0.001$). The results successfully verify the presence of the non-conservative readings. Most of the participants (35) offered high ratings ($\geqslant 3.5$) to three or four target items. This suggests that a large proportion of the population have access to non-conservative readings. Nevertheless, there were 10 participants who assigned low ratings ($\leqslant 2$) to three or four target items. In addition, 17 participants did not consistently assign a rating, i.e. they might assign high ratings to two target items but low ratings to the other two. It indicates that, although non-conservative readings are available for RM constructions in Mandarin, individual variation indeed exists. An explanation of the individual variation is left for future research.

Appendix B: More data on scope interaction

Necessity modals

(1) Wǒmēn **bìxū** zhāo sānfēzhīyī de qiúzhìzhě.
we have.to recruit one.third LNK candidates

a. Conservative: have to > one third candidates (*de dicto*)
'For any world w compatible with rules in the actual world, there are some candidates in w such that they make one third of all locals and we recruit them in w.'

b. Conservative: one third candidates > have to (*de re*)
'There are some candidates in the actual world such that they make one third of all candidates and, for any world w compatible with the order or rule in the actual world, we recruit them in w.'

(2) Wǒmēn **bìxū** zhāo sānfēzhīyī de RUǍNJIÀN gōngchéngshī (sānfēzhīèr de we have.to recruit one.third LNK software engineers two.thirds LNK YÌNGJIÀN gōngchéngshī).
hardware engineers

a. Non-Conservative: have to > one third candidates (*de dicto*)
'For any world w compatible with rules in the actual world, there is a maximal set X of software engineers in w such that X makes up one third of all the engineers that we hire in w.'

b. #Non-conservative: one third candidates > have to (*de re*)
'There is a maximal set of software engineers X in the actual world such that X makes up one third of all engineers and, for any world w compatible with the rules in the actual world, we hire X in w.'

Possibility modals

(3) Wǒmēn **kěyǐ** jiè sānfēnzhīyī de xiǎoshuō.
we can borrow one.third LNK novels

a. Conservative: can > one third novels (*de dicto*)
'For some world w conforming to what is allowed in the actual world, there is a maximal set X of novels in w such that X makes up one third of the novels and we borrow all X in w.'

b. Conservative: one third novels > can (*de re*)
'There is a maximal set X of novels in the actual world such that X makes up one third of all novels and, for some world w conforming to what is allowed in the actual world, we borrow all X in w.'

(4) Wǒmēn **kěyǐ** jiè sānfēnzhīyī de XIǍOSHUŌ (sānfēnzhīèr de ZÁZHÌ).
we can borrow one.third LNK novels two.thirds LNK magazines

a. Non-conservative: can > one third novels (*de dicto*)
'For some world w conforming to what is allowed in the actual world, there is a maximal set X of novels in w such that X makes up one third of the books that we borrow in w.'

b. #Non-conservative: one third novels > can (*de re*)
'There is a maximal set X of novels in the actual world such that, for some world w conforming to what it is allowed in the actual world, X makes up one third of the materials that we borrow in w.'

Universal quantifiers

(5) **Měigè xuéshēng dōu** dú-le sānfēnzhīyī de xiǎoshuō.
every student DIST read-PRF one.third LNK novels

a. Conservative: every student > one third novels
'For each student y, there is a maximal set X of novels such that X makes up one third of the novels and y read each of X.'

b. ??Conservative: one third novels > every student
'There is a maximal set X of novels such that X makes up one third of all novels and, for each student y, y read each of X.'

(6) **Měigè xuéshēng** dōu dú-le sānfēnzhīyī de XIǍOSHUŌ (sānfēnzhīèr de
every student DOU read-PRF one.third LNK novels two.thirds LNK
ZÁZHÌ).
magazines

a. Non-conservative: every student > one third novels
'For each student y, there is a maximal set X of novels such that X makes up one third of the materials that y read.'

b. #Non-conservative: one third novels > every student
'There is a maximal set X of novels such that, for each student y, X makes up one third of the materials that y read.'

Proportional quantifiers

(7) **Dàbùfen de xúeshēng** dōu dú-le sānfēnzhīyī de xiǎoshūo.
most LNK students DIST read-PRF one.third LNK novels

a. Conservative: most students > one third locals
'There is a maximal set Y of students such that Y makes up more than half of all students and, for each y of Y, there is a maximal set X of novels such that X makes up one third of all novels and y read each of X.'

b. #Conservative: one third locals > most students
'There is a maximal set X of novels such that X makes up one third of all novels and, for each x of X, there is a maximal set Y of students such that Y makes up more than half of all students and each y of Y read x.'

(8) **Dàbùfen de xúeshēng** dōu dú-le sānfēnzhīyī de XIǍOSHUŌ (sānfēnzhīèr
most LNK students DIST read-PRF one.third LNK novels two.thirds
de ZÁZHÌ).
LNK magazines

a. Non-conservative: most students > one third novels
'There is a maximal set Y of students such that Y makes up more than half of all students and, for each y of Y, there is a maximal set X of novels such that X makes up one third of all books read by y.'

b. #Non-conservative: one third novels > most students
'There is a maximal set X of novels such that X makes up one third of the books read by a set Y of students such that Y makes up more than half of all students.

Appendix C: A remark on the scope relation of a degree quantifier and an intensional verb

In Section 3.4, I discussed why the scope taking of a proportional number expression cannot cross another scope-bearing element. The spirit of the explanation lies in the interaction between the minimality operator **min** and a degree plurality. To the extent that other number expressions do not exhibit this kind of interaction, they are predicted to be able to take wide scope over another scope-bearing element. In fact, it is well known that many number expressions can take scope over an intensional verb (Heim

2000; Hackl 2000; Nouwen 2010; Lassiter 2012; Kennedy 2015; a.o.). Consider (9). This sentence has a reading where the modified number expression *fewer than five* scopes over the verb *need*. In this reading, (9) expresses that anyone who comes up with more than four brilliant ideas is not excluded from getting tenure.

(9) At MIT one needs to come up with fewer than five brilliant ideas to get tenure.
⇝ There is a number n such that $n < 5$ and for any world compatible with MIT's requirement a person comes up with at least n ideas to get tenure.

A similar scope relation is also observed for proportional number expressions. Consider (10), which can express that a tech company's needs are satisfied as long as the software engineers hired in this company make up at least one third of all employees.

(10) Yì-jiā kējì gōngsī xūyào gù sānfēnzhīyī de RUǍNJIÀN gōngchéngshī.
one-CL tech company need hire one.third LNK software engineers
⇝ There is a fraction n such that $n = \frac{1}{3}$ and, in all worlds compatible with a tech company's needs, at least n of the engineers hired by the company are software engineers.

This reading is not a typical *de re* or *de dicto* reading. On one hand, there are no particular software engineers that a tech company needs to hire. This excludes the *de re* reading. On the other hand, a tech company's needs could be satisfied in a world where two thirds of engineers hired by Huawei are software engineers. This excludes the *de dicto* reading. In order to derive this reading, we may assume that the proportional number expression *one third* can be further decomposed into two parts, as in (11).

(11) a. $[\![\text{one third}]\!]^g = \lambda D.\mathbf{max}\{d : D(d)\} = \frac{1}{3}$ Type: (d → t) → t

b. $[\![\texttt{prop}_c]\!]^g = \lambda d \lambda \mathscr{F} \lambda P \lambda w. \frac{\mathbf{min}\{d : \mathscr{F}(d)(P \cap g_c)(w)\}}{\mathbf{min}\{d : \mathscr{F}(d)(g_c)(w)\}} = d$

defined only if Type: d → (d → Q) → Q

for any P' and w', $\mathbf{min}\{d : \mathscr{F}(d)(P')(w')\}$ is an atomic degree

The fraction expression denotes a quantifier over degrees of proportion (Solt 2018), whereas the null item `prop` denotes a function from degrees of proportion to degree quantifiers. As a consequence, the fraction expression can scopally interact with the intensional verb *need*. In addition, it does not encode the definedness condition that `prop` has. So, the problem of QR-ing a proportional number expression across an intensional verb (see Section 3.4.2) is not expected when the fraction expression scopes over *need*.

The scope relation illustrated in (10) is not restricted to an RM construction with a nonconservative reading. It is also available with an RM construction with a conservative reading, as in (12).

(12) Líbái xūyào dú sānfēnzhīyī de xiǎoshuō.
Libai need read one.third LNK novels
⇝ There is a fraction n such that $n = \frac{1}{3}$ and in all worlds compatible with Libai's needs, he reads n of the novels.

It shows that the scope taking of the fraction expression is independent of that of `prop`. Specifically, in (10) and (12), the fraction expression takes DP-external scope; whereas, `prop` takes DP-external scope in (10) but DP-internal scope in (12).

Appendix D: A brief comparison with Pasternak & Sauerland (to appear)

Pasternak & Sauerland (to appear) have studied German RM constructions comprehensively. In their analysis of non-conservative readings, a proportional number expression in German (consisting of a number expression and the morpheme *Prozent* 'percent') denotes a degree quantifier, as in (13). In an RM construction, the proportional number expression takes DP-external scope at the edge of the sentence root node.

(13) $[\![40\%]\!] = \lambda D.\mathbf{max}(D) \geqslant \frac{40}{100} \times \mathbf{max}(\mathbf{dom}(D))$ Type: $(d \to t) \to t$

At first glance, the analysis proposed in this paper is similar to Pasternak & Sauerland's. In fact, these two analyses diverge from each other in the following three areas:

i. Pasternak & Sauerland assign different structures to 'conservative' RM phrases and 'non-conservative' RM phrases , because of the fact that the two types of RM phrases in German exhibit syntactic–morphological differences. However, I assume that 'conservative' and 'non-conservative' RM phrases share the same surface structure, since there is no syntactic–morphological distinction between the two types of RM phrases in Mandarin.

ii. Pasternak & Sauerland does not assume that the NP complement in a 'non-conservative' RM phrase undergoes covert focus movement. By contrast, the covert focus movement is crucial to the derivation of 'non-conservative' readings in my analysis. In Section 4.2, assuming such covert movement sheds light on a structural asymmetry involving 'non-conservative' RM phrases .

iii. Pasternak & Sauerland do not discuss the scope patterns of RM phrases and their implementation does not incorporate degree pluralities (although as far as I can see, their implementation is compatible with degree pluralities).

Accordingly, the main empirical issue and the target language in my analysis and Pasternak & Sauerland's are not the same. A fair comparison is only possible after a cross-linguistic investigation of the scope of RM phrases , which is beyond the scope of the present paper. So, I leave it for future research.

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