

On the Inverse Trace Conversion and maximal informativeness analysis of Japanese internally-headed relative clauses: A reply to Erlewine and Gould 2016

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Abstract In this response to [Erlewine & Gould 2016](#), we show that an account of internally-headed relative clauses using Inverse Trace Conversion and the maximal informativeness semantics for definites of [von Fintel et al. 2014](#) does not derive the observed interpretations when the internal head is quantified by certain downward entailing quantifiers and no interpretation at all for non-monotonic and some upward entailing quantifiers. We then argue that the cases that [Erlewine & Gould \(2016\)](#) claim to be a newly identified interpretation of internally-headed relatives are actually headless relatives.

Keywords: Internally-headed relative clauses; quantification; Maximal informativeness; trace conversion; entailment; headless relative clauses

1 Introduction

[Erlewine & Gould \(2014, 2016\)](#) claim to identify a previously unrecognized interpretation for Japanese internally-headed relative clauses (IHRCs): the salient set reading. [Erlewine & Gould \(2016\)](#) (henceforth E&G) develop an account of this interpretation within a unified theory of internally, externally, and so-called doubly headed relatives. To separate the salient set interpretation of IHRCs from their standard readings, E&G invoke the maximal informativeness semantics for definites of [von Fintel et al. 2014](#). In this response, we show that the proposal using maximal informativeness does not, in fact, deliver the standard readings for IHRCs with quantified internal heads: it either derives the wrong reading (for certain downward entailing quantifiers) or none at all (for non-monotonic quantifiers and certain upward entailing quantifiers).¹

¹ When we refer to monotonicity in this paper, it is the monotonicity on the first argument.

A secondary goal of this response is to suggest that the salient set reading does not arise from an IHRC but rather a headless relative with a gap. The confusion arises, we claim, because the postposition or case marker that introduces the gap site does not surface (Kameshima 1989, 1990, Matsumoto 1997), giving the illusion of an IHRC.

2 The so-called salient set reading and Inverse Trace Conversion

E&G focus on IHRCs of the form in (1). These have an external quantifier *zenbu* ‘all’ and an internal head (IH) modified by a numeral *ringo-o mit-tsu* ‘three apples’.

- (1) Junya-wa [IHRC [Ayaka-ga [IH ringo-o **mit-tsu**] mui-ta]-no]-o
 Junya-TOP Ayaka-NOM apple-ACC three-CL peel-PAST-NO-ACC
 zenbu tabe-ta.
 all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled **three** apples].’ (E&G: 7(13))
 ‘Ayaka peeled **three** apples and Junya ate all of them.’

The expected interpretation of such an IHRC with an internal head is one in which the numeral takes internal scope, rather than taking the whole RC as its restrictor (as it would in an externally headed relative). On the regular reading Ayaka peels three apples and Junya eats those three apples. The salient set reading, on the other hand, arises when the IHRC refers not to the three peeled apples but to a set of apples of which the peeled apples are three. The pictures in (2) and (3) from E&G demonstrate two scenarios where this larger set is made salient. The salient set reading is true in context (2) if Junya ate the entire group of apples that Ayaka peeled three of. That larger group numbers 12. Context can play a large role in making one particular superset more salient. For instance, in context (3), two groups or baskets of apples are presented, one of which Ayaka peeled three apples from. The salient set reading here is one in which the IHRC refers to this basket of six apples, hence the interpretation that Junya ate all of those six apples.

- (2)  (3) 

Interpretation of (1) in Context (2):

- (i) Junya ate the three peeled apples.
- (ii) Junya ate the twelve apples.

Regular Reading
Salient Set Reading

Interpretation of (1) in Context (3):

- (i) Junya ate the three peeled apples. *Regular Reading*
 (ii) Junya ate the six apples in the first group. *Salient Set Reading*²

One popular analysis of Japanese (and Korean) IHRCs is an E-type anaphora analysis. Essentially, the IHRC is semantically interpreted as a clause coordinated with the matrix clause, resumed by cross-sentential anaphora (Hoshi 1995, Shimoyama 1999, 2001, Kim 2007). The paraphrase in (4) illustrates this analysis:

- (4) [Ayaka peeled **three apples**] and [Junya ate all of **them**].

It is claimed in E&G that the Japanese translation of (4) using cross-sentential anaphora does not have the salient set reading.³ If the salient set reading is indeed a reading of IHRCs, this observation could be added to the list of other differences between cross-sentential anaphora and IHRCs, as discussed in, for example, Hoshi 1995, Shimoyama 1999, 2001, Kim 2007, and Grosu & Landman 2012. We will show in Section 5.3, however, that there is an alternative syntactic parse, a headless relative parse, that would derive the salient set reading without any special mechanisms. This syntactic parse is independently available and we show that it can account for cases that the proposal in E&G cannot.

As noted, E&G attempt to derive the regular and the salient set readings from a single structure for IHRCs. They propose that all relative clauses derive from a

² Looking at this particular example, one might ask whether the salient set reading is an independent reading from the regular reading, as the former seems to entail the latter, as pointed out to us by Name Withheld (p.c.). We can see that the salient set reading is indeed an independent reading when we look at other examples where entailment no longer holds between the two readings. For instance, in the following example in (i), the matrix quantifier *zenbu* ‘all’ has been replaced by *huta-tsu-dake* ‘only two’. The salient set reading is true when he ate any two, peeled or unpeeled, out of all the apples in context (2), or out of all the apples in the first group in context (3). In such a context, however, the regular reading is not always true. For the regular reading to be true, the apples that Junya eats must be two of the three peeled apples in both contexts (2)/(3).

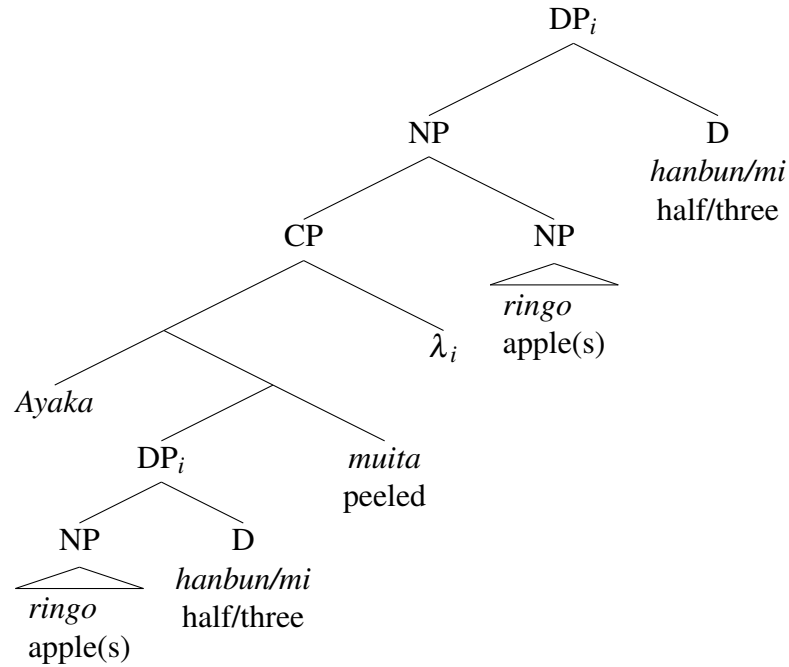
- (i) Junya-wa [[Ayaka-ga [ringo-o mit-tsu] mui-ta]-no]-o huta-tsu-dake tabe-ta.
 Junya-TOP Ayaka-NOM apple-ACC three-CL peel-PAST-NO-ACC two-CL-only eat-PAST
 ‘(lit.) Junya ate only two of [that Ayaka peeled three apples].’
 ‘Ayaka peeled three apples and Junya ate only two of them.’

We note in passing that the salient set reading sounds less accessible with matrix numerals as in this case, as opposed to *zenbu* ‘all’ that is used in all of E&G’s examples. Intuitively, it has to do with the lack of overt head. The reading comes out more naturally when *no* is replaced by *sono ringo* ‘the/those apple(s)’ (i.e., a doubly-headed relative). As far as we can see, the system proposed in E&G is not sensitive to different types of external quantifiers as the head is filled with a copy of the internal head.

³ See Erlewine & Gould 2014 (p. 168), however, for the opposite claim that the salient set reading is observed in cross-sentential anaphora, using an example from English.

‘proto-relative’ structure in which the head and its determiner are clause-internal (regardless of whether they are externally-, internally- or doubly-headed, or in English or Japanese). In (5), the internal head is copied and merged external to the RC. (They assume a process of Late Merge that gives a resulting structure in which the head’s determiner is re-positioned so the higher head NP and the CP predicate form a constituent to the exclusion of the higher copy of the determiner.)

(5) *Japanese proto-relative structure after Copy and Late Merge* (E&G: 18(31))



In order to interpret such structures, with multiple copies of the determiner, the general strategy since Fox 2002 is to employ a rule of trace conversion. In standard trace conversion, a lower copy’s quantificational determiner is replaced by a definite determiner, which is then bound by the higher quantifier. Trace conversion is demonstrated below with quantifier raising (QR). In (6), the generalized quantifier *every apple* QRs. As a movement process, QR leaves a copy in its merge position, giving rise to the narrow syntactic representation in (6b). As it stands, (6b) cannot be semantically interpreted. Fox 2002 (see also Sauerland 1998) proposes a rule that effectively converts the lower copy into a co-varying definite description (6c) bound by the higher copy.

- (6) Interpreting movement (QR) with copies:
- a. Ayaka peeled every apple.
 - b. *Narrow syntax*
[every apple]₁ Ayaka peeled [every apple]₁ (QR with copy)
 - c. *LF after Trace Conversion*
[every apple] λx . Ayaka peeled [the apple x] (Fox 2002)

Trace conversion has two components: variable insertion and determiner replacement. Variable insertion (7a) adds an (identity) predicate that introduces a variable, and this predicate intersects with the NP. This essentially equates the lower copy with the variable indexed by movement. The second component is determiner replacement: the quantifier in the lower copy is replaced by the definite determiner THE.

- (7)
- a. *Variable insertion*
every λy .apple(y) \rightarrow every [λy .apple(y) & y = x]
 - b. *Determiner replacement*
every [λy .apple(y) & y = x] \rightarrow THE [λy .apple(y) & y = x]

Erlewine 2014 proposes an innovation with Inverse Trace Conversion. In Inverse Trace Conversion (ITC) it is the higher copy that is converted to a definite description. Inverse Trace Conversion captures various properties of scope reconstruction. An example is shown below with the narrow scope reading of the universally quantified subject *every apple* with respect to negation (E&G:13):

- (8) Every apple isn't rotten.
- a. *Narrow syntax*
[every apple]₁ NEG [_{VP} [every apple]₁ is rotten]
 - b. *LF after Inverse Trace Conversion*
[THE λy .apples(y)] λX . NEG [_{VP} [every [λy .apple(y) & y \sqsubseteq X] is rotten]

In this case, variable insertion introduces a predicate that mereologically relates the lower copy to the higher copy: the individuals in the restrictor of the quantified lower copy constitute an atomic individual part (\sqsubseteq) of the plurality of apples that the higher copy refers to.

E&G use ITC to compose IHRCs, which as noted, involve movement on their account just as externally headed relatives do. The difference is in which copy is pronounced. In IHRCs, the lower copy is pronounced and the higher copy undergoes ITC. Applying the process to the syntactic representation in (5), this results in the

higher copy as a definite description, while allowing the quantifier to be interpreted in the lower copy (Hoshi 1995, Shimoyama 1999, 2001).

- (9) *LF after Inverse Trace Conversion (ITC)* (E&G: 26⁴)
- a. $[\text{DP THE } [\text{NP apple } [\text{CP } \lambda X [\text{Ayaka peeled } [\text{DP three } [\text{NP } [\text{NP apple(s)}] [\lambda y. y \sqsubseteq X]]]]]]]$
 - b. $\llbracket \text{DP} \rrbracket = \llbracket \text{THE} \rrbracket (\lambda X. X \text{ apple(s) and Ayaka peeled three [atomic apple parts of X]})$

The IHRC as a whole, then, denotes the plurality of apples such that Ayaka peeled three apples in that plurality. This of course is the salient set reading: the IHRC denotes the larger set from which the lower quantifier takes its domain. The different contexts in (2)/(3) make different domain sets salient, hence the referent of the whole IHRC differs. The referent of the IHRC DP in (9) is the apple sum $1+2+3+4+5+6+7+8+9+10+11+12$ in context (2), and $1+2+3+4+5+6$ in context (3).

3 Derivation of the regular reading

To generate the regular reading—where the IHRC denotes just the three peeled apples in the examples above—E&G invoke a recent analysis of definite descriptions found in von Fintel et al. 2014. To appreciate this innovation, it is helpful to review the earlier, standard, analysis of definite descriptions (Sharvy 1980, Link 1983), which took them to denote the unique maximal object (or degree). For instance, the definite description in (10) denotes the maximal object that satisfies the restriction, i.e. the maximal number that is the number of children that John has. A formal definition is given in (11):

- (10) the number of children that John has
- (11) $\llbracket \text{THE } \varphi \rrbracket$ (where φ is of type $\langle \alpha, t \rangle$) is defined only if there is a unique maximal object x such that $\varphi(x)$ is true (based on the ordering on elements of type α). The reference of *the* φ (when defined) is this unique maximal element. (Sharvy 1980, Link 1983)

The restrictor of THE is the set of degrees in (12a). Given the context in (12b), the unique maximal object in that set is 4 (12c,d): 5 and greater are not in the restrictor set, and 3 and below are not maximal compared to 4.

- (12) a. $\lambda d. \text{ John has } d\text{-many children}$
 b. Context: John has exactly four children.

⁴ For ease of presentation, we use the English word order in the Japanese LF.

- c. $1 < 2 < 3 < \mathbf{4} < 5 < 6 < 7 < \dots$
- d. THE returns the unique maximal object satisfying the restriction
(E&G: 26–27)

von Fintel et al. (2014) address a case where the maximal object/degree is not the denotation of the definite. Take (13):

- (13) the amount of walnuts sufficient to make a pan of baklava
(von Fintel et al. 2014: 168)

If we used the maximality-based semantics of ‘the’ in (11), this definite would be undefined. For instance, if 150g of walnuts is enough then so, technically, is 200g, 700g, and so on. But this means there’s no maximal object/degree that satisfies the restrictor, hence the definite is undefined. von Fintel et al. 2014’s solution is to redefine maximality in terms of informativeness, not degrees. This maximal informativeness semantics for THE (MIS) is given below.

- (14) **Maximal informativeness semantics for THE (MIS)**
(von Fintel et al. 2014)
- a. $\llbracket \text{THE} \rrbracket(\varphi)$ is defined in w only if there is a uniquely maximal object x , based on the ordering \geq_φ , such that $\varphi(w)(x)$ is true. The reference of “the φ ” (when defined) is this maximal element.
 - b. For all x, y of type α and property φ of type $\langle s, \langle \alpha, t \rangle \rangle$, $x \geq_\varphi y$ iff $\lambda w. \varphi(w)(x)$ entails $\lambda w. \varphi(w)(y)$.

The recipe here is, as before, to look at the individuals that satisfy the restrictor, but unlike the standard account, we collect the propositions each of these individuals/degrees form with the restrictor. The next step is then to identify the proposition that entails all the other propositions.

- (15)
- \vdots
 - a. ‘that 170 g of walnuts is sufficient to make a pan of baklava’
 - b. ‘that 160 g of walnuts is sufficient to make a pan of baklava’
 - c. **‘that 150 g of walnuts is sufficient to make a pan of baklava’**
 - d. ‘that 140 g of walnuts is sufficient to make a pan of baklava’
 - e. ‘that 130 g of walnuts is sufficient to make a pan of baklava’
 - \vdots

Which propositions should we consider? Well, if 150g is sufficient, then amounts higher than 150 are too simply because of what *sufficient* means.⁵ So

⁵ This is a simplification. See von Fintel et al. 2014, footnotes 3 and 4, and Buccola 2015.

all such numbers satisfy the property and generate propositions that are under consideration. But propositions that involve amounts lower than 150g are not considered—that’s why (15d,e) are crossed out.⁶ Now, of the remaining candidate propositions, we ask which one entails all others: well if 150g is sufficient—again, just because of what *sufficient* means—this entails that any number greater than 150 is sufficient too. But this means the most informative proposition is the one that involves the lowest sufficient amount. What makes all the difference here compared to the original Sharvy/Links cases is that the restrictor property involves the predicate *sufficient* which reverses the entailment relations:

- (16) a. Property: $\lambda d.d$ -much walnuts is sufficient to make a pan of baklava
 b. Context: 150 g of walnuts is sufficient to make a pan of baklava
- (17) Whenever ‘d-much walnuts is sufficient to make a pan of baklava’ is true, it is necessarily true that ‘d’-much walnuts is sufficient to make a pan of baklava’ where $d' \geq d$.

On the MIS account, the correct prediction is made that the referent of the definite description in (13) is the smallest amount of walnuts that would yield a true proposition, namely 150 g.

Returning to IHRCs, E&G claim that the MIS account of definites derives the regular reading. Consider the IHRC in (1), repeated below, on its regular reading where it denotes the three apples that are peeled by Ayaka. On the analysis of IHRCs as derived from the proto-Japanese relative in (5), along with ITC, the IHRC is a definite description of the form in (19a), where the property ϕ is defined in (19b).

- (18) Junya-wa [_{IHRC} [Ayaka-ga [_{IH} ringo-o **mit-tsu**] mui-ta]-no]-o
 Junya-TOP Ayaka-NOM apple-ACC three-CL peel-PAST-NO-ACC
 zenbu tabe-ta.
 all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled **three** apples].’
 Ayaka peeled three apples and Junya ate all those three. (regular reading)
- (19) a. THE ϕ
 b. $\phi = “\lambda X.\lambda w. X$ apple(s) and Ayaka peeled three [atomic apple parts of X] in w”

In the regular reading of example (1)/(18), the referent of the IHRC DP is 1+2+3 in either context (2) or context (3). The LF is repeated from (9) above.

⁶ We are pretending in (15) that we weigh walnuts only in units of 10g.

(20) LF after Inverse Trace Conversion (ITC)

- a. $[_{DP} \text{ THE } [_{NP} \text{ apple } [_{CP} \lambda X [\text{Ayaka peeled } [_{DP} \text{ three } [_{NP} [_{NP} \text{ apple(s)}] [\lambda y. y \sqsubseteq X]]]]]]]$
- b. $[[DP]] = [[THE]](\lambda X. \lambda w. X \text{ apple(s) and Ayaka peeled three [atomic apple parts of X] in } w)$

(E&G: 26)

To determine the referent of (20b) on the MIS account of definite descriptions, we consider the propositions that result from saturating the property complement of THE with various pluralities—what we will call the ‘whole’ or ‘X-slot’ produced by ITC. Further, we consider only those propositions that are true in the context in which we evaluate the definite description. In context (2) (it works the same way with context (3)), the list of propositions in (21) are the true propositions generated by saturating the property with plural individuals. There are many such plural individuals, since not only are groups like 1+2+3+4 possible, but also 1+2+3+7 or 1+2+3+9+12. Vertical ellipsis indicate a non-exhaustive list. We are also using an *at least* semantics for the numeral (deriving the *exactly* interpretation by implicature), because an *exactly* semantics, being non-monotonic, would not generate any entailments. We take this up more fully in Section 4.1. The propositions listed below are a short hand: where we say A. peeled at least 3 apples of 1+2+3, we technically mean ‘1+2+3 are apples and Ayaka peeled at least 3 atomic apple parts of 1+2+3.’⁷

- (21) a. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3 \text{ in } w$
- b. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+4 \text{ in } w$
- c. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+5 \text{ in } w$
- d. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+5+6 \text{ in } w$
- ⋮
- e. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+4+5 \text{ in } w$
- f. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+4+6 \text{ in } w$

⁷ We are thus not expressing the external head, following E&G (p. 28). However, von Fintel et al. (2014, pp. 172–173) contend with cases in which the external head of a relative and the relative clause differ in their direction of informativity. (von Fintel et al. (2014) describe the predicate $\lambda d. \lambda w. d \text{ is sufficient to make a pan of baklava in } w$ ‘downward’ monotone in terms of informativity and the predicate $\lambda d. \lambda w. \text{ John has } d\text{-many children in } w$ ‘upward’ monotone in terms of informativity. A simple noun like *apples* is ‘upward’ informative.) As von Fintel et al. (2014) point out, when a head and a relative with different monotone properties are conjoined, the result is a non-monotone predicate and thus no strongest proposition can be found. E&G’s example in (18) fits this pattern, as the upward monotonic head *apples(s)* and the downward monotonic RC property $\lambda X. \text{ Ayaka peeled at least three apples of } X$ are conjoined. The solution offered in von Fintel et al. 2014 for this issue may apply to (18). The same issue of a mismatch in the direction of informativity arises with the examples we discuss in section 4.2, constituting a problem for the ITC-MIS analysis in addition to the one we discuss in that section.

- ⋮
- g. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+4+5+6 \text{ in } w$
- h. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+10+11+12 \text{ in } w$
- ⋮
- i. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+4+5+6+7 \text{ in } w$
- ⋮
- j. $\lambda w. A. \text{ peeled at least 3 apples of } 1+2+3+4+5+6+7+8+\dots+12 \text{ in } w$

We've collected all the true propositions in the relevant context. At this point the recipe says to step back and identify the entailment relations among these propositions. As E&G show, there *is* an entailment relation among the propositions because whenever you peel at least three atomic apples in X, it is necessarily true that you peeled at least three apples in Y, when X is a part of Y:

- (22) 'that Ayaka peeled at least three atomic apple parts of apples X' entails 'that Ayaka peeled at least three atomic apple parts of apples Y' where $X \sqsubseteq Y$

So this means that the smaller the value of X is, the more informative the proposition 'that Ayaka peeled at least three atomic apple parts of apples X' is. The proposition in (21a) entails all other true propositions in (21).

- (23) 'that Ayaka peeled at least three atomic apple parts of apples 1+2+3' entails 'that Ayaka peeled at least three atomic apple parts of apples Y' for all Y such that $1+2+3 \sqsubseteq Y$

On the other hand, there is no entailment when going from a larger plurality to smaller plurality. In general, if someone peels at least three atomic apple parts of X, it does NOT follow that she peeled at least three atomic apple parts of W, where W is a part of X. The proposition in (21j) for instance, can be true in many different situations other than the situation where apples 1, 2, 3 are peeled. For example, (21j) is true in a situation where apples 10, 11, 12 are peeled. In such a situation, however, not all of the other propositions in (21) are true. For instance, (21a)–(21g) are not true. (Other propositions might be: like (21h)).

- (24) 'that Ayaka peeled at least three atomic apple parts of X' does NOT entail 'that Ayaka peeled at least three atomic apple parts of W' where $W \sqsubseteq X$

What all this means is that putting (22) and (24) together, the strongest proposition is (21a), where the number of peeled apples is the same as the plurality from which they are taken, i.e. three. More technically, based on informativeness-based ordering (14b), then, the ordering in (25) follows.

- (25) a. $X \geq_{\varphi} Y$ if and only if ‘that Ayaka peeled at least three atomic apple parts of X’ entails ‘that Ayaka peeled at least three atomic apple parts of Y’
 b. $X \geq_{\varphi} Y$ if and only if $X \sqsubseteq Y$. (E&G: 27)

The ITC-MIS analysis of the regular reading thus correctly predicts that the referent of the IHRC DP in (9) in context (2) or (3) is the apple sum $1+2+3$. Given (14a) and (25), the apple sum $1+2+3$ is the uniquely maximal (or most informative) object in the sense that it creates the most informative or strongest true proposition, *that Ayaka peeled three apple parts of $1+2+3$* . So despite the variable insertion that would initially only give us a referent plurality that properly includes the individuals denoted by the internal head, E&G’s proposal lets the entire IHRC denote just those individuals picked out by the internal head with MIS.

When the internal head is universally quantified, the ITC-MIS account derives the observed reading. Assume a scenario in which Ayaka peels all 12 of 12 apples.

- (26) Junya-wa [[Ayaka-ga dono ringo-mo mui-ta]-no]-o zenbu
 Junya-TOP Ayaka-NOM every apple-MO peel-PAST-NO-ACC all
 tabe-ta.
 eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled **every** apple].’
 ‘Ayaka peeled every apple and Junya ate all of them.’

This is true if Ayaka peeled all 12 apples and Junya ate those apples. This is a regular reading, and the ITC-MIS derives it. The true propositions in this case are:

- (27) a. $\lambda w. A.$ peeled every apple of 1 in w
 b. $\lambda w. A.$ peeled every apple of $1+2$ in w
 \vdots
 c. $\lambda w. A.$ peeled every apple of $1+2+3+4+5+6+7+8+9+10+11+12$ in w

The entailment relations are such that since *every* is downward entailing, only the proposition with the largest value of X entails all other propositions here and is not entailed by any other propositions. So if one peels all of a set X , one does not necessarily peel all of a superset of X . But if one peels all of a set X one necessarily peels all of a subset of X . So the referent of the IHRC DP will be the plural individual that constitutes all 12 apples, as desired.

4 Under-generation

While the ITC-MIS analysis correctly derives the regular reading in the two cases discussed above, there are other instances in which it does not. We divide these into three categories. The first involves internal heads with non-monotonic quantifiers (*exactly n*, *at least/exactly half*). With these, no unique, maximally informative proposition can be identified, hence the IHRC DP is undefined on a regular reading. The second involves a closer look at upward entailing quantifiers, like *at least n* as above and *more than n*. We will show that by overtly signalling *at least n* on the internal head, this has undesired consequences in certain scenarios.

The third category of problems involves (non-universal) downward entailing quantifiers (*fewer than n*, *at most n*), where the ITC-MIS delivers the wrong plural individual as the meaning for the IHRC DP. We will walk through each of these cases as explicitly as possible, illustrating the issues with informal prose for the reader.

4.1 Non-monotonic quantifiers

4.1.1 Exactly n

In the last section we noted that it is crucial to interpret numerals with an *at least* semantics. With an *exactly* semantics, there is no unique strongest proposition. Consider (18) again with an *exactly* semantics for the numeral:

- (28)
- a. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3 in w
 - b. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+4 in w
 - c. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+5 in w
 - d. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+5+6 in w
 - ⋮
 - e. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+4+5 in w
 - f. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+4+6 in w
 - ⋮
 - g. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+4+5+6 in w
 - h. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+10+11+12 in w
 - ⋮
 - i. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+4+5+6+7 in w
 - ⋮
 - j. $\lambda w.$ A. peeled exactly 3 apples of 1+2+3+4+5+6+7+...+11+12 in w

As the reader can verify, no proposition here will entail any other regardless of whether the whole is ‘larger’ or ‘smaller’:

- (29) a. ‘that Ayaka peeled exactly 3 apples of W’ does NOT entail ‘that Ayaka peeled exactly 3 apples of X’, where $W \sqsubseteq X$.
 b. ‘that Ayaka peeled exactly 3 apples of Y’ does NOT entail ‘that Ayaka peeled exactly 3 apples of X’, where $X \sqsubseteq Y$.

The proposition that one peels exactly n of some set does not entail that one peels exactly n of some super set. So not only does the semantics fail to pick out the plural individual that is required on the regular reading (18) but the IHRC DP will be undefined since there is no unique strongest proposition. As von Stechow et al. (2014) explicitly state (pp. 169–170), this would lead to a presupposition failure if there is more than one object that fulfills the predicate description, which is the case here. Crucially, though, a Japanese IHRC with an internal head *overtly* quantified by *exactly* is possible and felicitously has a regular reading, so that the IHRC refers to the plurality of three apples peeled:

- (30) Junya-wa [IHRC [Ayaka-ga [IH ringo-o **choodo mit-tsu**]
 Junya-TOP Ayaka-NOM apple-ACC exactly three-CL
 mui-ta]-no]-o zenbu tabe-ta.
 peel-PAST-NO-ACC all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled **exactly three** apples].’
 Ayaka peeled exactly three apples and Junya ate all those three. (regular reading)

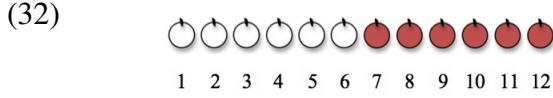
We do not see, then, how a regular reading arises with predicates that contain non-monotonic quantifiers.

4.1.2 *At least half/exactly half*

The non-monotonic quantifier *half* causes similar problems. Consider (31) with *hanbun* ‘half’ in the context in (32), namely 1+2+3+4+5+6 out of the twelve apples are peeled by Ayaka. Example (31) has the regular reading, namely the reading that is true when Junya ate the six peeled apples, 1+2+3+4+5+6. Under this reading, the denotation of the IHRC DP in (33) should be 1+2+3+4+5+6.

- (31) Junya-wa [[Ayaka-ga ringo-o **hanbun** mui-ta]-no]-o zenbu
 Junya-TOP Ayaka-NOM apple-ACC half peel-PAST-NO-ACC all
 tabe-ta.
 eat-PAST

‘(lit.) Junya ate all of [that Ayaka peeled **half** of the apples].’ (E&G:5)
 ‘Ayaka peeled **half** of the apples and Junya ate all of them.’



This is the representation that the syntax generates for the IHRC DP:

(33) $\llbracket \text{DP} \rrbracket = \llbracket \text{THE} \rrbracket (\lambda X. \lambda w. X \text{ apples and Ayaka peeled } \mathbf{half} \text{ of the [atomic apple parts of } X] \text{ in } w)$

The first step of the MIS recipe is to assemble the true propositions, given a context, in which the property ϕ —the argument of THE in (33)—is saturated by alternative individuals. In the case of ITC-generated sentences, the alternative propositions to consider are ones where the value of the whole (X) are different. In the context in (32), where apples 1 through 6 out of twelve apples are peeled, plural individuals (filling the X slot of (33), the ‘whole’) that yield true propositions under an ‘at least’ semantics for *hanbun* ‘half’ are given in (34).

- (34) a. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1 \text{ in } w$
 b. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2 \text{ in } w$
 c. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3 \text{ in } w$
 d. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4 \text{ in } w$
 e. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5 \text{ in } w$
 f. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5+6 \text{ in } w$
 g. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5+6+7 \text{ in } w$
 h. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5+6+7+8 \text{ in } w$
 i. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5+6+7+8+9+10 \text{ in } w$
 j. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5+6+7+8+9+10+11 \text{ in } w$
 k. $\lambda w. A. \text{ peeled at least } 1/2 \text{ of } 1+2+3+4+5+6+7+8+9+10+11+12 \text{ in } w$

Note first off, that an *at least* semantics for *hanbun* ‘half’ is required, since on an *exactly* semantics, the only proposition in (34) that would be true would be (34k). This would make apples 1–12 the referent of the IHRC DP. We still do not generate the regular reading. So as with the case of overt *exactly n* we just saw above in (30), we can similarly overtly add *exactly* to *half* in (31). The referent of the IHRC DP remains the same (the six apples) but the ITC-MIS derives twelve apples as its denotation.

Let’s turn now to an *at least* semantics for *half*. There is a simplification in (34): there are, in fact, many other true propositions we could list as well. For instance the proposition that Ayaka peeled at least half of the atomic apple parts of 4+5+6+7+8+9. Or that Ayaka peeled at least half of 1+2+3+10+11+12, among

many others. We do not list these here, because we can show that even without those additional propositions, the target proposition—the one that would generate the regular reading under ITC-MIS—is not the uniquely maximally informative proposition. In order to derive the regular reading on the MIS, it would have to be the case the proposition (34f) be the most informative one—where the DP refers to the 6 peeled apples. (Intuitively, this is where the ‘whole’ is equal to the part.) We ask what kind of entailment relations exist among these propositions, first going from a smaller to larger value of the ‘whole’ (i.e. the X slot). In general, if someone peels at least half of the atomic apple parts of apples X, it does NOT follow that she peels at least half of the atomic apple parts of apples Y, where X is a part of Y. The proposition in (34f) can be true in a situation, for example, where apples 1, 2, 3 are peeled. None of the propositions with larger plural individuals in (34g)–(34k) is true in such situation. Thus,

- (35) ‘that Ayaka peeled at least half of the atomic apple parts of X’ does NOT entail ‘that Ayaka peeled at least half of the atomic apple parts of Y’ where $X \sqsubseteq Y$.

So, (34f) does not entail the propositions (34g)–(34k).

Now let’s look at the entailment relations between propositions going from a larger value of the whole X to smaller. In general, if Ayaka peeled at least half of the atomic apple parts of apples X, it does NOT follow that Ayaka peeled at least half of the atomic apple parts of apples W, where W is a part of X. The proposition in (34f) can be true in a situation, for example, where apples 4, 5, 6 are peeled. None of the propositions with smaller plural individuals in (34a)–(34e) is true in the situation. Thus,

- (36) ‘that Ayaka peeled at least half of the atomic apple parts of X’ does NOT entail ‘that Ayaka peeled at least half of the atomic apple parts of W’ where $W \sqsubseteq X$.

There is no entailment relation among these propositions; *a fortiori* there is no (unique) strongest, most informative proposition, and so no way for the definite to refer (without resorting to a salient set reading). So the ITC-MIS analysis predicts that there is no regular reading available in sentence (31), contrary to fact. More specifically, the ITC-MIS analysis fails to derive the fact that the six peeled apples 1+2+3+4+5+6 are the referent of the IHRC DP, because the proposition where the ‘whole’ is 1+2+3+4+5+6 is not stronger than any other (true) proposition.

E&G (pp. 28–29) do discuss the ‘half’ example in (31), but only in connection to the fact that it is false in context (2), where only apples 1, 2, 3 are peeled out of the twelve apples.⁸ Let’s assume that Junya ate these three peeled apples. The

⁸ It is claimed in E&G (p. 5, 30) that the sentence (31) does not have the regular reading but only has the salient set reading in context (3). It is not clear to us that the reported judgment is robust. Perhaps

sentence in (31) is judged to be false or infelicitous, intuitively because it is not the case that Ayaka peeled half of the apples. But for E&G, the infelicity has a different source. E&G note that “there is no productive entailment pattern between ϕ_{half} -propositions corresponding to different apple sums” (p. 28). They note further that the uniqueness presupposition of THE is not met, as $1+2+3+4+5+6$, as well as $1+2+3+7+8+9$, for example, make the relevant proposition true. There is thus no uniquely maximal object as required by MIS in (14), and the denotation of the IHRC DP is undefined. In any event, while E&G’s account may correctly rule out (31) in context (2), so will the existing E-type account (Hoshi 1995, Shimoyama 1999) or that of Grosu & Landman 2012. Furthermore, the ITC-MIS approach cannot deliver the regular reading in context (32) as shown above.

4.2 Upward monotonic quantifiers: *At least/more than n*

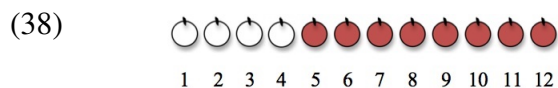
At the beginning of Section 3 we showed how the ITC-MIS analysis derived the regular reading for internal heads quantified by numerals (under an *at least* semantics). However, here we show that the ITC-MIS analysis does not deliver the correct regular reading with a slightly modified context—indeed, it turns out to deliver no regular reading at all.

Consider the sentence in (37), which is just like (18) except that *at least* is overtly included.

- (37) Junya-wa [IHRC [Ayaka-ga [IH ringo-o **sukunakutomo mit-tsu]**
 Junya-TOP Ayaka-NOM apple-ACC at.least three-CL
 mui-ta]-no]-o zenbu tabe-ta.
 peel-PAST-NO-ACC all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled **at least three** apples].’
 Ayaka peeled at least three apples and Junya ate all of them.

Now, by adding *at least* we have removed the *exactly* implicature that (18) has. This then allows for (37) to be true in scenarios where Ayaka peeled more than 3 apples. So for instance, (37) is true in the scenario in which Ayaka peeled 4 apples and Junya ate those 4 apples (38). (The choice of *at least* by the speaker could be for whatever reason: (ir)relevance, ignorance.)

the regular reading may not be easily accessed to some speakers because they would have to focus on the first group of apples. However, this line of speculation about the reported lack of the regular reading would not fit with the ITC-MIS analysis. Given the proposed derivation of the salient set reading—namely that when there is a salient set in the context, one can ignore MIS—it is not clear to us why the same set is not salient enough to make the regular reading available (‘half of the salient set’).



But given the meaning of the quantifier, it turns out that in this context there are several equally informative true propositions. This renders the IHRC DP undefined. Here's why: in the context in (38), true propositions of the appropriate form derived by ITC are listed below, with replacement of the X slot by various pluralities constituting three through twelve apples. Note that we include various pluralities for which it is true that Ayaka peeled at least three (atomic) parts of that plurality: this means there are four propositions where the plurality itself is constituted by just three apples: apples 1+2+3 (39a), apples 1+3+4 (39b), apples 2+3+4 (39c), and apples 1+2+4 (39d). There is of course the 'target' proposition in (39e), where the plurality filling the 'whole' slot is four, and this should be the proposition that MIS would need to pick out so that these four apples are the denotation of the IHRC DP in (37). In addition, we need to include larger pluralities that are extensions for each of (38a–d) as well as (38e), which are given—with many elided—in (39f) onward.

- (39)
- a. λw . A. peeled at least 3 apples of 1+2+3 in w
 - b. λw . A. peeled at least 3 apples of 1+3+4 in w
 - c. λw . A. peeled at least 3 apples of 2+3+4 in w
 - d. λw . A. peeled at least 3 apples of 1+2+4 in w
 - e. λw . A. **peeled at least 3 apples of 1+2+3+4 in w**
 - f. λw . A. peeled at least 3 apples of 1+2+3+5 in w
 - g. λw . A. peeled at least 3 apples of 1+2+3+6 in w
 - ⋮
 - h. λw . A. peeled at least 3 apples of 1+2+3+8+10 in w
 - ⋮
 - i. λw . A. peeled at least 3 apples of 1+2+3+4+5 in w
 - j. λw . A. peeled at least 3 apples of 1+2+3+4+5+6 in w
 - k. λw . A. peeled at least 3 apples of 1+2+3+4+5+6+7 in w
 - ⋮
 - l. λw . A. peeled at least 3 apples of 1+2+3+4+5+6+7+8+9+10+11+12 in w

The first problem is that the target proposition (39e) is not the strongest, since (39e) is entailed by all of (39a)–(39d) and (39e) does not itself entail any of (39a)–(39d).

Moreover, there is no unique strongest proposition since no proposition in (39a)–(39d) entails any of the other in that group. So on the MIS semantics, a definite would be undefined (and even if it were, it would deliver a plurality of three as the denotation, which is not the meaning of the IHRC DP in (37) in the context in (38)). And it turns out that the propositions in (39a–d) are not necessarily stronger

than all of the other propositions: for instance, (39b) does not entail (39f). (And we would find similar instances for (39a,c,d).) So not only are (39a-d) not stronger than each other—nor the correct proposition to generate the denotation of the IHRC DP in (37)—none are necessarily stronger than all of the other propositions. (They may entail some—(39a) entails (39f), for instance—but not all.) The most salient problem, to repeat, is that (39e) (which would allow the IHRC DP to denote the four apples) is not the strongest proposition and therefore we cannot account for the meaning of (37).

Similar considerations will arise with *n-yori takusan* ‘more than n’, as expected. We provide a brief sketch using sentence (40).

- (40) Junya-wa [IHRC [Ayaka-ga [IH ringo-o **huta-tsu yori takusan**
 Junya-TOP Ayaka-NOM apple-ACC two-CL than many
 mui-ta]-no]-o zenbu tabe-ta.
 peel-PAST-NO-ACC all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled **more than two** apples].’
 ‘Ayaka peeled more than 2 apples and Junya ate all of them.’

The sentence in (40) is true in the context above in (38), where Ayaka peels four apples of a set of twelve, if Junya ate those four apples (i.e. the maximal apples Akaya peeled) but not if Junya ate just three. As in the case with *sukunakutomo mit-tsu* ‘at least three’ above, we fail to generate the apple sum $1+2+3+4$ as the denotation of the IHRC DP. We can see this by replacing ‘at least three’ with ‘more than two’ in the propositions in (39): ‘that Ayaka peeled more than two atomic apple parts of $1+2+3+4$ ’ is not the strongest proposition among the true propositions.

- (41) a. $\lambda w. A.$ peeled more than 2 apples of $1+2+3$ in w
 b. $\lambda w. A.$ peeled more than 2 apples of $1+3+4$ in w
 c. $\lambda w. A.$ peeled more than 2 apples of $2+3+4$ in w
 d. $\lambda w. A.$ peeled more than 2 apples of $1+2+4$ in w
 e. $\lambda w. A.$ **peeled more than 2 apples of $1+2+3+4$ in w**
 f. $\lambda w. A.$ peeled more than 2 apples of $1+2+3+5$ in w
 g. $\lambda w. A.$ peeled more than 2 apples of $1+2+3+6$ in w
 :
 h. $\lambda w. A.$ peeled more than 2 apples of $1+2+3+8+10$ in w
 :
 i. $\lambda w. A.$ peeled more than 2 apples of $1+2+3+4+5$ in w
 j. $\lambda w. A.$ peeled more than 2 apples of $1+2+3+4+5+6$ in w
 k. $\lambda w. A.$ peeled more than 2 apples of $1+2+3+4+5+6+7$ in w
 :
 :


1. λw . A. peeled more than 2 apples of $1+2+3+4+5+6+7+8+9+\dots+12$ in w

In the next section we will turn to left downward monotonic quantifiers. Aside from the left downward monotonic quantifier *dono-N-mo* ‘every’, the ITC-MIS procedure fails to derive the regular reading in each of these cases.

4.3 Downward monotonic quantifiers: At most n /fewer than n

When the internal head bears the quantificational expression *ookutomo itsu-tsu* ‘at most five’ as shown in (42), the ITC-MIS account cannot derive the regular reading and in fact produces a larger-set reading due to the entailment patterns of *at most n*.

- (42) Junya-wa [Ayaka-ga **ringo-o ookutomo itsu-tsu** muita-no]-o zenbu
 Junya-wa Ayaka-NOM apple-ACC at.most five-CL peeled-no-ACC all
 tabeta.
 ate
 ‘(lit.) Junya ate all of [that Ayaka peeled at most five apples]
 Ayaka peeled at most five apples and Junya ate those (five) apples.

- (43) 
 1 2 3 4 5 6 7 8 9 10 11 12

This sentence, on the regular reading, is true in context (43), where Ayaka peels four apples of a larger set of twelve, and where Junya eats those four apples. Following the ITC-MIS procedure, we collect the true propositions that vary over the ‘whole’ slot as provided by ITC. In this context, examples of true propositions are in (44):

- (44) a. λw . A. peeled at most 5 apples of 1 in w
 b. λw . A. peeled at most 5 apples of $1+2$ in w
 c. λw . A. peeled at most 5 apples of $1+3$ in w
 \vdots
 d. λw . A. peeled at most 5 apples of $1+2+3$ in w
 e. λw . A. peeled at most 5 apples of $1+2+4$ in w
 \vdots
 f. λw . A. **peeled at most 5 apples of $1+2+3+4$** in w
 \vdots
 g. λw . A. peeled at most 5 apples of $1+2+3+4+5$ in w
 \vdots
 h. λw . A. peeled at most 5 apples of $1+2+3+4+5+6+7+8+9+10+11+12$ in w

To obtain the regular reading with MIS, we would want the proposition in (44f) to be the maximally informative one; that would set the denotation of the IHRC DP to be the X , where $X = 1+2+3+4$. There is a unique strongest proposition in (44) but it is not (44f). If Ayaka peeled at most five apples of apples $1+2+3+4$, it does not follow that she peeled at most five apples when we add two more apples—maybe she peeled those two apples. Now, if Ayaka peeled at most five apples of apples $1-12$, it *does* follow that she peeled at most five apples in a subset of those twelve. That makes (44h) the most informative proposition, and so under MIS the referent of the IHRC DP is the twelve apples that Ayaka peeled at most five of. That’s what E&G call the salient set reading, which is possible. But the ITC-MIS account does not derive the regular reading, contrary to fact.

As expected, similar considerations apply when the internal head is quantified by *ringo-o mut-tsu miman* / *mut-tsu-yori sukunai ringo* ‘fewer than six apples’. The sentence in (45) can be true in the context in (43) with a regular reading (viz. that Junya ate all the apples that Ayaka peeled—in this case $1+2+3+4$):

- (45) Junya-wa [Ayaka-ga {ringo-o mut-tsu miman / mut-tsu-yori
 Junya-wa Ayaka-NOM {apple-ACC six-CL fewer.than / six-CL-than
 sukunai ringo-o} muita-no]-o zenbu tabeta.
 few apple-ACC} peeled-no-ACC all ate
 ‘(lit.) Junya ate all of [that Ayaka peeled fewer than six apples]’

We can use the list in (44) above, with ‘at most 5’ replaced by ‘fewer than 6’, as the story here is the same as the one for ‘at most 5’. To derive the regular reading, we would want ‘that Ayaka peeled fewer than 6 atomic apple parts of $1+2+3+4$ ’, our target proposition, to be the most informative, so that $1+2+3+4$ can be the denotation of IHRC DP (viz., ‘the four apples that Ayaka peeled fewer than six of.’). But as with *at most n* , the entailment relations are such that the proposition with the largest value for the X ‘slot’ entails all others. So if one peels fewer than five apples in a set X , it follows that one peels at fewer than five apples in a subset of X . On the other hand, if one peels fewer than five apples in a set Y , it does not follow that one peels fewer than five apple in a superset of Y —maybe that superset includes a peeled apple. So once again, ITC-MIS derives a referent for the IHRC DP that is far ‘larger’ than the regular reading actually is.

In sum, for the downward entailing quantifiers that we have looked at, we derive the regular reading only in the case of the universal. That is because the strongest proposition involves the largest plural individual that meets the description ‘which Ayaka peeled’. This is equivalent to all the apples. For the other downward entailing quantifiers, *at most n* , *fewer than n* , the strongest proposition—the largest plurality for the ‘whole’—does not correspond to the maximal individual that fulfills

the description ‘that which Ayaka peeled’. The E-type strategy (Hoshi 1995, Shimoyama 1999), on the other hand, delivers just this: the referent of the IHRC (or its associated E-type pronoun in the matrix clause) is the maximal individual that is apples that Ayaka peeled—not the maximal individual that Ayaka peeled a subset of apples from.

4.4 Summary

Using various types of quantifiers on internal heads, we have shown that the ITC-MIS analysis is not successful in generating the regular reading. In the next section, we address the salient set interpretation. We first point out problems in deriving this reading from an LF that is shared with the regular reading. We then argue that the sentences that have the salient set reading are not IHRCs at all but surface identical headless relatives.

5 The salient set reading and an alternative

5.1 Salient Sets Restriction

We will now turn to the salient set reading. Notice that with the introduction of MIS, the salient set reading is no longer generated. In order to derive the salient set reading of (1)/(18), the pragmatic condition in (46) is added in E&G. After this condition applies, the referent of the IHRC DP in (9) is the apple sum $1+2+3+4+5+6+7+8+9+10+11+12$ in context (2), and $1+2+3+4+5+6$ in context (3).

- (46) **Salient Sets Restriction (SSR):** The existence of salient sets in the context allows for limiting the set of possible outputs of $\llbracket \text{THE} \rrbracket$ to those salient sets (represented as plural sums). (E&G, 29(56))

The Salient Sets Restriction is intended to “formalize the effect of context in definite description evaluation” (E&G, p. 3), applying generally beyond cases with Inverse Trace Conversion. According to E&G (p. 29), the sentence in (47) is unambiguously interpreted to mean Junya will eat apples 1 and 2 because of the Salient Sets Restriction: it allows us to consider only $1+2$ vs. 3 as possible referents.⁹

- (47) Junya will eat the two apples.

⁹ While the SSR is proposed as a general principle for interpreting definite descriptions, it is assumed that “SSR is generally not active for the resolution of cross-sentential anaphora” (E&G, footnote 23). They are forced to adopt this assumption in order to block the salient set reading from E-type pronouns/definite descriptions in cross-sentential anaphora.

- (48) 

5.2 *A problem in deriving the salient set reading*

In the ITC-MIS analysis, the regular reading and the salient set reading are assumed to be associated with a single syntactic structure for IHRC. A maximal informativeness semantics for definites is supposed to derive the regular reading, while the salient set reading is derived only if there are salient sets in the context, which triggers the pragmatic constraint, the Salient Sets Restriction, to kick in. We will now show (i) that the ITC analysis of the salient set reading makes wrong predictions with certain examples; and in the next subsection (ii) that there is a syntactic parse already available in the narrow syntax from which the salient set reading can be derived without any additional mechanisms, and which does not run into the problem in (i).

The salient set reading of (1), repeated below, is compatible with a scenario where there are some peeled or unpeeled *pears* in the pile, in addition to peeled and unpeeled apples. The sentence is true in context (50).

- (49) Junya-wa [IHRC [Ayaka-ga [IH ringo-o mit-tsu] mui-ta]-no]-o
 Junya-TOP Ayaka-NOM apple-ACC three-CL peel-PAST-NO-ACC
 zenbu tabe-ta.
 all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled three apples].’
 ‘Junya ate all of that which Ayaka peeled three apples of.’
- (50) There are two mixed baskets of six apples and six pears. Ayaka peeled three out of six apples in basket 1, while Tsubasa peeled six out of six apples in basket 2. Junya ate all the twelve apples and pears in basket 1.

The ITC analysis does not predict this reading because in the LF syntax (see (9)) there is a copy of the internal head in the external position, limiting the referent to apple objects. A related problem arises with the example in (51).

- (51) Junya-wa [IHRC [Ayaka-ga [IH ringo-o mit-tsu] mui-ta]-no]-kara
 Junya-TOP Ayaka-NOM apple-ACC three-CL peel-PAST-NO-from
 nashi-o huta-tsu totte tabe-ta.
 pear-ACC two-CL take eat-PAST
 ‘(lit.) Junya took and ate two pears from [that Ayaka peeled three apples].’
 ‘Junya took and ate two pears from what Ayaka peeled three apples of/in.’
 #‘Junya took and ate two pears from the apples that Ayaka peeled three of.’

The relative here, on the ITC account, has a silent external head ‘apple’. But then that would mean that this sentence says that Junya ate two *pears* from a salient set of *apples*, which is non-sensical.¹⁰ Instead, (51) expresses that Junya took two pears from a group of apples *and* pears.

5.3 *Alternative analysis: Headless relative parse*

We suggest that the interpretation of sentences like (1), repeated below in (52), which was taken to represent a new species of internally headed-relative with the parse in (52a) in E&G, are really independently attested headless relatives with the parse in (52b).

- (52) Junya-wa [IHRC [Ayaka-ga [IH ringo-o **mit-tsu**] mui-ta]-no]-o
 Junya-TOP Ayaka-NOM apple-ACC three-CL peel-PAST-NO-ACC
 zenbu tabe-ta.
 all eat-PAST

a. *ITC parse*

[IHRC THE [NP apple(s) [CP λX . Ayaka peeled [IH three apple(s) $\sqsubseteq X$]]]

b. *Headless relative parse*

[THE (one) [CP λx . Ayaka peeled [three apple(s) of x]]]
 \approx ‘that which Ayake peeled three apples of’

The headless relative parse in (52b) does not involve ITC, but rather a standard gap that is the object of a postposition or case marker. It is easy to mistake (52) as something more exotic because postpositions and case markers are deleted as a response to the fact that stranding of postpositions and case markers by relativization is not possible in Japanese. This is shown by the standard externally-headed RC in (54) (built from the independent sentence in (53)). As there is no overt relative pronoun, pied-piping is not an option either, as shown in (55). The result is that the postposition or case marker does not surface, as in (56).¹¹

¹⁰ Erlewine & Gould 2014 (p. 165) brings up the possibility of mixed baskets like this, but their comments do not bear on the conditions tested here.

¹¹ It is beyond the scope of this paper to review the literature on this and related phenomena. For presentational reasons we indicate the position of a gap in the relevant examples, but we are in principle not committed to the gap analysis of such relatives. Some authors in fact argue for a gapless analysis, relying on, for example, null resumptive pro-PPs. See, for example, Kuno (1973), Larson (1987), Kameshima (1989, 1990), Murasugi (1991), Kaplan, Tamar I. and Whitman, John B (1995), Matsumoto (1997).

- (53) Yoko-ga Sota-kara hon-o morat-ta.
 Yoko-NOM Sota-from book-ACC receive-PAST
 ‘Yoko received a book from Sota.’
- (54) *[Yoko-ga <gap>-kara hon-o morat-ta] hito
 Yoko-NOM -from book-ACC receive-PAST person
 ‘the person who Yoko received a book from’
- (55) *[∅ -kara [Yoko-ga <gap> hon-o morat-ta]] hito
 -from Yoko-NOM book-ACC receive-PAST person
 ‘the person from whom Yoko received a book’
- (56) [Yoko-ga <gap> hon-o morat-ta] hito
 Yoko-NOM book-ACC receive-PAST person
 ‘the person who Yoko received a book from’

So a gap is sometimes hidden, and this leads to potential ambiguity as in the following example. For interpreting such sentences, context and pragmatic knowledge and expectations play a role (see Matsumoto 1997, for example).

- (57) [hon-o katta] gakusei
 book-ACC bought student
 a. ‘the student who bought a book’
 b. ‘the student from whom (I) bought a book’
 c. ‘the student for/to whom (I) bought a book’ (Matsumoto 1997, 40)

Looking at an example closer to (52), note that in the externally-headed relativization (EHRC) (59) of sentence (58), the genitive case marker *-no* that is translated as ‘in’ or ‘of’ in the sentence does not surface.

- (58) Ayaka-ga sono yama-no ringo-o mit-tsu mui-ta.
 Ayaka-NOM that mountain-NO apple-ACC three-CL peel-PAST
 ‘Ayaka peeled three apples in/of the pile.’
- (59) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta] yama EHRC
 Ayaka-NOM apple-ACC three-CL peel-PAST mountain
 ‘The/a pile that Ayaka peeled three apples in/of.’

The headless relative counterpart of (59) is (60), and its LF in (61).¹²

¹² Resumptive pronouns are possible in such relatives with overt P/case marker, as in (i) and (ii), though they would sound better with dependencies across islands, for example.

- (i) [Ayaka-ga soko-no ringo-o mit-tsu mui-ta]-no
 Ayaka-NOM there-GEN apple-ACC three-CL peel-PAST-NO
 ‘{(That which/the one that/what) Ayaka peeled three apples of it.’

- (60) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta]-no *Headless relative*
 Ayaka-NOM apple-ACC three-CL peel-PAST-NO
 ‘{(That which/the one that/what} Ayaka peeled three apples in/of.’

- (61) [DP THE [NP (one) [CP λx [Ayaka peeled three apples in/of x]]]]

Notice that the headless relative in (60) is string-identical to the IHRC DP in (52). What is claimed to be a previously unidentified reading of IHRC in E&G is in fact an expected interpretation of independently available headless relatives such as (60). The sentence is thus syntactically ambiguous between the IHRC parse and the headless relative parse. Naturally, context plays a role in interpreting headless relatives like (60). There is only one group of apples in context (2), where Ayaka peeled three apples. The entire group of apples is thus the referent of the DP in (60). In context (3), on the other hand, there are two groups: one where Ayaka peeled three apples, and the other one where no one peeled any. The referent of the DP in (60) in this context is the first group of apples.

We note here that even though we used *yama* ‘pile (lit. mountain)’ as the external head in (59) to illustrate one possible externally-headed counterpart of the headless relative in (60), there are of course other possibilities as shown in (62)–(64).¹³ We are not suggesting, however, that these externally-headed relative clauses underlie the headless relatives. Depending on the context, the referent of the headless relative in (60) could be the apples themselves (as in E&G’s example), or their container (a cardboard box, for example, as in (65)).

- (62) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta] **hako/kago** *EHRC*
 Ayaka-NOM apple-ACC three-CL peel-PAST box/basket
 ‘the/a box/basket that Ayaka peeled three apples in’

- (63) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta] **{ringo/kudamono}-no**
 Ayaka-NOM apple-ACC three-CL peel-PAST apple/fruit-NO
yama
 mountain
 ‘the/a pile of apples/fruits that Ayaka peeled three apples in’

- (ii) [Sota-ga *so-no* ashi-o ni-hon kowashi-ta]-no
 Sota-NOM that-GEN leg-ACC two-CL break-PAST-NO
 ‘{(That which/the one that/what} Sota broke two legs of it (a chair, for example).’

¹³ Note that example (64) with *sorerano ringo* ‘those apples’ as the external head is similar to what is described as a doubly headed relative in E&G, except for the use of the explicitly plural form *sorerano* ‘those’ here, instead of *sono* ‘that/those’. While detailed investigation of the doubly-headed relative clause is outside the scope of this paper, let us note that two possibilities may co-exist: (i) a kind of internally headed relative clause with the particle *-no* spelled out as a definite description (this would give us the regular reading); or, (ii) the externally headed relative as in (64).

- (64) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta] **sorerano**
 Ayaka-NOM apple-ACC three-CL peel-PAST those
ringo/kudamono
 apples/fruits
 ‘those apples/fruits that Ayaka peeled three apples of’
- (65) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta]-no-ni atena-o
 Ayaka-NOM apple-ACC three-CL peel-PAST-NO-DAT addressee-ACC
 kai-ta.
 write-PAST
 ‘(I) wrote the addressee’s name and address on the one that Ayaka peeled three apples in.’

Examples such as (49) and (51) from Section 5.2—cases of “mixed baskets” of pears and apples—whose interpretations are not generated in the ITC analysis, are no longer a problem in the headless relative parse. This is because the interpretation of the ‘head’ is determined by the context, in more or less the same manner in which English headless/free relatives are interpreted (‘that which/what Ayaka peeled three apples of’). The gapped headless relative parse is always available independently and this structure gives us the salient set reading without recourse to any additional mechanisms.

A part-whole relation plays a big role in the ITC analysis of IHRC. Relativization that involves a part-whole relation has been discussed in the literature.¹⁴ In each of (66) and (67), a phrase in the relative clause and the referent of the entire DP containing the relative clause form a part-whole relation (e.g., ‘the tail’ and ‘the cat’). Thus, the headless relative (i.e. *-no*) versions of these examples may at first sight appear to be amenable to the ITC analysis of IHRCs. However, the property we could derive within the ITC analysis in (68) for (66) is not the right one.

- (66) [[Yuya-ga shippo-o hippat-ta] {neko/-no}]-ga okot-ta.
 Yuya-NOM tail-ACC pull-PAST cat/-no-NOM get.angry-PAST
 ‘The cat/one that Yuya pulled the tail of got angry.’
- (67) Yoko-ga [Yuya-ga ashi-o ni-hon kowashi-ta] {isu/-no}]-o
 Yoko-NOM Yuya-NOM leg-ACC two-CL break-PAST chair/-no-ACC
 naoshi-ta.
 fix-PAST
 ‘Yoko fixed the chair/one that Yuya broke two legs of.’
- (68) λX . X is a tail and Yuya pulled the tail of X

¹⁴ See, for example, Matsumoto (1997) pp. 130–131 for some examples of relativization involving inalienable possession, including body parts and kinship terms.

For example, the whole IHRC of (66) would denote the tail, such that Yuya pulled the (or a) tail part of it. And the sentence would assert that the larger tail whole got angry. This is not the right interpretation of (66). Clearly, then, we do not want to apply the ITC analysis to such examples. So even within the ITC analysis, it needs to be admitted that such examples should receive a gapped headless relative parse and not an IHRC parse. In sum, even if the ITC analyses exists for some IHRCs, the headless relative parse would have to be assumed in order to generate sentences such as (49), (51), (65), (66) and (67) with appropriate interpretations, as these cannot be handled by the ITC analysis. What remains to be seen is independent evidence for additionally generating IHRCs with Inverse Trace Conversion, which derives the salient set reading for only a subset of the cases we have discussed.

Finally, recall that on the ITC-MIS analysis, the salient set reading is derived when the Salient Sets Restriction (SSR) is invoked by the presence of one or more salient sets in the context. E&G report that three survey participants consistently only had access to the regular reading. Their explanation is that these speakers did not use the SSR, and they speculate that these speakers “did not perceive the schematic grouping as salient enough in the written survey, but would use the SSR for definite description reference in a real world context” (p. 31). Related to this, it is noted in E&G that “[t]he directional light noun *hoo* is often used when salient sets are referred to or contrasted. Therefore another possibility for the speakers described in this section is that the use of the SSR is lexically tied more closely to the use of *hoo* for these speakers than for others” (footnote 25).

In the headless relative analysis, the so-called salient set reading is an expected reading when the ‘whole’ position of a part-whole relation is relativized. As we briefly touched upon in relation to sentence (57), contextual information and pragmatic knowledge is crucial as there is no overt indicator of a gap. In the headless relative analysis, we can view the use of *hoo*, a contrastive focus marker (Schwarzschild 2011, Matsui & Kubota 2012, Bamba 2016), as facilitating the interpretation of such relatives. The use of *hoo* in (69) clearly highlights the so-called salient set reading, by making the property ‘ λx .Ayaka peeled three apples in/of x ’ contrastive with some other property, for example, with ‘ λx .no one peeled any apples in/of x ’, in the case of context (3) with two groups of apples. Other types of properties can be contrasted, depending on which smaller focused constituents *hoo* associates with, as shown in (70).

- (69) [Ayaka-ga <gap> ringo-o mit-tsu mui-ta]-hoo-no
 Ayaka-NOM apple-ACC three-CL peel-PAST-HOO-NO
 ‘the one that/that which/what Ayaka peeled three apples in/of’

- (70) a. that which no one peeled any apples in/of
 b. that which [Yoko]_F peeled three apples in/of (if [Ayaka]_F in (69))

- c. that which Ayaka peeled three [pears]_F in/of (if [apples]_F in (69))
 d. that which Ayaka peeled [five]_F apples in/of (if [three]_F in (69))

The presence of the marker *hoo* in these examples actually provides a further argument against treating the salient set reading as derived from an IHRC. In unambiguous IHRCs as in (71), *hoo* does not quite sit well in the IHRC-final position.

- (71) [[Shiroi inu-ga hoeteita](??-hoo)-no]-ga neko-o oikaketa.
 white dog-NOM was.barking-HOO-NO-NOM cat-ACC ran.after
 ‘A white dog that was barking ran after a cat.’

This tells us that the structure that the salient set reading is derived from is not an IHRC.

To summarize, we have shown in this section that there are problems in deriving the salient set reading from an IHRC parse using ITC, and that these problems do not arise with an independently available headless relative parse. The ITC analysis would then need to assume a headless relative parse for those cases, and the question boils down to whether we have independent motivation for generating an IHRC parse with ITC.

We have arrived at a picture where the sources of the regular and salient set readings are dissociated. The regular reading is left to be handled by the existing analyses of IHRCs (see Grosu 2012, and references therein), as the ITC-MIS analysis largely undergenerates the regular reading as we saw in Section 4. The salient set reading should have a different syntactic source, a headless relative, because an IHRC analysis fails to generate correct interpretations as we saw in Section 5.2. Other than these empirical reasons, there are additional conceptual reasons to dissociate the syntactic sources of the two readings. The LF structure within the ITC-MIS analysis always includes a part-of relation, regardless of whether the salient set reading is present or not. This is counter-intuitive in ways we briefly sketch below.

In example (72), the ‘whole’ part in the part-of relation, ‘in that pile of apples’, is syntactically present so that the relative clause is unambiguously internally headed. In the context in (3) with two groups of apples, readings (73a) and (73b) are available, while reading (74a)—which invokes an even larger plurality of apples of which the pile is part—is not. As variable insertion is an obligatory process in the derivation of IHRC from a proto-relative, the property in (74b) is always generated. While the reading in (74a) may not be generated in the end because the SSR would not apply without a salient set in the context, tying the regular reading to the LF with a part-of relation seems questionable. It is also not clear how the ITC analysis can generate the reading in (73b).

- (72) Junya-ga [Ayaka-ga *sono ringo-no yama-no* ringo-o mit-tsu
 Junya-NOM Ayaka-NOM that apple-NO mountain-NO apple-ACC three-CL
 mui-ta]-no-o zenbu tabe-ta.
 peel-PAST-NO-ACC all eat-PAST
 ‘(lit.) Junya ate all of [that Ayaka peeled three apples in that pile of apples].’
- (73) a. Ayaka peeled three apples of that pile of apples and Junya ate all three of them.
 b. ?Ayaka peeled three apples of that pile of apples and Junya ate all the apples in the pile.
- (74) a. Ayaka peeled three apples of that pile of apples and Junya ate all the apples in some salient set that the pile of apples are part of.
 b. $\llbracket \text{DP} \rrbracket = \llbracket \text{THE} \rrbracket (\lambda X. X \text{ apples in that pile of apples and Ayaka peeled [three atomic parts of apples [of that pile of apples]] of } X)$

Another example comes from Erlewine & Gould (2014), and it generally has to do with IHRCs with creation verbs. It is reported there (p. 169) that sentence (75), credited to Chris Davis (p.c.), has a regular reading where the teacher reads what I wrote, half a paper. The expected salient set reading, where the entire paper is read is not possible, as it has not been written. And yet, the LF structure for (75) would still contain a part-of relation (‘I wrote half paper of paper X’).

- (75) $\llbracket \text{Tetsuya-shite ronbun-o hanbun kaita} \rrbracket\text{-no-o sensei-ga}$
 all.nighter-did paper-ACC half wrote-NO-ACC teacher-NOM
 yonde-kureta.
 read-BENEFACTIVE.PAST
 (lit.) ‘The teacher read (for me) [(I) pulled an all-nighter and wrote half paper].’
 ‘(I) pulled an all-nighter and wrote half a paper and the teacher read it for me.’

Again, the salient set reading may be blocked as there is no salient set (the whole paper) in the context and the SSR does not kick in. However, such LF with a part-of relation is counter-intuitive for creation verbs.

6 Summary

In this response, we have demonstrated that the ITC-MIS semantics for IHRCs does not derive the observed interpretations for relatives with a number of quantified internal heads. Furthermore, a unified account of IHRCs with the regular reading and those relatives with the so-called salient set reading cannot be maintained. Among other problems, the unification cannot capture readings where the individuals

denoted by the internal head are not sub-parts of denotation the IHRC as a whole—e.g. the mixed basket scenario of apples and pears. We have suggested that the so-called salient set reading does not arise from a IHRC but rather is just the expected interpretation of a headless relative. Because postposition/case markers stranded by movement are deleted, these headless relatives are surface identical to some IHRCs. When the constructions are disambiguated, it becomes clear that the salient set interpretation needn't arise from an IHRC.

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