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RESEARCH

Unifying Japanese relative clauses: copy-chains and context-sensitivity

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We offer a new, unified approach to the derivation and interpretation of head-external, head-internal, and heretofore understudied doubly-headed relative clauses in Japanese. Our proposal is motivated by new data on the interpretation of these different forms of relative clauses with quantificational heads, in different contexts. Head-internal and doubly-headed relative clauses are interpreted as definite descriptions with their quantificational head interpreted in their surface, relative-clause-internal positions. We show that the complex patterns of possible interpretations, as well as the shape of observed inter-speaker variation, are derived by interpreting definite descriptions using a maximal informativeness semantics and a simple assumption regarding the role of contextual information, which we call the *Salient Sets Restriction*.

Syntactically, we propose a novel DP head-raising derivation for relative clauses that takes advantage of the Copy Theory of movement and the late-merger of relative clauses. This allows for the unification of head-internal and doubly-headed relativization strategies with the familiar head-external form, which would otherwise not be possible. We believe this approach is suitable for head-raising relative clauses in other languages as well, including English. Our proposal avoids some complications of previous head-raising derivations, instead taking advantage of independently motivated mechanisms of copy-chain resolution at LF.

Keywords: Japanese; relativization; head-internal relative clause; doubly-headed relative clause; Copy Theory; chain resolution; maximal informativeness; Salient Sets Restriction

1 Introduction

Japanese is known for having a rich inventory of relative clause constructions (see e.g. Kuno 1973; Kuroda 1975–76; 1976–77 among many others). In this paper we focus on three of these, which we claim are derivationally related to one another. Two of these are among the most well studied in Japanese: the first is the head-external relative clause (HERC), in which the head noun appears *outside* the relative clause (1a) and the second is the head-internal relative clause (HIRC), in which the head noun appears *inside* the relative clause (1b). There is a third variety, which has received very little previous attention in the literature (see brief mentions in Inada 2009; Tomioka 2012): this is what we will refer to as a *doubly-headed* relative clause (DHRC). In the DHRC in (1c), the head noun 'apples' appears both *inside* and *outside* the relative clause. The head outside the relative carries an obligatory deictic element *sono*, an important aspect of this construction which we will later discuss. With its repetition of the head noun both inside and outside the relative, then, a DHRC would appear to be a synthesis of both a head-internal and head-external relative.

In examples in this paper, we use brackets labeled HERC, HIRC, and DHRC to highlight the extent of the entire relative clause constructions under discussion. This includes both the relative clause proper as well as its head(s). Heads of relative clauses will be italicized. Relative clauses without external head nouns end with a morpheme *-no*, as in (1b).

(1) **Three types of relatives and their head positions:**

a. + external, – internal (head-external):
Junya-wa [$_{\text{HERC}}$ Ayaka-ga mui-ta *ringo*]-o tabe-ta.
Junya-TOP Ayaka-NOM peel-PAST apple-ACC eat-PAST
'Junya ate the *apples* that Ayaka peeled.'

b. – external, + internal (head-internal):
Junya-wa [$_{\text{HIRC}}$ Ayaka-ga *ringo*-o mui-ta -no]-o tabe-ta.
Junya-TOP Ayaka-NOM apple-ACC peel-PAST -NO-ACC eat-PAST
literally 'Junya ate [that Ayaka peeled *apples*].'

c. + external, + internal (doubly-headed):
Junya-wa [$_{\text{DHRC}}$ Ayaka-ga *ringo*-o mui-ta *sono-ringo*]-o tabe-ta.
Junya-TOP Ayaka-NOM apple-ACC peel-PAST that-apple-ACC eat-PAST
literally 'Junya ate [*those apples* that Ayaka peeled *apples*].'

In this paper we offer a unified framework for the syntax and semantics of the three types of relative clauses exemplified in (1). Building on Itô's (1986) discussion of head-internal and head-external relatives in Japanese (see also Cole 1987), we propose that the internal and external head positions are related by movement in the narrow syntax (which feeds both LF and PF) in all three relative clauses in (1), with differences in how these chains are pronounced at PF and interpreted at LF. We present a concrete implementation of this idea using the Copy Theory of movement and associated work on the interpretation of copy-chains (Chomsky 1993; 1995; *inter alios*). Variability in the timing of semantic chain resolution operations, before or after Spell-Out, leads to differing surface realizations at PF. We demonstrate that our core proposal is also a valuable revision to previous head-raising derivations for English head-external relative clauses.

In support of our proposal, in Section 2 we present two related pieces of novel empirical evidence. First, we discuss the semantics of HIRCs and HERCs with quantified heads. In particular, the interpretation of relative clauses with a proportional quantifier modifying the head, interpreted inside the relative clause, exhibits an interesting dependence on the context of evaluation. Second, we shine a light for the first time on the semantics of DHRCs. We show how their interpretation patterns with those of their more familiar head-internal counterparts and provide support for our copy-theoretic analysis. Our proposal accounts for these interpretations and the systematic nature of their context-sensitivity, as well as differences between the interpretations of HIRCs and HERCs.

Our approach contrasts sharply with the influential proposal of Shimoyama (1999), which interprets Japanese head-internal relative clauses (HIRC) through E-type anaphora. Shimoyama shares with her predecessor Hoshi (1995) the intuition that HIRCs are interpreted as if they are independent clauses, with an anaphoric element similar to a cross-sentential anaphor interpreted in the HIRC's position. We can illustrate this approach explicitly through the Japanese paraphrase in (2) and its English translation:

(2) **A paraphrase for (1b) in the spirit of Hoshi (1995) and Shimoyama (1999):**
Ayaka-wa *ringo*-o mui-ta. Junya-wa *sore/sono-ringo*-o tabe-ta.
Ayaka-TOP apple-ACC peel-PAST Junya-TOP that/that-apple-ACC eat-PAST
'Ayaka peeled *apples*. Junya ate *them/those apples*.'
⇒ *them/those apples* = the apples that Ayaka peeled

The evidence we present in Section 2 shows that this E-type approach is in general untenable for both head-internal and doubly-headed relative clauses. When we consider the interpretation of HIRCs and DHRCs with quantificational heads, we see that there are examples for which paraphrases using cross-sentential anaphora do not derive the correct interpretations.

Later we will also discuss the proposal of Grosu (2010) and Grosu & Landman (2012), who also argue against an E-type analysis on independent grounds. Our analysis shares with Grosu & Landman the idea that HIRCs are truly relative clauses that are interpreted as definite descriptions, but otherwise differs substantially. We will argue that our approach is superior both empirically and theoretically, with the new data we propose in Section 2 being problematic for the Grosu & Landman proposal, and our unified syntactic analysis being preferable from the point of view of theoretical parsimony.

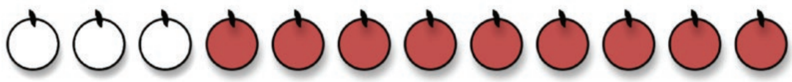
Section 3 presents our syntactic proposal and the strategies for copy-chain resolution alluded to above. There we will also discuss the relationship of our proposal to the Relevancy Condition of Kuroda (1975–76; 1976). Section 4 discusses the semantic interpretation of the different types of relative clauses. There we will adopt a recent proposal to model definiteness as maximal informativeness (von Fintel, Fox & Iatridou 2014). Further, we introduce the *Salient Sets Restriction*, which formalizes the effect of context in definite description evaluation; this will be crucial for the interpretation of HIRCs and DHRCs with quantificational heads. We show that the one main form of inter-speaker variation that we observe in the interpretation of Japanese relatives is easily explained by differences in the willingness of speakers to invoke the Salient Sets Restriction in our judgment tasks. We conclude in Section 5.

2 Three relatives and their interpretations

In this section we present new data that focus on the interpretive similarities and differences that cut across the three relative constructions in (1). In basic cases, all three relative clauses will yield the same extension, but systematic differences emerge depending on the context, and with the addition of quantifiers inside or outside the relative clause.[1]

A few methodological points are in order. First, as we will see, the interpretation of these relative clauses will be sensitive to the organization of entities in the discourse context, and therefore their interpretations will be discussed in relation to explicit contexts. We consider first the straightforward context in (3). There are twelve apples; our friend Ayaka has peeled three and the others are unpeeled. The use of contexts will be discussed further below.

(3) **Context with three peeled apples and nine unpeeled apples**



The second point concerns the source of our data. What we are interested in here is the extension of these different types of relative clauses in a context such as (3). The data we present will be entailment judgments that make this extension clear: which apples do we know to be eaten in this context, given a sentence such as those in (1) above? The results

[1] One well-known property of HIRCs is Kuroda's (1975–76) *Relevancy Condition*, which seems to place semantic-pragmatic constraints on what can be a HIRC head vis-à-vis properties of the surrounding relative clause and the matrix clause. This Relevancy Condition does not apply to HERCs. See Nishigauchi (2004), Kim (2007; 2008), Grosu (2010), and citations therein for discussion. In this section and indeed most of the paper, we will concentrate on examples where corresponding HERCs, HIRCs, and DHRCs are all possible. The Relevancy Condition will be discussed again briefly in Section 3.3.

that we present here aggregate responses from over a dozen Japanese speakers who were consulted individually in person and/or completed a written survey, as well as those who responded to our earlier presentations of preliminary findings. The written survey asked participants to read test sentences in illustrated contexts such as (3) and to circle the apples that would be eaten, and also to indicate if multiple readings are possible. In this section we present the dominant pattern of judgments; alternative, distinct patterns of judgments are discussed later in Section 4.

The third point is a consideration related to the lack of definiteness marking in Japanese. Consider the head-external relative clause example from (1a), repeated below in (4). This example evaluated in context (3) does *not* entail that Junya ate all three of the apples that Ayaka peeled, but simply that Junya ate *some* of the apples that Ayaka peeled. The availability of such a non-maximal reading makes it difficult to identify the precise extension of the relative clause itself.

(4) **Basic head-external relative clause, repeated from (1a):**
Junya-wa [$_{\text{HERC}}$ Ayaka-ga mui-ta *ringo*]-o tabe-ta.
Junya-TOP Ayaka-NOM peel-PAST apple-ACC eat-PAST
'Junya ate (one/some of) the apples that Ayaka peeled.'

We can block such non-maximal readings by adding the quantifier *zenbu* 'all' outside of the nominal expression in question. The addition of *zenbu* in (5), for example, makes the sentence entail that all three of the peeled apples in (3) were eaten. We will use this manipulation in all of our examples here, to facilitate the identification of the nominals' full extensions.[2]

(5) **Basic head-external relative clause (1a) with external *zenbu* 'all':**
Junya-wa [$_{\text{HERC}}$ Ayaka-ga mui-ta *ringo*]-o zenbu tabe-ta.
Junya-TOP Ayaka-NOM peel-PAST apple-ACC all eat-PAST
'Junya ate all of the apples that Ayaka peeled.'
Evaluated in context (3): ⇒ Junya ate all three of the apples Ayaka peeled.

These manipulations – the addition of *zenbu* 'all' and an explicit context – now allow us to compare the extension of the head-external relative in (5) with the corresponding head-internal and doubly-headed relatives in (6–7), which are based on (1b–c). In this basic case, all three relatives denote the same extension of the three apples that Ayaka peeled in (3):

(6) **Basic head-internal relative clause (1b) with external *zenbu* 'all':**
Junya-wa [$_{\text{HIRC}}$ Ayaka-ga *ringo*-o mui-ta -no]-o zenbu tabe-ta.
Junya-TOP Ayaka-NOM apple-ACC peel-PAST -NO-ACC all eat-PAST
Evaluated in context (3): ⇒ Junya ate all three of the apples Ayaka peeled.

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[2] It is worth noting that the possibility of such non-maximal readings is a general property of nominal interpretation in Japanese, rather than a property specific to relative clauses. Consider example (i), which looks to be a straightforward translation of the English "Junya ate these apples". However, consider a context where Junya is standing next to a large pile of apples. The Japanese sentence in (i) is judged as true if Junya has eaten some portion of the apples from the pile; it does not require that he ate all of the apples. We therefore propose "Junya ate *from* these apples" as a more appropriate English translation for (i). It is precisely such non-maximal readings that are blocked by the addition of *zenbu* 'all'.

(i) Junya-wa kono-ringo-o tabe-ta.
Junya-TOP PROXIMAL-apple-ACC eat-PAST
'Junya ate from these apples.'

In the case of HIRCs, Hoshi (1995: 132) and Shimoyama (1999: 150) claim that only maximal readings exist. The addition of *zenbu* 'all' to HIRCs is then predicted to be redundant and not affect their interpretation. In our experience, however, the addition of *zenbu* 'all' makes judgments of the full extensions of these relative clauses much clearer. A comment by an anonymous reviewer also corroborates the importance of *zenbu* in these examples, contrary to the predictions of Hoshi and Shimoyama's claims.

(7) **Basic doubly-headed relative clause (1c) with external *zenbu* 'all':**
Junya-wa [$_{\text{DHRC}}$ Ayaka-ga *ringo*-o mui-ta *sono-ringo*]-o zenbu tabe-ta.
Junya-TOP Ayaka-NOM apple-ACC peel-PAST that-apple-ACC all eat-PAST
Evaluated in context (3): ⇒ Junya ate all three of the apples Ayaka peeled.

In this paper we introduce new data on the interpretation of relative clauses involving quantifiers. We will consider relatives whose heads are modified by the proportional quantifier *hanbun* 'half' and the numeral 'three.'[3] For expository purposes, in this paper we focus on examples with these two quantifiers, but we note that the approach we present extends to many other types of quantifiers on internal heads as well.

First, consider the HIRC in (8).[4] This example is infelicitous in the simple context in (3) where three of twelve apples have been peeled. But notice what happens when we introduce the context in (9), which has the same number of peeled and unpeeled apples as in (3), but with the twelve apples now presented in two groups of six. Ayaka peeled three of the apples in the first group (the white apples); in the second group, all apples are unpeeled. Evaluated in this context, the HIRC in (8) is now felicitous, and it denotes the six apples in the first group, half of which Ayaka has peeled.[5]

(8) **HIRC with quantifier *hanbun* 'half':**
Junya-wa [$_{\text{HIRC}}$ Ayaka-ga *ringo*-o *hanbun* mui-ta -no]-o zenbu tabe-ta.
Junya-TOP Ayaka-NOM apple-ACC half peel-PAST -NO-ACC all eat-PAST
literally 'Junya ate all of [that Ayaka peeled *half of the apples*].'
Evaluated in context with no grouping (3): infelicitous
Evaluated in context with two groups (9): ⇒ Junya ate the six apples in the first group.

(9) **Context with two groups of apples:**

We briefly comment here on the use of contexts presented in this study. Our observation in (8) is that this HIRC can be uttered felicitously in a two-group situation as in (9), but we are not claiming that exactly this two-group context is required for the felicitous expression of (8), nor that an utterance such as (8) by itself evokes a situation such as (9). Nonetheless, the use of such explicit contexts is an important part of our methodology. Crucially, we are interested in and report on the felicity and truth-conditional interpretations of various relative clauses given particular contexts. As we show throughout the paper, these interpretations allow us to explore the different predictions that are made by competing linguistic analyses.

Examples such as (8) evaluated in context (9) are problematic for previous approaches to Japanese HIRCs. Proponents of the E-type analysis, Hoshi (1995) and Shimoyama (1999), draw an explicit parallel between the interpretation of HIRCs and cross-sentential anaphora, as illustrated above in example (2). Consider the cross-sentential paraphrase for example (8) in (10) below:

[3] Similar structures using the proportional quantifier *hotondo* have been discussed in the literature, especially by Shimoyama (1999) who gives the translation 'most'. Grosu (2010: 263) notes that *hotondo* is better translated as 'nearly all' or 'an overwhelming majority of', and we agree with this. We use *hanbun* 'half' and 'three' here as their meanings are very clear, facilitating crisper judgments for our present purposes.
[4] There is another type of reading possible with these examples using the quantifier *hanbun* 'half'; this reading refers to some apples being (individually) half-peeled, i.e. with half of each apple's skin having been peeled. We do not consider such readings here.
[5] As noted above, other patterns of judgments will be discussed in subsequent sections.

(10) **A cross-sentential paraphrase for the HIRC with 'half' (8) is unavailable:**

Ayaka-wa	*ringo*-o	*hanbun*	mui-ta.	
Ayaka-TOP	apple-ACC	half	peel-PAST	
Junya-wa	*sore/sono-ringo*-o		zenbu	tabe-ta.
Junya-TOP	that/that-apple-ACC		all	eat-PAST

'Ayaka peeled *half of the apples*. Junya ate all of *them/those apples*.'
Evaluated in context with no grouping (3): infelicitous
Evaluated in context with two groups (9):

- For some speakers: infelicitous
- For other speakers: ⇒ Junya ate the three peeled apples.[6]

Example (10) is judged as infelicitous by all speakers in the context with no grouping, in (3). For the context with two groups in (9), speakers split into two patterns of judgments. Some speakers report that the entire utterance in (10) is also judged as infelicitous in the context in (9), commenting that the first sentence in (10) is false as Ayaka did not peel half of the apples in the context. For these speakers, the second sentence is therefore unable to identify a referent for the cross-sentenential anaphor 'those' or 'those apples'. Other speakers report that (10) entails that Junya ate the three peeled apples, apparently accommodating that the first sentence is referring to the first group of apples, half of which Ayaka peeled. Note that for both patterns of judgments, the interpretation of the cross-sentential paraphrase in (10) differs from the interpretation of the HIRC in (8). This suggests that HIRCs are not interpreted using E-type anaphora, contra Hoshi (1995) and Shimoyama (1999). Data such as (8) are also problematic for the "quantificational disclosure" approach of Grosu (2010) and Grosu & Landman (2012), which we will discuss in Section 4.4.

Next we consider example (11), which includes the doubly-headed version of the relative clause in (8). The DHRC involves an external head with an obligatory deictic *sono*, which at first glance may suggest the explicit use of an E-type anaphor, as in Hoshi and Shimoyama's E-type analysis for HIRCs. However, the DHRC in (11) is felicitous in the context in (9), and furthermore has the same interpretation as the HIRC (8) in this context. It is similarly infelicitous in the context with no groupings, in (3).

(11) **DHRC with quantifier *hanbun* 'half':**

Junya-wa	[$_{\text{DHRC}}$	Ayaka-ga	*ringo*-o	*hanbun*	mui-ta	*sono-ringo*]-o
Junya-TOP		Ayaka-NOM	apple-ACC	half	peel-PAST	that-apple-ACC
zenbu	tabe-ta.					
all	eat-PAST					

literally 'Junya ate all of [*those apples* that Ayaka peeled *half of the apples*].'
Evaluated in context with no grouping (3): infelicitous
Evaluated in context with two groups (9): ⇒ Junya ate the six apples in the first group.

The HIRC and DHRC with the proportional quantifier *hanbun* 'half' have the same interpretation and, unlike HIRCs and DHRCs without quantifiers inside the relative as in (6–7) above, are not amenable to paraphrases using cross-sentential anaphora. Their felicitous interpretation is possible in (9), which differs minimally from (3) in organizing the apples into salient groups.

[6] One speaker noted that this could be interpreted as Junya eating all six of the apples in the first group of apples, but volunteered that this six-apple interpretation is dispreferred to the three-apple reading.

The extension picked out by these relative clauses in (8) and (11) is intuitively *the salient set of apples, half of which Ayaka peeled*. We propose this as an accurate and informative paraphrase for these relative clauses. In a similar fashion to this English paraphrase, the same interpretation can also be obtained through a Japanese HERC with the quantifier *hanbun* 'half' stranded *inside* the relative clause, as in (12).[7]

(12) **HERC with internally stranded quantifier *hanbun* 'half':**

Junya-wa	[$_{\text{HERC}}$	Ayaka-ga	*hanbun*	mui-ta	*ringo*]-o	zenbu	tabe-ta.
Junya-TOP		Ayaka-NOM	half	peel-PAST	apple-ACC	all	eat-PAST

'Junya ate all of [*the apples* that Ayaka peeled *half of*].'
Evaluated in context with no grouping (3): infelicitous
Evaluated in context with two groups (9): ⇒ Junya ate the six apples in the first group.

Thus when evaluated in contexts (3) and (9), the HIRC, DHRC, and HERC with internal stranding have the same extension with the proportional quantifier *hanbun* 'half'. This observation will inform our analysis in subsequent sections.

The examples that we constructed above all use the proportional quantifier *hanbun* 'half'. Next we will consider a simple numeral, here 'three'. The numeral 'three' takes a numeral classifier *tsu* here, with the numeral and classifier together realized as *mit-tsu*. The HIRC and DHRC with 'three' are in (13) and (14), respectively. We also give the HERC with 'three' stranded internally in (15), parallel to our example (12) above. We will discuss their interpretations below.

(13) **HIRC with numeral *mit-tsu* 'three-CL':**

Junya-wa	[$_{\text{HIRC}}$	Ayaka-ga	*ringo*-o	*mit-tsu*	mui-ta	-no]-o	zenbu	tabe-ta.
Junya-TOP		Ayaka-NOM	apple-ACC	three-CL	peel-PAST	-NO-ACC	all	eat-PAST

literally 'Junya ate all of [that Ayaka peeled *three apples*].'

(14) **DHRC with numeral *mit-tsu* 'three-CL':**

Junya-wa	[$_{\text{DHRC}}$	Ayaka-ga	*ringo*-o	*mit-tsu*	mui-ta	*sono-ringo*]-o
Junya-TOP		Ayaka-NOM	apple-ACC	three-CL	peel-PAST	that-apple-ACC
zenbu	tabe-ta.					
all	eat-PAST					

literally 'Junya ate all of [*those apples* that Ayaka peeled *three apples*].'

(15) **HERC with internally stranded numeral *mit-tsu* 'three-CL':**

Junya-wa	[$_{\text{HERC}}$	Ayaka-ga	*mit-tsu*	mui-ta	*ringo*]-o	zenbu	tabe-ta.
Junya-TOP		Ayaka-NOM	three-CL	peel-PAST	apple-ACC	all	eat-PAST

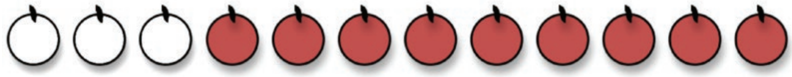
'Junya ate all of [the *apples* that Ayaka peeled *three of*].'

As with the corresponding HIRC and DHRC with *hanbun* 'half' above in (8) and (11) and the HERC with internally stranded *hanbun* 'half' in (12), the HIRC in (13) and DHRC in (14), and the HERC with internally stranded 'three' in (15) all have the same interpretive possibilities for any particular context. We'll again consider the context with no grouping and the context with two groups, repeated from above.

[7] Again, there is also a reading that refers to apples that are half-peeled, which is quite salient in (12), but we leave aside this reading here.

(16) **Interpretations of HIRC (13) and DHRC (14) with *mit-tsu* 'three-CL' and HERC with internally stranded *mit-tsu* 'three-CL' (15):**

a. Evaluated in context with no grouping, repeated from (3):



i. ⇒ Junya ate the three peeled apples.
ii. ⇒ Junya ate all twelve apples.

b. Evaluated in context with two groups, repeated from (9):

i. ⇒ Junya ate the three peeled apples.
ii. ⇒ Junya ate the six apples in the first group.

Examples (13), (14), and (15) are judged as felicitous in the context with no grouping (16a) and these relative clauses may refer to the three apples that Ayaka has peeled (16ai) or secondarily to all twelve apples (16aii). In the context with two groups in (16b), all three structures again have two possible readings: on one reading, the relative clause refers to the three apples that Ayaka peeled (16bi), just as in (16ai), and on the other reading, the relative clause denotes the salient set of six apples, three of which Ayaka peeled (16bii).

We again contrast the pattern of interpretation of the HIRC (13), DHRC (14), and HERC with internal stranding (15) in these contexts, illustrated in (16), with the interpretation of a cross-sentential paraphrase in (17). The dominant pattern is that the utterance in (17) is felicitous in both the context without salient groupings and with groupings, and that in either case the head 'them/those apples' in the second clause unambiguously refers to the three apples that Ayaka peeled. The context with two groups does not allow for the reading, available with the HIRC (13) and DHRC (14) in (16bii), that picks out the salient set of apples that Ayaka peeled three of.

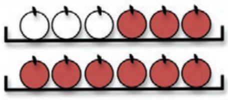
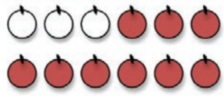
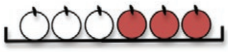
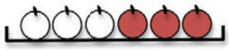
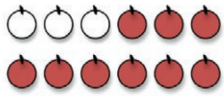
(17) **Cross-sentential paraphrase for the HIRC (13) and DHRC (14) with 'three-CL':**

Ayaka-wa *ringo*-o *mit-tsu* mui-ta.
Ayaka-TOP apple-ACC three-CL peel-PAST
Junya-wa *sore/sono-ringo*-o zenbu tabe-ta.
Junya-TOP that/that-apple-ACC all eat-PAST
'Ayaka peeled *three apples*. Junya ate all of *them/those apples*.'
Evaluated in context with no grouping (3)/(16a): ⇒ Junya ate the three peeled apples.
Evaluated in context with two groups (9)/(16b): ⇒ Junya ate the three peeled apples.[8]

Let us take stock of the patterns documented in this section. We summarize the different denotations of the different relative clause constructions as well as the corresponding cross-sentential anaphora, in the two contexts we consider, in the table in (18).

[8] One speaker reported that the referent could be the first six apples in the group on the left, but again suggested that this reading may be dispreferred.

(18) **Summary of denotations in different contexts:**

Context:		
HIRC (8), DHRC (11), and HERC (12) with internal 'half':		#
HIRC (13), DHRC (14), and HERC (15) with internal 'three':	i.  ii. 	i.  ii. 
Cross-sentential anaphor for 'half' (10):	# -or- for some speakers: 	#
Cross-sentential anaphor for 'three' (17):		

The table in (18) collapses the interpretations of HIRCs, corresponding DHRCs, and corresponding HERCs with the numeral or quantifier stranded internally, as supported by the data presented in this section. The complex pattern of interpretation of the HIRC examples above is consistently mirrored by the interpretation of parallel DHRC constructions in the same contexts, the interpretation of which has never been described before.

One point that the table (18) highlights is the strong context-sensitivity of these judgments. In particular, the HIRCs and DHRCs with 'half' and 'three' are able to refer to the six apples on the left in the context with two group of apples, but not in the context without such groups. Intuitively, the addition of salient sets allows for the first group of apples to be referenced, which satisfies the descriptions "λX . Ayaka peeled half of the apples in X" or "λX . Ayaka peeled three of the apples in X". These *salient set* readings clearly distinguish the behavior of the HIRC and DHRC from their corresponding paraphrases with cross-sentential anaphora. These readings presented here make clear that the interpretation of HIRCs and DHRCs with quantifiers cannot be straightforwardly explained by an E-type account as in Hoshi (1995) and Shimoyama (1999), which retrieve the denotation of the HIRC through an E-type anaphor akin to a cross-sentential anaphor.

This interpretation of relative clauses with internal quantifiers, summarized in (18), importantly differs from the interpretation of relative clauses with quantifiers pronounced in the external head position. The examples in (19a) and (19b) are interpreted identically, and are in turn truth-conditionally equivalent to the English translations given below.

(19) **HERC and HIRC with quantifiers in external head position:**

a. HERC with external quantifier:

Junya-wa	[$_{\text{HERC}}$ Ayaka-ga	mui-ta	*ringo-o*	*hanbun/mit-tsu*]	tabe-ta.
Junya-TOP	Ayaka-NOM	peel-PAST	apple-ACC	half/three-CL	eat-PAST

b. HIRC with external quantifier:

Junya-wa	[$_{\text{HIRC}}$ Ayaka-ga	*ringo-o*	mui-ta	-no-o	*hanbun/mit-tsu*]
Junya-TOP	Ayaka-NOM	apple-ACC	peel-PAST	-NO-ACC	half/three-CL

tabe-ta.
eat-PAST
'Junya ate *half/three of the apples* that Ayaka peeled.'

In these examples, the quantifier 'half' or numeral 'three' behaves as a regular quantifier in the matrix clause, with its domain being all apples that Ayaka peeled. This interpretation contrasts sharply with the interpretation of relative clauses with quantifiers pronounced in internal head position, summarized in (18). The generalization is that there is a one-to-one correspondence between the pronounced and interpreted positions of the quantifiers: if the quantifier is pronounced in the internal head position, inside the relative clause, it takes scope within the relative clause (in a manner that will be made precise in subsequent sections), whereas if it is pronounced in the external head position, it will take scope in the higher clause. This isomorphism is noted by Shimoyama (1999: 152–155), based on a subset of the configurations discussed here. For Shimoyama, this constitutes evidence that quantificational heads of HIRCs do not move at LF. In our own proposal, we will relate these positions by movement but derive the observed readings using independently-motivated options for the resolution of copy-chains.

Again, for expository purposes, in this paper we will concentrate on these examples with the quantifiers 'half' and 'three' on their internal heads, but our proposal is applicable to many other types of quantifiers on internal heads as well. We note in passing that it has been claimed that heads of HIRCs must be indefinite in many languages (see e.g. Williamson 1987; Basilico 1996) but this indefiniteness requirement seems *not* to hold of internal heads in Japanese. See especially discussion in Hoshi (1995: 103ff.) and Shimoyama (1999: 170ff.).

In the remainder of this paper, we will present our account for these relative clause constructions in Japanese. In Section 3, we will present our syntactic account, which unifies the underlying syntax of HERCs, HIRCs, and DHRCs, using the Copy Theory of movement and related work on the interpretation of copy-chains. In Section 4, we will then present our semantic analysis for these constructions, which offers a principled explanation for the patterns of readings presented in this section, including their context sensitivity. At the end of Section 4, we discuss the E-type analysis, as well as the alternative proposal of and Grosu (2010) and Grosu & Landman (2012).

3 A unified syntax for relativization

In this section we present our analysis of the structure of the three relative clause constructions under consideration. We propose that in each of these relatives there is movement in the narrow syntax of the head DP from a position within the relative clause CP to a position outside of it. Furthermore, we assume that this movement results in there being multiple *copies* of the head DP (cf. Chomsky 1993; 1995). Support for this proposal comes from the various systematic options that exist for the pronunciation and interpretation of these copies. If only the highest copy is pronounced, the result is a head-external relative, and if only the lowest copy is pronounced, what results is a head-internal relative. Crucially, it is also possible for both high and low copies to be pronounced, resulting in a doubly-headed relative. Yet another option is for the NP of only one of the copies to be pronounced, while the quantificational material is pronounced on the other copy.

We begin by reviewing in Section 3.1 how Chomsky's Copy Theory proposal has been refined to account for the semantic consequences of movement. In Section 3.2 we present a novel derivation for head-external relatives, involving head-raising of a DP. This derivation takes advantage of the Copy Theory and the idea from Lebeaux (1988; 1991) that relative clauses may be *Late Merged* into the structure. In Section 3.3, we then show how this proposal allows for a natural unification of the range of relative clause structures observed in Japanese. In Section 4, we will then present our account for the interpretation of these Japanese relative clauses.

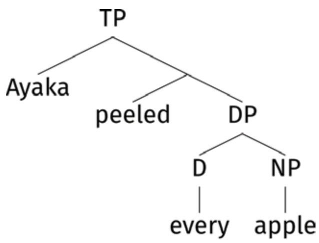
3.1 Background: Copy Theory and the resolution of copy-chains

We begin with a brief introduction to the Copy Theory of movement (Chomsky 1993; 1995). The Copy Theory of movement proposes that syntactic movement of X from position A to B results in two copies of X, one at A and one at B, rather than leaving a "trace" in position A as in earlier conceptions of movement. See Chomsky (1993; 1995), Sauerland (1998), and Fox (1999; 2002), among others, for various arguments for the Copy Theory of movement. Copy-chains commonly require modification for interpretation at the PF and LF interfaces, which we refer to as mechanisms of *chain resolution*.

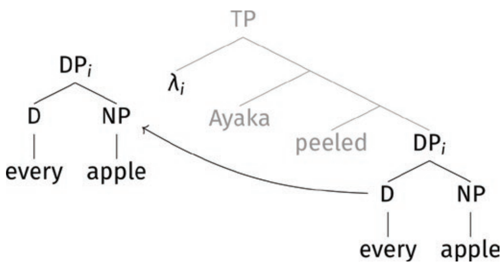
We can conceive of the process of movement more granularly as the result of two elementary operations, Copy and Merge (Chomsky 1995). Suppose we begin with the structure in (20a), which is a simple English TP clause. Details of the internal structure of TP are not illustrated here, as they are not relevant for our discussion. We will demonstrate the process of moving the DP *every apple* to a higher position. We first Copy the DP into the workspace in Step 1, resulting in two separate objects in the workspace, with root nodes labeled DP and TP. A corresponding λ-binder is adjoined to the TP at this point to bind the position of the original *every apple*; we will discuss its interpretation below. We then Merge this new root DP with the original TP in Step 2.

(20) **Movement as Copy and Merge:**

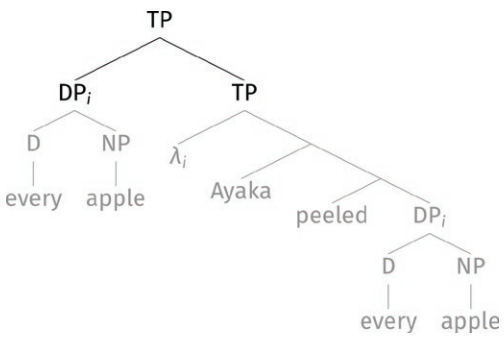
a. Step 0: Build TP



b. Step 1: Copy DP, adjoin corresponding λ-binder to TP



c. Step 2: Merge the new DP with TP



We begin by discussing the pronunciation of copy-chains at PF. In most instances of movement, only one of the copies within a chain will be pronounced at PF. Nunes (2004) proposes that this is because fully pronouncing two identical copies in the same copy-chain leads to a crash at PF. Any linearization algorithm for syntactic constituents that treats copies as exactly the same object for linearization will run into an ordering contradiction: the same object could end up preceding some constituent X because of the higher copy, but also following X because of the lower copy. For example, a linearization of (20c) will include the instruction *every apple* < *Ayaka* due to the higher copy of *every apple* but also *Ayaka* < *every apple* based on the lower copy, leading to a contradiction. A common strategy to avoid such linearization contradictions is to delete all but one of the copies at PF. In Section 3.2, we will introduce another strategy, which involves manipulating the copies in the chain.

The movement illustrated in (20) is an instance of Quantifier Raising (QR), a movement of quantificational DPs in object position for reasons of semantic interpretation (May 1977; 1985). This movement is covert in English; that is, one way to think about this movement is that the higher copy is interpreted at LF, but that the higher copy is deleted at PF, resulting in pronunciation of only the lower copy (see also footnote 19).

We now turn to the interpretation of the movement in (20). In considering how DP movement can be interpreted within a compositional semantics, we first review the standard approach in a framework with movement that does not leave copies. Such DP movement is hypothesized to leave a "trace" in the lower position of movement and this trace is interpreted as a variable of type *e*. Movement triggers λ-abstraction that binds the variable left behind. This is illustrated schematically in (21). The end result is that the quantifier *every* will scope higher while binding a variable in the object position of the verb. See e.g. Heim & Kratzer (1998) for further discussion of this widely adopted approach.

(21) **Interpreting movement as in (20), without copies:**
LF: [every apple] λx . Ayaka peeled x

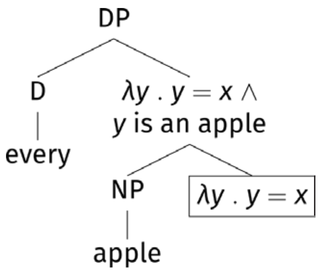
The question, then, is how to reconcile this basic semantics of movement with a theory of movement that leaves copies. Specifically, how is the lower copy to be interpreted? To address this question, Fox (2002) introduces a semantic chain resolution procedure called *Trace Conversion*, which converts the lower copy into a definite description (see also Rullmann & Beck 1998; Sauerland 1998; Fox 1999). For example, in (20), the lower copy of *every apple* will be interpreted as "the apple x", meaning the unique apple that is x, and the higher λ-binder will abstract over this value of x. The truth conditions of (22b) are identical to that of the non-copy-theoretic LF in (21).

(22) **Interpreting movement (QR) with copies:**
a. Narrow syntax (20c): [every apple]$_i$ λ_i Ayaka peeled [every apple]$_i$
b. LF after Trace Conversion: [every apple] λx . Ayaka peeled [the apple x]

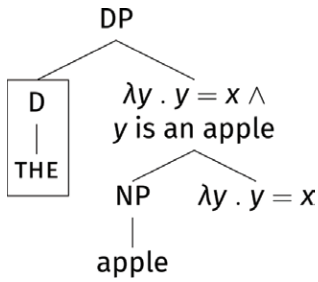
Fox (2002) presents Trace Conversion as the combination of two elementary operations. The first operation is Variable Insertion (23a): the original NP "apple" is modified intersectively by the predicate $\lambda y \,.\, y = x$, resulting in the modified domain "the apples that are x", where x is a variable. The higher λ-binder λ_i is now interpreted as λx to abstract over this variable. The second operation is Determiner Replacement (23b), which replaces the quantifier of the lower copy – here, *every* – with the definite determiner THE. The end result is as in (22b), where the lower copy of movement is interpreted as a definite description variable that is abstracted over by the λ-binder, whereas the highest copy will be interpreted with the quantificational force of the original determiner. If there are more than two copies in the chain, all lower copies can be converted in this fashion.

(23) **Trace Conversion of the lower copy, in detail:**

a. Step 1: Variable Insertion



b. Step 2: Determiner Replacement



The discussion thus far has illustrated how a quantifier such as *every* will be interpreted in the position of the highest copy of the DP. It is also possible for the quantifier in a lower copy position to be interpreted instead, resulting in lower quantificational scope, which is referred to as syntactic reconstruction. A common approach to syntactic reconstruction is to suppose that at LF the merger of the higher copy is "undone" or "ignored" (see Chomsky 1993; Hornstein 1995; Fox 1999). An alternative conception of syntactic reconstruction, which will be relevant for our proposal later, is the *Inverse Trace Conversion* proposal of Erlewine (2014). Under this approach, both the higher and lower copies are interpreted at LF, but now the quantifier of the *lower* copy is interpreted, and the *higher* copy is interpreted as a definite description.

We illustrate this approach in (24), where Inverse Trace Conversion is used to reconstruct the subject *every apple* into the *v*P-internal position in *Every apple isn't rotten* with its inverse scope interpretation, meaning "not every apple is rotten". Following Inverse Trace Conversion in (24b), the higher copy is interpreted as the plural individual "the apples", and the lower copy is interpreted as "every apple in [that higher plural individual *the apples*]". In this simple case, this is equivalent to interpreting the lower copy as simply "every apple", under the scope of negation.

(24) **Interpreting the lower copy quantifier through syntactic reconstruction:**
Inverse scope reading (not > every) of "Every apple isn't rotten."

a. Narrow syntax:
[every apple]$_i$ NEG [$_{vP}$ [every apple]$_i$ is rotten]

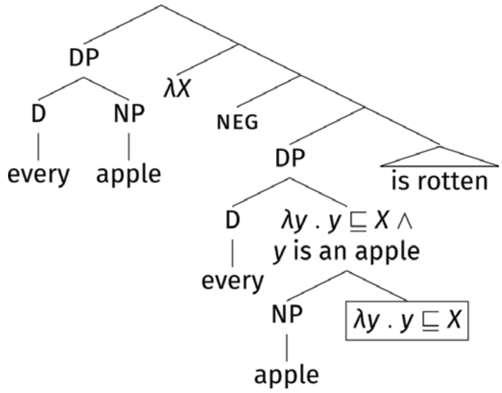
b. LF after Inverse Trace Conversion:
[THE apple(s)] λX . NEG [$_{vP}$ [every [apple in *X*]] is rotten]

Inverse Trace Conversion derives this result through a different application of the Variable Insertion and Determiner Replacement operations of standard Trace Conversion, with slight modifications. First, we apply a version of Variable Insertion to the lower copy (25a) to change the restrictor "apple" to "apple in *X*". Formally, here we use the $\sqsubseteq$

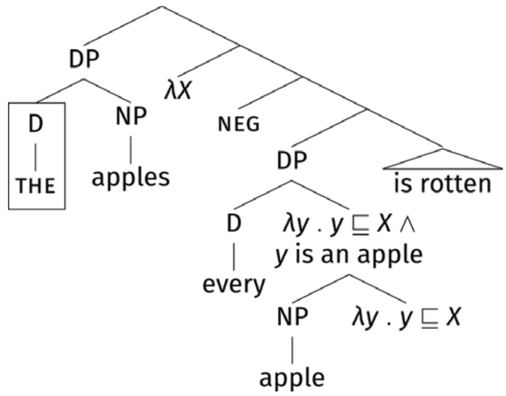
part-of relation. The higher λ-binder abstracts over this (possibly plural) type *e* individual variable *X*. Second, Determiner Replacement targets the *higher* copy (25b).[9]

(25) **Inverse Trace Conversion, in detail:**

a. Step 1: Variable Insertion of the lower copy, with the part-of relation ⊑



b. Step 2: Determiner Replacement of the higher copy



Erlewine (2014) motivates Inverse Trace Conversion through the interaction of reconstruction and focus association in English and demonstrates its utility for the interpretation of quantifier float. In Section 3.3 below, we will show that Inverse Trace Conversion offers a natural derivation for Japanese HIRCs, DHRCs, and HERCs with internally stranded quantifiers. See Chapter 7 of Erlewine (2014) for further discussion of Inverse Trace Conversion, including how Inverse Trace Conversion can be made compatible with the binding reconstruction facts discussed in Fox (1999).

In summary, movement can be recast as the result of two operations, Copy and Merge (20). This results in structures with two identical nodes in the structure, which must be modified for proper interpretation at the interfaces. The processes governing chain resolution discussed here are summarized in (26):

(26) **Copy-chain resolution:**
Copy-chains must be modified for interpretation at the interfaces.

a. Phonological chain resolution:
Pronunciation of multiple, identical copies is not linearizable (Nunes 2004). The chain must be modified by PF in order to avoid this problem, often by deletion of copies.

[9] Because the higher copy will denote the plural individual "the apples", for illustration purposes we change the higher noun "apple" to be plural. Note that this complication will not arise in Japanese, which has no number marking.

b. Semantic chain resolution:
One of two operations apply by LF to modify the chain:
i. Trace Conversion
ii. Inverse Trace Conversion

3.2 Head-raising through late-merger into a copy

In this section, we will present a unique approach to the derivation of head-external relative clauses for English and Japanese, which takes advantage of the Copy Theory of movement, reviewed above. Our approach builds on the idea, first developed by Lebeaux (1988; 1991), that relative clauses can be *Late Merged* into a DP in a derived position. Together with the Copy Theory reviewed above, this now widely-accepted proposal has successfully explained a range of DP scope, ellipsis, extraposition, and binding facts (see e.g. Sauerland 1998; Fox 1999; 2002; Fox & Nissenbaum 2000; Takahashi & Hulsey 2009).

To illustrate late-merger, consider the following contrast from Freidin (1986). Example (27a) is ungrammatical with coreference between *John* and the pronoun *he*. This is explained as a Condition C violation at LF, as the pronoun *he* c-commands the coreferential *John* in its base position of movement. In contrast, *John* in the relative clause in (27b) does not trigger a Condition C violation.

(27) **Condition C obviation with late-merger of the relative clause:**
a. *Which report that $John_i$ was incompetent did he_i submit?
Narrow syntax: *[Which report [that $John_i$ was incompetent]] did he_i submit [which report [that $John_i$ was incompetent]]?

b. Which report that $John_i$ revised did he_i submit?
Narrow syntax: [Which report [$_{\text{late-merged}}$ that $John_i$ revised]] did he_i submit [which report]?

Lebeaux proposes that adjuncts such as relative clauses can be attached after their host DPs have undergone movement. Thus, the DP *which report* is base-generated within the VP in (27b) and undergoes *wh*-movement, after which the relative containing *John* adjoins within the *wh*-DP. There is thus no instance of *John* that is c-commanded by *he* in (27b). The option for late-merger is not available to complements; consequently *he* must c-command the lower copy of the complement clause containing *John* in (27a), resulting in the familiar Condition C effect.

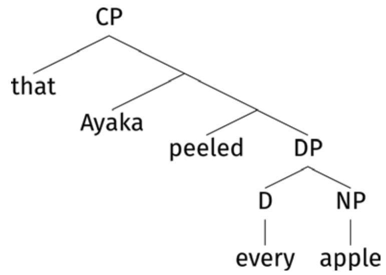
Our proposal for the derivation of relative clauses is as follows. First, build a CP via successive applications of Merge (28a). Next, Copy into the workspace the DP that will be the head of the relative (28b). At this point, copying the DP triggers the adjunction of a λ-binder to the root of the tree that contains the original DP being copied. Finally, the CP is Late Merged with that copy of the DP in the workspace (28c). We represent this late-merger as adjunction of the CP to the NP of the relative's head.[10] For the sake of conveni-

[10] In (28c), we illustrate the non-root-extending adjunction of the CP into the copied DP as taking place before the copied DP is merged into any larger structure. This adjunction could take place, for example, after the surrounding matrix clause has been completely built. We will stay agnostic here as to the precise timing of this adjunction.
This late-merge of the CP containing the lower copy of DP *into* the higher copy of DP seems to be a movement that violates the Proper Binding Condition (Fiengo 1977). However, if the spirit of the Proper Binding Condition is instead best stated as a semantic condition requiring the lower copy to have a c-commanding binder, the λ-binder introduced in Step 1 above would satisfy this requirement.
Note also that both instances of the DP will be in case-positions. A reviewer raises a concern that this may incorrectly lead to double case-marking on the head. There are at least two ways to address this question. The first possibility is that the copying of the head DP in (28b) takes place before it is case-assigned, leaving the internal head DP to be case-assigned within the relative clause and the external head DP to be case-assigned by the external clause. A second possibility is that case can be stacked onto DPs, but post-syntactic rules limit their pronunciation; in the case of Japanese, only one case-marker is allowed per DP. See e.g. Pesetsky (2013), Levin (2016), and references therein. We leave open these questions of case and DP licensing for future work.

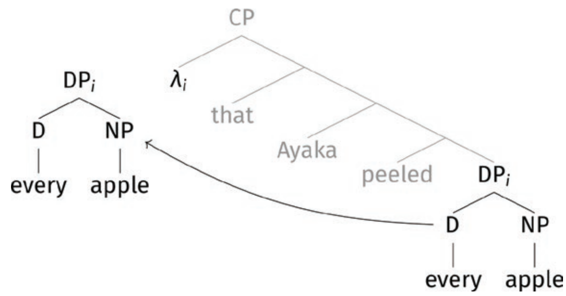
ence, we will refer to this structure in (28c) as that of a *proto-relative*, the common core of all of the relative clause derivations that we will discuss.

(28) **Derivation of a proto-relative:**

a. Step 0: Build CP

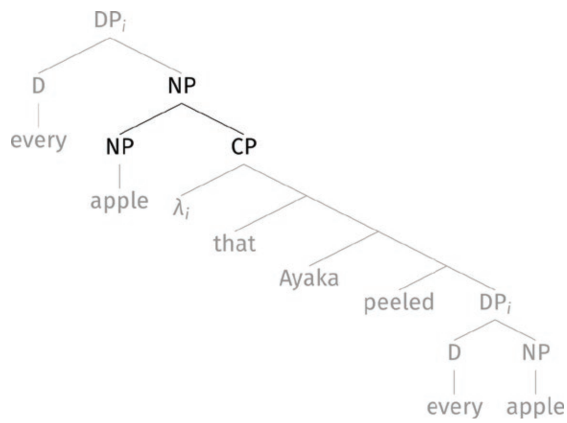


b. Step 1: Copy DP, adjoin corresponding λ-binder to CP



c. Step 2: Merge root CP to NP *apple* under the copied DP

i.e. Late Merge (Lebeaux's "late Adjoin-α") CP *into* the restrictor of DP

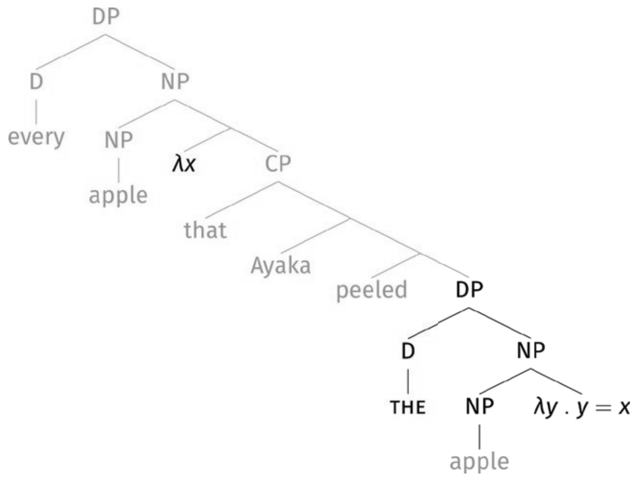


We propose that the structure in (28c) is the common core of all relative clause structures that we are studying here. The representation in (28c) shows the two copies of 'every apple' co-indexed with each other. As discussed above, the Copy Theory makes available different options for interpreting these copies at LF and at PF. For expository purposes, we will first demonstrate how the structure in (28c) can form a familiar English head-external relative clause. We discuss the application of this approach for the various relative clause strategies in Japanese in the following section.

For an English head-external relative, we propose that the higher copy of *every apple* in (28c) is pronounced and the lower instance is unpronounced. This results in the PF representation in (29). At LF, we apply Trace Conversion to the lower copy in (28c) to give us the structure in (30). The nominal domain "apple" and the CP relative clause are interpreted intersectively to form the domain "λx . *x* is an apple and Ayaka peeled [the apple *x*]" for the quantifier "every" (see e.g. Partee 1975).

(29) **A HERC at PF: pronounce the higher copy**
"every apple that Ayaka peeled"

(30) **A HERC at LF: Trace Convert the lower copy**



A precursor to this derivation of relative clauses is Henderson (2007), who similarly conceives of movement as Copy and Merge. Henderson proposes Copying the head noun NP of the relative clause and later late-merging the relative clause to an instance of that head noun. Our proposal differs from Henderson's in that we copy the DP, which allows for the possibility of pronouncing and interpreting the DP's quantifier in either the lower or the higher position. DP movement will play an important role in the compositional semantics we propose for Japanese relatives, as well as in the Spell-Out of copies at PF, in particular the higher copies in DHRCs which require the deictic *sono*. We now turn to our account of the various relative clause structures in Japanese.

3.3 The derivation of the three Japanese relatives

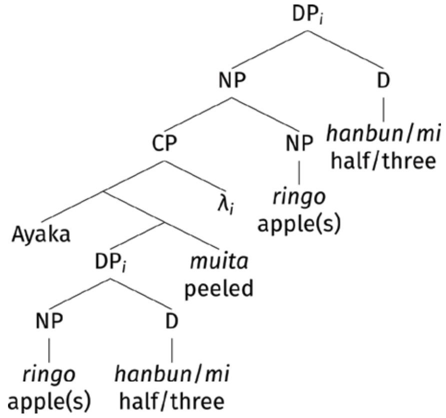
We now turn to our account of the various relative clause structures in Japanese, based on the general approach to the syntax of relative clauses introduced above. After outlining the shared underlying structure of the different relative clauses and the core structure of their LFs (Section 3.3.1), we discuss two conditions that govern the PF choices for Japanese relative clauses (3.3.2) and then present detailed derivational options (3.3.3). A detailed treatment of the semantics of these relatives is in Section 4.

3.3.1 The proto-relative and LF structures

We begin by following the Copy and Late Merge approach outlined in (28) above for Japanese relative clauses with the head DPs 'half apple' and 'three apple'. This results in the structure in (31), which we propose to be the common core of the three Japanese relative clause strategies.[11]

[11] The internal structure of the CP clause is again not illustrated. Also not illustrated here is the internal structure of the Japanese DPs *ringo hanbun* 'half apple' and *ringo mit-tsu* 'three apple'. We believe our proposal for the derivation of Japanese relative clauses is compatible with different options for the internal composition of Japanese DPs and in particular the position of quantifiers, numerals, and classifiers; see for example Watanabe (2006) and references therein for previous proposals. What is important for our purposes is that all material outside of the NP will be targeted by the Determiner Replacement step of Trace Conversion and Inverse Trace Conversion, not simply the D layer, narrowly-defined. We therefore illustrate both the quantifier *hanbun* 'half' and the numeral and classifier *mit-tsu* 'three-CL' under the D head in (31) and subsequent structures, but this should be taken as standing in for a potentially richer DP-internal representation. See also footnote 17 below on the position of demonstratives.

(31) **Japanese proto-relative structure after Copy and Late Merge (cf. (28)):**

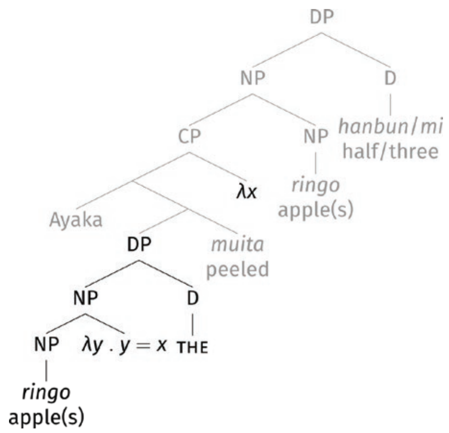


We propose that Japanese HERCs, HIRCs, and DHRCs all involve this underlying proto-relative derivation, which involves movement of the head DP. Evidence from island constraints shows that Japanese HERCs involve movement of the head (see e.g. Inoue 1976; Hasegawa 1981; and for a recent review, Ishizuka 2009). Watanabe (1992; 2003) similarly present evidence that the head inside a HIRC cannot be embedded inside a syntactic island; see also additional data in Grosu (2010), attributed by Grosu to Akira Watanabe (p.c.). Watanabe (1992) and subsequently Grosu (2010) and Grosu & Landman (2012) have used this evidence to motivate the movement of a null operator from the position of the internal head in HIRCs.[12] Our own analysis here is best thought of as a modern reincarnation of Itô (1986), which proposes that the head of a HIRC moves to an external position at a level of representation that does not feed the surface form, drawing a direct parallel to the derivation of HERCs in Japanese. In contrast to Itô, our proposal involves movement in the narrow syntax; this movement can unify the derivations of HERCs, HIRCs, and DHRCs and can explain the relationship between their surface realizations and semantic interpretations, which we present in the remainder of this section and in Section 4.

For the proto-relative structure in (31) to be interpretable, one of the semantic chain resolution strategies (26b) – Trace Conversion or Inverse Trace Conversion – must apply by LF to the movement chain of the head DP. We propose that in the derivation of Japanese relative clauses, these operations can apply either in the narrow syntax (which then feeds both LF and PF) or at LF after Spell-Out. Whether these operations apply before or after Spell-Out will have consequences for how these chains are pronounced at PF, and each possibility will be discussed later in this section. We will first discuss the final LFs after Trace Conversion and Inverse Trace Conversion, which will be the same regardless of when these operations take place. As illustrated for English in (30), Trace Conversion of the lower copy yields an LF as in (32). Note that this structure in (32) reflects the two instances of the nominal domain of ‘apple(s)’ at LF. We propose that (32) represents the LF for HERCs and HIRCs with quantifiers in external head position, in (19).

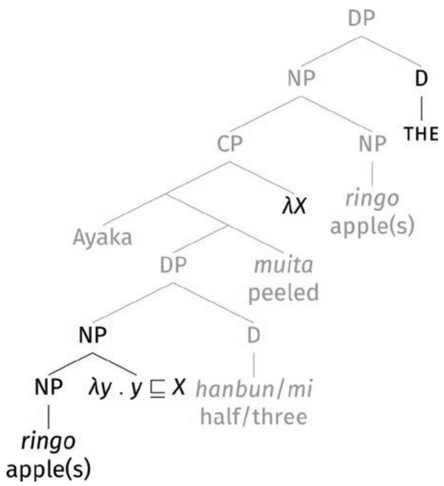
[12] Technically, for Grosu (2010) and Grosu & Landman (2012), this null operator moves from the position of the associated ChooseRole head, which is in a local relationship with the internal head, taking the head-containing VP as its complement. See Section 4.4 for further discussion.

(32) **LF for (31) after Trace Conversion of lower copy:**



The other option for semantic resolution of the copy-chain is the use of Inverse Trace Conversion, giving us the structure in (33) below. This allows the quantificational material (here, 'half' or 'three') to be interpreted in the lower copy inside the relative clause at LF, with the entire structure interpreted as a definite description. We propose that this option represents the structure of HIRCs, DHRCs, and HERCs with internal quantifiers, which we saw in Section 2 to consistently have the same interpretation. The interpretation of this structure in (33) in Japanese will be discussed in detail in Section 4.

(33) **LF for (31) after Inverse Trace Conversion:**



A precursor to this LF in (33) is Bhatt's (2002) mechanism for the interpretation of quantificational material on a lower copy of the head in an English head-external relative, with the higher λ-binder preserved. See Bhatt's Section 5.1. Note that Bhatt's syntactic proposal involves disregarding the higher copy of movement at LF, but not undoing the corresponding λ-binder of movement, which does not correspond to any independent syntactic reconstruction procedure. The approach we illustrate in (33) instead involves the straightforward application of the independently-motivated operation of Inverse Trace Conversion.

The demonstration above shows how the proto-relative clause structure in (31) can result in two distinct types of LFs. The quantificational material of the relative's head DP can be interpreted outside the relative with Trace Conversion (32) or inside the relative with Inverse Trace Conversion (33).

3.3.2 Two conditions on relative clause PFs

We now turn to the derivation of different PF forms and their relationship to the relative clause LFs above. As noted in Section 2, a number of distinct relative clause forms yield the same felicity- and truth-conditions. In terms of the LF forms discussed here, we propose that each of the various PF forms maps to the LF structure in (32) or (33). An important generalization regarding this mapping is the isomorphism between pronounced and interpreted position of the relative clause head's quantifier, also discussed in Shimoyama (1999): quantifiers that are pronounced internal to relative clauses are interpreted within the relatives, and quantifiers that are pronounced external to relative clauses are interpreted outside the relatives.

In order to ensure this result across all structures considered here, we adopt Bobaljik's *Minimize Mismatch* constraint as stated in Bobaljik (1995), which requires that the position of a quantifier at LF dictates the position where it is pronounced at PF. The condition can be thought of as a filter on possible pairs of PF and LF representations.

(34) **Minimize Mismatch** (Bobaljik 1995: 360):[13]
Pronounce the copy of an element which is mapped to the quantificational structure.

Bobaljik's condition in (34) is essentially a copy-theoretic restatement of a long-established condition on the relationship between surface structure and quantifier scope. See in particular proposals relating the relative scope of quantifiers to c-command relations at surface structure, such as the Scope Principle of Reinhart (1976: 191) and the Hierarchical Condition of Huang (1982: 220), the latter also referred to as the Isomorphic Principle by Aoun & Li (1989) and subsequent work. It is worth noting that a restatement of Huang's Hierarchical Condition/Isomorphic Principle was then adopted by Hoji (1985) to explain patterns of scope-rigidity in Japanese. For our current purposes, we will claim only that Minimize Mismatch in (34) holds of copy-chains in Japanese relative clause constructions, without making a more general claim regarding the status of Minimize Mismatch in Japanese.

We propose that a second condition governing the choice of PF form is the *Relevancy Condition* of Kuroda (1975–76; 1976). Kuroda notes that HIRCs, unlike HERCs, are only felicitous under certain conditions, where the event described in the relative clause is "directly relevant" to the embedding clause, as codified in (35).[14]

(35) **The Relevancy Condition** (Kuroda 1975–76; reprinted in Kuroda 1992: 147):
For a pivot-independent [head-internal] relative clause to be acceptable, it is necessary that it be interpreted pragmatically in such a way as to be directly relevant to the pragmatic content of its matrix clause.

---

[13] Minimize Mismatch is reformulated in Bobaljik (2002), but we use the formulation in (34), as we find the language in (34) to be clearer for presentation purposes. In more recent work, Bobaljik & Wurmbrand (2012) introduce a condition called Scope Transparency as a successor to Minimize Mismatch. The statement of Scope Transparency relates LF scope to linear precedence at PF instead of structural position at PF. However, it is clear that we do not want to say that a quantifier on the head that takes scope high, over the entire relative, must also precede the entire relative. Endnote 24 in Hoji (1985: 297) is apt here: "the choice between 'c-command' and 'precedence' is a tricky one in Japanese… On a binary branching tree, whenever A c-commands B, A precedes B, *except in the case of relative clauses*" [emphasis ours].

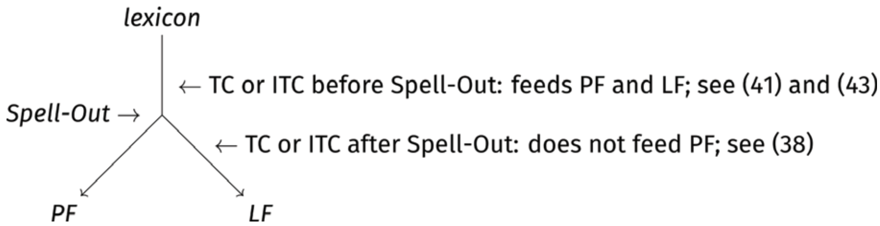
[14] The precise formulation of the Relevancy Condition has been a subject of some debate. See especially Yong-Beom Kim (2002), Nishigauchi (2004), Min-Joo Kim (2007; 2008), Grosu (2010), and citations therein for discussion.

An anonymous *Glossa* reviewer makes the important observation that the DHRCs studied here are also subject to this Relevancy Condition. We therefore propose that pronunciation of the lower copy nominal – the property shared by HIRCs and DHRCs, to the exclusion of HERCs – is licensed by satisfaction of the Relevancy Condition. Here we will leave open the question of exactly how the Relevancy Condition is evaluated (see footnote 14) and how this is tied to the pronunciation of the lower copy at PF. As this same reviewer points out, it remains to be seen to what extent this or similar constraints govern the pronunciation of lower copies of chains cross-linguistically and in other contexts; see e.g. discussion of similar constraints on Korean HIRCs in Yong-Beom Kim (2002) and Min-Joo Kim (2007; 2008).

3.3.3 Derivations

We are now in a position to consider each derivational option in turn. As noted above, we propose that semantic chain resolution operations (Trace Conversion and Inverse Trace Conversion) can apply *before or after* Spell-Out in Japanese, for the purposes of relative clause formation. These two options are represented schematically in the inverted Y-model illustration in (36):

(36) **Two options for the timing of semantic chain resolution:**



We will first discuss derivations with Trace Conversion or Inverse Trace Conversion taking place after Spell-Out. If these operations apply at LF, the PF representation will simply include two identical copies of the DP head of the relative, as illustrated in (37):

(37) **Structure at Spell-Out after no chain resolution in narrow syntax (31):**
$[_{\mathrm{DP}i}$ $[_{\mathrm{NP}}$ $[_{\mathrm{CP}}$ Ayaka $[_{\mathrm{DP}i}$ apple half/three] peeled] apple] half/three]

As the two copies in the PF in (37) are not distinct, linearization of the structure in (37) will result in linearization contradictions, necessitating deletion (Nunes 2004). For example, based on the lower copy, we yield the ordering instruction *apple* < *peeled*, but from the higher copy we yield the conflicting *peeled* < *apple*. Such conflicts are resolved by deletion of one copy of the quantifier and one copy of the head 'apple'.[15] This results in four different possible PF forms, given in (38), all of which are attested. Notice that because linearization considerations will force deletion of parts of the copy-chain, the derivation of relative clauses with semantic chain resolution operating post-Spell-Out will not result in DHRCs.

[15] We do not consider final PFs where both nouns or both quantifiers are deleted, as the intended nominal domain and quantifier would then be unrecoverable (cf. Fiengo & Lasnik 1972).

(38) **PF outputs for (37) after deletions for phonological chain resolution:**[16]

a. Pronouncing the higher noun and higher quantifier = canonical HERC (19a):
[$_{DP}$ [$_{CP}$ Ayaka-ga mui-ta] *ringo* *hanbun/mit-tsu*]
Ayaka-NOM peel-PAST apple half/three-CL

b. Lower noun and higher quantifier = HIRC with external quantifier (19b):
[$_{DP}$ [$_{CP}$ Ayaka-ga *ringo*-o mui-ta]-no *hanbun/mit-tsu*]
Ayaka-NOM apple-ACC peel-PAST-NO half/three-CL

c. Lower noun and lower quantifier = canonical HIRC (8)/(13):
[$_{DP}$ [$_{CP}$ Ayaka-ga *ringo-o* *hanbun/mit-tsu* mui-ta] -no]
Ayaka-NOM apple-ACC half/three-CL peel-PAST -NO

d. Higher noun and lower quantifier = HERC with internal stranding (12)/(15):
[$_{DP}$ [$_{CP}$ Ayaka-ga *hanbun/mit-tsu* mui-ta] *ringo*]
Ayaka-NOM half/three-CL peel-PAST apple

The choice between the four options in (38) is then governed by the two constraints discussed in Section 3.3.2 above. First, Minimize Mismatch (34) necessitates that the pronounced position of the quantifier reflect the position of the quantifier at LF. Second, pronunciation of the nominal domain of the lower copy is only possible if the Relevancy Condition is (35) is satisfied. Note that we interpret Minimize Mismatch (34) as only dictating the PF position of the quantificational material (D's). The Relevancy Condition and constraints on linearization are the only factors governing the pronunciation of NP's.

Consider the two possible relative clause LFs, discussed in Section 3.3.1 above. If the copy-chain in (37) is resolved through Trace Conversion at LF, we yield the LF in (39). Minimize Mismatch requires that the quantifier be pronounced high in this case, resulting in the HERC with external quantifier in (38a) and the HIRC with external quantifier in (38b). The choice between (38a) and (38b) is then limited by the Relevancy Condition: pronunciation of the lower copy noun in (38b) is only possible if Relevancy is satisfied.

(39) **LF after Trace Conversion (32):**
[$_{DP}$ [$_{NP}$ [$_{CP}$ [Ayaka [$_{DP}$ [apple x] the] peeled] λx] apple] **half/three**]

[16] One characteristic of the resulting HIRC forms is the morpheme *-no*, which does not appear with HERCs or DHRCs. This morpheme has been treated variously as, for example, a complementizer in Itô (1986) and a definite determiner in Shimoyama (1999). Under our approach, the presence or absence of *-no* is simply a superficial PF difference, with the relevant descriptive generalization being that *-no* never occurs when the higher copy of the head's NP is pronounced. Such an approach is adopted by several previous authors. For concreteness, we note that Kitagawa & Ross (1982) propose that a modification marker (MOD; *no* in Japanese and *de* in Mandarin Chinese) is inserted between prenominal modifiers (including relative clauses) and their nominal heads (i), with a subsequent Japanese-specific *NO*-Deletion Rule (ii). The application of MOD-Insertion and *NO*-Deletion late at PF, evaluating condition (iia) after it has been determined whether the higher copy NP will be pronounced or not, derives the correct distribution of *-no* for all Japanese RCs under our unified approach.

(i) MOD-Insertion (Kitagawa & Ross 1982: 23):
[$_{NP}$ X NP] → [$_{NP}$ X MOD NP]

(ii) *NO*-Deletion (Kitagawa & Ross 1982: 23):
[$_{NP}$ X *no* NP] → [$_{NP}$ X NP]
where (a) NP $\neq$ e (i.e., the head NP is occupied by a phonologically full lexical item); and
(b) X = [… tense] (i.e., X is tensed [+V] final)

This MOD-Insertion and NO-Deletion approach is also adopted and revised in Kitagawa (2005). Itô (1986) also proposes a similar PF constraint on *-no*, which is a version of Chomsky & Lasnik's (1977) doubly-filled COMP filter. A reviewer asks whether this approach from Kitagawa & Ross and others can also extend to clausal arguments which also end in *-no*. We speculate that this is possible, if clausal arguments with *-no* are in fact DPs. This resonates with recent work arguing that finite clausal arguments in fact modify (possibly) null content nouns such as 'fact'; see e.g. Moulton (2015) and references therein.

If the copy-chain is resolved through Inverse Trace Conversion at LF, we yield the LF in (40). Minimize Mismatch will require the lower copy of the quantifier to be pronounced, giving us the canonical HIRC with internal quantifier in (38c) and the HERC with internal quantifier in (38d). The choice between these two forms is then limited by the Relevancy Condition, the satisfaction of which is required for the HIRC form in (38c).

(40) **LF after Inverse Trace Conversion (33):**
[$_{DP}$ [$_{NP}$ [$_{CP}$ [Ayaka [$_{DP}$ [apple $\sqsubseteq X$] **half/three**] peeled] λX] apple] the]

We now turn to the possibility of applying Trace Conversion or Inverse Trace Conversion in the narrow syntax, before Spell-Out. Recall that both of these independently-motivated operations involve tampering with copies in a copy-chain, making them formally distinct. The application of these chain resolution operations prior to Spell-Out will then feed the PF representation with two distinct copies in the chain. We propose that this can lead to both copies in the movement chain being pronounced, without resulting in linearization contradictions of the form discussed by Nunes (2004). In addition, the early application of semantic chain resolution will directly ensure the tight correspondence between final PF and LF representations otherwise necessitated by Minimize Mismatch.

We first illustrate the pre-Spell-Out application of Inverse Trace Conversion. This results in the PF representation in (41). In (41), the lower copy consists of the quantifier – where it is interpreted as per the LF in (33), satisfying Minimize Mismatch (34) – and the head noun, whereas the higher copy consists of the definite determiner and the head noun.

(41) **PF representation after Inverse Trace Conversion in the narrow syntax:**
[$_{DP}$ [$_{NP}$ [$_{CP}$ [Ayaka [$_{DP}$ [apple $\sqsubseteq X$] half/three] peeled] λX] apple] THE]
Resulting PF output = DHRC (11)/(14):
[$_{DP}$ [$_{CP}$ Ayaka-ga *ringo-o* *hanbun/mit-tsu* mui-ta] *sono-ringo*]
Ayaka-NOM apple-ACC half/three-CL peel-PAST that-apple

Inverse Trace Conversion tampers with both the higher and lower copies of a copy-chain, making them formally distinct. Both copies can then be simultaneously pronounced and linearized, resulting in a DHRC (41). Pronouncing the lower copy in (41) straightforwardly gives us the internal head of a DHRC. As for the external head, we propose that the medial demonstrative *sono* is the conventionalized strategy for pronouncing the definite determiner introduced by Inverse Trace Conversion in such a configuration.[17] Evidence for this view comes from the fact that proximal and distal demonstratives cannot be used in the same position (42), even if the event of Ayaka peeling the apples or the resultant apples are construed as very close to or far from the speaker.

(42) **Doubly-headed relative clauses must use *sono* (41), not other demonstratives:**
*[$_{DP}$ [$_{CP}$ Ayaka-ga *ringo-o* *hanbun/mit-tsu* mui-ta] *kono/ano-ringo*]
Ayaka-NOM apple-ACC half/three-CL peel-PAST PROXIMAL/DISTAL-apple

This obligatory *sono* deictic on the higher head in DHRCs supports our DP-movement analysis for relative clauses, in this case with the higher copy pronounced following Inverse Trace Conversion. If relative clauses instead involved movement of only the head NP (restrictor), the choice of demonstrative at the outside edge of the entire relative clause construction should be completely independent of the internal derivation of the relative clause, and therefore allow any demonstrative marker.

[17] In the trees given above, the higher layers of the DP are illustrated as a single left-branching DP. Note, though, that demonstratives are necessarily prenominal. As mentioned in footnote 11 above, there is internal structure in the DP that we do not illustrate here. We assume the *sono* demonstrative is prenominal and the relative clause preposes to yield the observed RC-*sono*-NP order.

Having discussed the PF outcome of applying Inverse Trace Conversion before Spell-Out (viz. DHRCs), we next consider applying Trace Conversion to the lower copy before Spell-Out. Again this results in a PF representation (43) that closely parallels an LF, this time the LF in (32). In (43), the higher copy consists of the quantifier – where it is interpreted as per the LF in (32), in accordance with Minimize Mismatch – and the head noun, whereas the lower copy consists of the definite determiner and the head noun.

(43) **PF representation after Trace Conversion in the narrow syntax:**
$[_{DP}$ $[_{NP}$ $[_{CP}$ [Ayaka $[_{DP}$ [apple *x*] THE] peeled] λx] apple] half/three]
Pronouncing both copies (cf 41):

*$[_{DP}$ $[_{CP}$ Ayaka-ga	*sono-ringo*-o	mui-ta]	*ringo*	*hanbun/mit-tsu*]
Ayaka-NOM	that-apple-ACC	peel-PAST	apple	half/three-CL

Because Trace Conversion has applied prior to Spell-Out, the lower copy in (43) is distinct from the higher copy for the purposes of linearization and pronunciation. We saw above that with Inverse Trace Conversion applied pre-Spell-Out, the higher copy with the definite determiner is pronounced with demonstrative *sono* (41). In contrast, pronouncing both the higher copy and the Trace Converted lower copy definite using a demonstrative *sono* is ungrammatical.

We propose that this reflects a general principle, observed in many languages, to not pronounce definite description lower copies (what we traditionally call *trace* positions), except in certain circumstances where pronunciation of the lower copy is necessitated. For example, island-violating movement in many languages can be substantially improved if a lower position in the chain can be pronounced as a “resumptive” pronoun, as seen in (44). Following Perlmutter (1972), Pesetsky (1997; 1998) develops the idea that this “resumptive” is a reduced form of the lower copy that is pronounced; see also discussion in Bošković (2002).

(44) **Pronouncing a lower copy only when necessary (Pesetsky 1998: 364):**

a. *Which picture of John were you wondering
[whether __ was going to win a prize at the exposition]?

b. Which picture of John were you wondering
[whether *it* was going to win a prize at the exposition]?

As predicted by this approach, there are certain situations where pronunciation of the definite description lower copy as in (43b) is grammatical. Kuno (1973) gives one such example in (45), which he describes as “awkward, but not ungrammatical”. Kuno (1973) and Haig (1976) point out that overt internal heads of this form are disallowed in argument positions; it is grammatical in (45) because it is a possessor. Further, possessors in Japanese do form islands for extractions such as scrambling. We liken the possessor position in (45) to the island-internal position in (44) in allowing exceptional pronunciation of the Trace-Converted lower copy.[18]

(45) **Doubly-headed relative with *sono* on lower copy (Kuno 1973: 237):**

$[_{DHRC}$ watakusi-ga	*sono-okyakusan*-no	namae-o	wasurete-sima-tta	*okyakusan*]
I-NOM	that-guest-GEN	name-ACC	forget-SIMA-PAST	guest

‘a guest whose name I have (unfortunately) forgotten’

Although (45) supports the availability of a derivation involving Trace Conversion before Spell-Out predicted by our account, we are ultimately unable to explain why this strategy

[18] Note further that the demonstrative *sono* in example (45) cannot be replaced with distal *ano* or proximal *kono* demonstratives, reflecting that *sono* here is the pronunciation of the Trace Converted lower copy definite description, rather than a regular deictic demonstrative. This parallels the observation in (42).

is generally unavailable, as reflected by the ungrammaticality of (43). We will leave this issue open for future research.

We have now seen the different PF possibilities of applying Trace Conversion or Inverse Trace Conversion before Spell-Out. Crucially these operations modify copies in the copy-chain so they are no longer identical at PF, allowing for multiple exponence. This results in both DP copies being pronounced following Inverse Trace Conversion, resulting in DHRCs (41), and under certain circumstances also following Trace Conversion, resulting in HERCs with "resumptives" as in (45). Further, we have seen how applying these operations before Spell-Out leads to the obligatory use of a medial demonstrative *sono*, which we propose is the pronunciation of the definite description resulting from semantic chain resolution. That the grammar enforces the exponence of the definite determiner supports our DP head-raising analysis.

3.4 Summary

In this section we presented our syntax for the three Japanese relative clause types considered here – head-external, head-initial, and doubly-headed – as well as their quantifier stranding variants. In particular, the doubly-headed relatives provide strong evidence for an analysis involving DP movement. Using our proposal from Section 3.2, which introduced a Copy and Late Merge approach to head-raising relative clause derivations, together with independently-motivated operations for the semantic interpretation of copy-chains, we arrive at a uniform framework for the diverse range of Japanese relativization strategies. The availability of Trace Conversion and Inverse Trace Conversion applying pre-Spell-Out naturally results in two previously understudied Japanese relative clause constructions: doubly-headed relatives and head-external relatives with a lower "resumptive" copy, as in (45).[19]

The various relative clause forms studied map onto just two different LF representations, corresponding to the choice of Trace Conversion or Inverse Trace Conversion to make the copy-chain interpretable. Given a target LF, the corresponding PF forms may be restricted by the fact that pronunciation of the lower copy noun phrase requires satisfaction of Kuroda's Relevancy Condition. Regardless of the timing of these operations, pre- or post-Spell-Out, and the choice of pronounced copies, the adoption of Bobaljik's Minimize Mismatch ensures that the pronounced and interpreted positions of the head DP's quantificational material match. This reflects the empirical facts presented in Section 2, which showed that all of the relatives with internal quantifiers have the same interpretational profile, and similarly with relatives with external quantifiers. In the next section, we turn to a detailed discussion of the interpretation of these LFs and their context-sensitivity observed in Section 2.

4 Interpreting relative clauses

Our proposal for the unified syntax of Japanese relativization presented in Section 3 predicts there to be two different LFs for Japanese relative clauses, corresponding to the choice of semantic chain resolution strategy. These two options are repeated below in (46) with their basic semantic denotations. The LF in (46b) resolves the copy-chain in (46a) using Trace Conversion, leaving the higher copy's quantifier interpreted. We propose that

[19] We suggested in the previous section that this general Copy and Late Merge approach may also apply for English relative clauses. A natural question is then why head-internal and doubly-headed relativization are not available in English. We suggest that semantic chain resolution operations such as Inverse Trace Conversion apply only at LF in English, and therefore a PF structure such as (41) would never be considered in English. Furthermore, the lack of head-internal relativization is explained by the generalization for English that the highest copy in chains derived in narrow syntax must be pronounced at PF, with covert movement being movement at LF.

(46b) exemplifies the LF of Japanese relative clauses with quantifiers in external head position, such as the HERC and HIRC in (19). The LF in (46c) instead uses Inverse Trace Conversion, leaving the lower copy's quantifier interpreted and instead interpreting the entire DP as a definite description. As discussed above, we propose that (46c) represents the LF for Japanese HIRCs, DHRCs, and HERCs that have internally quantified heads.

(46) **Two LFs for Japanese relative clauses:**

a. Proto-relative structure, after Late Merge of CP into the head DP (=(31)):
$[_{DPi}$ $[_{NP}$ $[_{CP}$ [Ayaka $[_{DPi}$ apple half/three] peeled] λ_i] apple] half/three]

b. LF after Trace Conversion (=(32)):
$[_{DP}$ $[_{NP}$ $[_{CP}$ [Ayaka $[_{DP}$ [apple $\boldsymbol{x}$] THE] peeled] $\boldsymbol{\lambda x}$] apple] half/three]
$[\![$DP$]\!]$ = $[\![$half/three$]\!]$(λx . x is an apple and Ayaka peeled the apple x)
= λP . half/three of $\{x \mid x$ is an apple and Ayaka peeled $x\}$ satisfy P

c. LF after Inverse Trace Conversion (=(33)):
$[_{DP}$ $[_{NP}$ $[_{CP}$ [Ayaka $[_{DP}$ [apple $\sqsubseteq \boldsymbol{X}$] half/three] peeled] $\boldsymbol{\lambda X}$] apple] THE]
$[\![$DP$]\!]$ = $[\![$THE$]\!]$(λX . X apple(s) and Ayaka peeled half/three [apple parts of X])

In this section we will focus on the interpretation of this denotation in (46c). We will show how this denotation, together with a maximal informativeness semantics for definiteness (von Fintel, Fox & Iatridou 2014), is able to account for the interpretations documented in Section 2 of Japanese HIRCs, DHRCs, and HERCs that have internally quantified heads. A simple assumption regarding the role of context on the interpretation of definite descriptions will explain the context-sensitivity observed in Section 2 and one major point of inter-speaker variation.

4.1 *Background: Definiteness as maximal informativeness*

In this paper we will adopt a proposal by von Fintel, Fox & Iatridou (2014) for modeling definiteness as *maximal informativeness*. As we will see in the next section, the adoption of a maximal informativeness semantics for the definite determiner is crucial for computing the correct interpretation for some Japanese relatives with quantificational heads.

Traditionally the definite determiner THE has been described as a *maximality* operator which returns the unique maximal individual satisfying the restriction (see e.g. Sharvy 1980; Link 1983). Consider the interpretation of the definite description *the number of children that John has* in (47) below. We assume that the domain of the predicate N = "λn . John has n-many children" is restricted to positive integers. The definite description is interpreted as the maximal value that satisfies this predicate in the context. In this case, the positive integers 1, 2, 3, and 4 satisfy the predicate N. $[\![$THE$]\!]$(N) returns the maximal value, 4.

(47) **Maximality semantics for the number of children that John has:**
Context: John has exactly four children.
1 < 2 < 3 < **4** < ~~5~~ < ~~6~~ < ~~7~~ <…

In contrast, von Fintel, Fox & Iatridou (2014) propose a new, intensional semantics for THE which returns the unique individual corresponding to the *maximally informative* true description. The denotation of the definite determiner THE is defined as follows:

(48) **Definiteness as maximal informativeness (von Fintel, Fox & Iatridou 2014):**

a. $[\![$THE$]\!]$(φ) is defined in w only if there is a uniquely maximal object x, based on the ordering $\geq_\varphi$, 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 $\lambda w . \varphi(w)(y)$.

In many cases, the maximal informativeness semantics in (48) yields the same result as the traditional maximality semantics for THE. For example, consider the interpretation of *the number of children that John has* using the maximal informativeness semantics for THE in (48). In this case we consider the intensional property φ = "λw . λn . John has n-many children in w" for different values of n. We discard the values of n where $\varphi(w^*)(n)$ is false, where w^* is the world of evaluation, and order the remaining values by $\geq_\varphi$. The φ-proposition "λw . John has 4 children in w" entails all other φ-propositions that are true in the context, and therefore it will be the *maximally informative* true φ-proposition. ⟦THE⟧(φ) returns the value of n corresponding to this maximally informative true proposition: 4.

(49) **Maximal informativeness semantics for *the number of children that John has:***
Context: John has exactly four children.
Ordering of φ-propositions by entailment: Resulting partial order $\geq_\varphi$:
… ⇐ λw . John has 3 children in w
⇐ **λw . John has 4 children in w** $1 \leq_\varphi 2 \leq_\varphi 3 \leq_\varphi$ **4** $\leq_\varphi$ ~~5~~ $\leq_\varphi$ ~~6~~ $\leq_\varphi$ …
⇐ ~~λw . John has 5 children in w~~ ⇐ …

The difference between maximality and maximal informativeness lies in the ordering used over the values that satisfy the restriction. In the case of *the number of children that John has*, both the natural ordering over numbers and the ordering $\geq_\varphi$ based on the entailment of corresponding φ-propositions yield the same result.

There are other cases, however, where only the maximal informativeness semantics yields the correct interpretation. For example, consider the definite description *the amount of flour sufficient to bake a cake*, beginning with the maximal informativeness approach from (48). We consider the intensional property φ = "λw . λn . n-much flour is sufficient to bake a cake in w" with different values of n, ordered by propositional strength. Note that if the proposition "λw . n-much flour is sufficient to bake a cake in w" is true, the corresponding proposition for any greater amount of flour, $m > n$, will also be true: "λw . m-much flour is sufficient to bake a cake in w". Therefore, φ-propositions corresponding to *smaller* values of n will be stronger. Of those φ-propositions that are true in the context in (50), the maximally informative proposition is "λw . 150g of flour is sufficient to bake a cake in w". ⟦THE⟧(φ) returns the corresponding value: 150g.

(50) **Maximal informativeness semantics for *the amount of flour sufficient to bake a cake*:**
Context: 150g of flour is sufficient to bake a cake.
Ordering of φ-propositions by entailment:
… ⇐ λw . 160g of flour is sufficient to bake a cake in w
⇐ **λw . 150g of flour is sufficient to bake a cake in w**
⇐ ~~λw . 140g of flour is sufficient to bake a cake in w~~ ⇐ …
Resulting partial order $\geq_\varphi$:
… $\leq_\varphi$ 170g $\leq_\varphi$ 160g $\leq_\varphi$ **150g** $\leq_\varphi$ ~~140g~~ $\leq_\varphi$ ~~130g~~ $\leq_\varphi$ …

(51) **Maximality semantics for *the amount of flour sufficient to bake a cake*:**
Context: 150g of flour is sufficient to bake a cake.
… < ~~130g~~ < ~~140g~~ < 150g < 160g < 170g < … *there is no maximal value!*

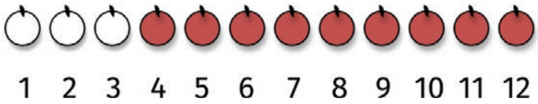
In contrast, we are unable to model this definite description accurately using the traditional maximality semantics. In the context in (51), 150g of flour is sufficient to bake a cake, but so is *any greater amount of flour*. Using the natural ordering over these values, there will be no unique maximal value.

4.2 Interpreting relatives and the effect of context

We are now in a position to compute the denotation of the HIRCs and DHRCs, as schematized in (46c), repeated here as (52). Consider first the denotation in (52) with the numeral 'three', in the simple context with no groupings, repeated in (53) below with the apples numbered.

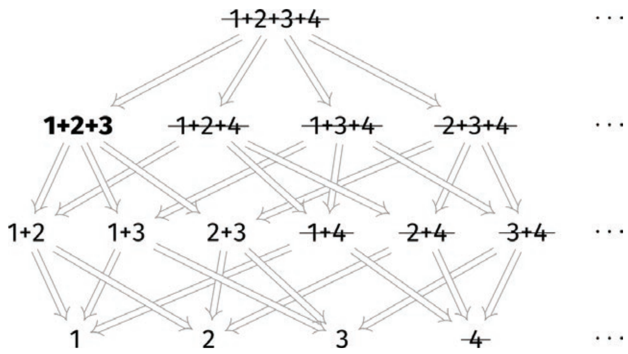
(52) **Proposed denotation for HIRC, DHRC, and HERC with internal quantifiers (46c):**[20]
⟦DP⟧ = ⟦THE⟧ (λX . X apple(s) and Ayaka peeled half/three [atomic apple parts of X])

(53) **Context with no salient subgroups, repeated from (3):**



We will use the maximal informativeness semantics for THE introduced above, with φ_{three} = "λw . λX . X apple(s) and Ayaka peeled three [atomic apple parts of X] in w". The following entailment pattern holds of φ_{three}-propositions: the statement "λw . Ayaka peeled three atomic apple parts of X in w" entails "λw . Ayaka peeled three atomic apple parts of Y in w" if and only if X is a part of Y. Entailment relations between φ_{three}-propositions for different apple sums are illustrated in (54). We use this entailment pattern to induce a partial order over the set of apples in (53) closed under sum formation, using the definition in (48b): $X \geq_{\varphi three} Y$ if and only if $X \sqsubseteq Y$.

(54) **Maximal informativeness semantics for (52) in context (3)/(53):**



Based on this ordering, the $\geq_{\varphi three}$-maximal individual that satisfies φ_{three} is the sum of the apples $1+2+3$, bolded in (54): the proposition "λw . Ayaka peeled three atomic apple parts in $1+2+3$ in w" entails "λw . Ayaka peeled three atomic apple parts in Y in w" for all Y which satisfy φ_{three} in the context. The denotation of the DP in (52) with 'three' will be ⟦THE⟧(φ_{three}) = $1+2+3$.[21]

Now consider (52) with the quantifier 'half' evaluated in (53). φ_{half} = "λw . λX . X apple(s) and Ayaka peeled half of the [atomic apple parts of X]". Notice that there is no productive entailment pattern between φ_{half}-propositions corresponding to different apple sums; that is, there is no general relation between X and Y such that peeling half of the apples in X entails that half of the apples in Y will also be peeled, except equality. We

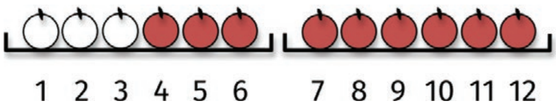
[20] The reference to *atomic* parts here in (52) is introduced by the quantifiers 'half' and 'three', which measure the number of atomic parts. This ensures, for example, that the sum of two apples 1 and 2 does not satisfy the numeral 'three': $1+2$ does contain three apple parts, 1, 2, and $1+2$, but only two atomic apple parts, 1 and 2.

[21] In Section 2, we reported the HIRC and DHRC corresponding to (42) has another reading, referring to the entire set of 12 apples. We return to this reading below.

therefore result in the (trivial) partial order $X \geq_{\varphi half} Y$ iff $X = Y$. Next, we note that there are multiple apple sums of the same size that satisfy φ_{half} in the context: for example, $1+2+3+4+5+6$ and $1+2+3+7+8+9$. Therefore there is no unique $\geq_{\varphi half}$-maximal apple sum that satisfies φ_{half} in the context, and therefore based on the definition in (48), $[\![\text{THE}]\!](\varphi_{half})$ is predicted to be undefined in context (53). This explains the infelicity of the HIRC and DHRC with *hanbun* 'half' in the context (53) without any grouping.

Of course, the HIRC and DHRC with the quantifier *hanbun* 'half' can be used felicitously in the richer context with two salient groups that we have considered, repeated here as (55). We propose that this effect is due to a more general effect of salient sets in the interpretation of definite descriptions, which we call the *Salient Sets Restriction*, given in (56).

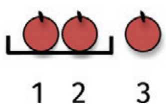
(55) **Context with two groups of apples, repeated from (9):**



(56) **Salient Sets Restriction (SSR):**
The existence of salient sets in the context allows for limiting the set of possible outputs of $[\![\text{THE}]\!]$ to those salient sets (represented as plural sums).

The effect of the Salient Sets Restriction is easily observable beyond our Japanese relative clause examples. For example, consider the context in (57) with three apples, two of which form an observable group, to the exclusion of the third. A sentence such as the English *Junya will eat the two apples* in this context is unambiguously interpreted to mean that Junya will eat apples 1 and 2. This reading is possible because of the SSR in (56): without the SSR, there are three possible referents satisfying the description "two apples" – $1+2$, $1+3$, and $2+3$ – with no way of ordering them based on this description.[22] The SSR introduces the option of considering only $1+2$ versus 3 as possible referents, of which only $1+2$ satisfies the description "two apples", giving us our unique referent.

(57) **Context with three apples, two of which form a group:**



Returning now to the context in (55), there are two salient sets of objects. Electing to use the SSR, we limit the possible referents for definite descriptions to just two plural individuals: $1+2+3+4+5+6$ and $7+8+9+10+11+12$. Only one of these individuals satisfies φ_{half} in the context: $1+2+3+4+5+6$. Therefore the denotation in (52) with 'half' will have a referent in the context in (55), explaining the felicity of the HIRC and DHRC with *hanbun* 'half' in this context with unambiguous reference to the entire first group of apples, $1+2+3+4+5+6$.

Let us now return to the interpretation of the HIRC and DHRC with the numeral 'three'. We showed above that we predict $[\![\text{THE}]\!](\varphi_{three})$ to refer to the peeled apples $1+2+3$ in the context with no groupings in (53) above. This same interpretation will be possible in the context with two groups in (55), ignoring its salient set information. However, The Salient Sets Restriction introduces additional possible readings for the HIRC and DHRC with 'three' in these contexts.

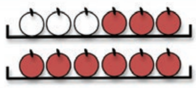
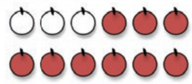
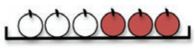
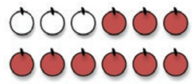
[22] Although we adopt the maximal informativeness semantics for definite descriptions in our analysis, this argument for the SSR still holds even if a traditional maximality semantics for the definite is adopted.

We first consider the context (53) with no groupings: if we consider the entire group of twelve apples in the context to be a salient set – perhaps in opposition to other apples which may exist outside of the relevant context – then electing to use the SSR allows us to consider only the entire group of twelve apples as a possible output for $[\![\text{THE}]\!](\varphi_{three})$. This sum of all twelve apples does satisfy φ_{three} in the context, as Ayaka has peeled three atomic apple parts thereof, explaining the possibility of interpreting $[\![\text{THE}]\!](\varphi_{three})$ as all twelve apples in (53).

In the context with two groups, (55), electing to use the SSR will give us a different result. The two possible referents will be $1+2+3+4+5+6$ and $7+8+9+10+11+12$, and only the former satisfies φ_{three}. Therefore $[\![\text{THE}]\!](\varphi_{three}) = 1+2+3+4+5+6$, the first group of apples.

As documented in Section 2 above, the interpretation of Japanese HIRCs and DHRCs is complex and context-sensitive. These patterns are summarized in the table in (58) below, which reproduces part of the summary table (18) from Section 2 above. In this section we showed how the simple definite description denotation we propose for these HIRCs and DHRCs in (52) accurately captures this pattern of judgments.

(58) **Summary of denotations in different contexts, repeated from (18):**

Context:		
HIRC (8), DHRC (11), and HERC (12) with internal 'half':		#
HIRC (13), DHRC (14), and HERC (15) with internal 'three':	i.  ii. 	i.  ii. 

In the simpler context with no grouping, (52) with 'half' will be undefined, and (52) with 'three' will refer to the three peeled apples or – if the SSR is used with the entire set of twelve apples considered – the entire group of twelve apples. In the context with two groups, (52) with 'half' will now be able to find a referent, the first group of six apples, using the SSR. (52) with 'three' is again ambiguous, referring to the three peeled apples or – if the SSR is invoked – the group of six apples in which three are peeled.[23]

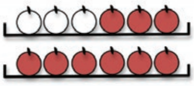
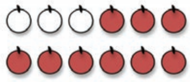
We note finally that the adoption of definiteness as maximal informativeness (von Fintel, Fox & Iatridou 2014) is crucial for our analysis. Using a more traditional maximality semantics for the definite, $[\![\text{THE}]\!](\varphi_{three})$ will refer to the maximal plural individual which satisfies φ_{three}. In the case where the SSR is not used, this will necessarily be the sum of all the apples in the context, because it too satisfies the description of Ayaka having peeled three of its atomic apple parts. Thus, maximal informativeness semantics is essential for deriving the reading of $[\![\text{THE}]\!](\varphi_{three})$ that denotes the three peeled apples.

[23] The discussion above now gives us a more precise way of characterizing the judgments reported in (17), which showed that cross-sentential anaphora pattern differently from relative clauses with an internal quantifier 'three'. Example (17) showed that a cross-sentential anaphor generally cannot pick out a salient set of six apples, three of which have been peeled (but cf. footnote 8). We conclude that the SSR is generally not active for the resolution of cross-sentential anaphora.

4.3 Another pattern of judgments

As mentioned at the beginning of Section 2, the denotations for Japanese HIRCs, DHRCs, and HERCs that have internally quantified heads, summarized in (58), reflect the judgments of the majority of speakers that we consulted with. However, three of our survey participants responded with a very different, internally consistent pattern of judgments. This pattern is summarized in the table in (59) below.

(59) **A different pattern of judgments, by some speakers (cf. (58)):**

Context:		
HIRC (8), DHRC (11), and HERC (12) with internal 'half':	#	#
HIRC (13), DHRC (14), and HERC (15) with internal 'three':		

The pattern of judgments reported by these speakers varies greatly from what we have reported above. The HIRC, DHRC, and HERC with internal quantifier 'half' are all judged as infelicitous in both types of contexts. In contrast, the HIRC, DHRC, and HERC with internal numeral 'three' are all judged as referring unambiguously to the three peeled apples.[24]

Two things are striking here. First, the pattern we summarize in (59) to represent responses from a minority of speakers is drastically different from the pattern we reported in Section 2 above and summarized in (58). Second, there is strong inter-speaker consistency within each of these groups of responses.

Fortunately, our proposal above offers a natural account for this difference. The interpretations for some speakers, summarized in (59), are precisely what we predict if the Salient Sets Restriction (SSR) in (56) is consistently not used by these speakers. Recall from the discussion in the previous section that the context with two groups allows for a reading where the six apples in the first group is picked out if the SSR is used; the first group satisfies the descriptions of Ayaka having peeled half or three of its atomic apple parts, but it is not the unique maximal possible referent of this form without the SSR. Furthermore, without the SSR, there is no option in the context with no groupings to consider just the entire group of twelve apples as a salient set, which satisfies the description of Ayaka having peeled three of its atomic apple parts. Following the discussion in the previous section, using the maximal informativeness semantics for definiteness, what remains without the SSR is then precisely what we observe as the behavior reported by these speakers in (59).

At this point we cannot say whether the availability of the SSR is a true point of inter-speaker variability or an artifact of the survey task that speakers responded to. We suspect that the answer is the latter. This survey used the same schematic illustrations that we use here to represent different configurations of apples, with or without grouping. We suspect that the speakers described in this section did not perceive the schematic grouping information as salient enough when participating in the written survey, but would use the SSR for definite description reference in a real world context.[25]

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[24] As noted above in Section 2, there is also a different reading available with the 'half' examples, referring to apples that have individually been half-peeled; we will leave such readings aside here.

[25] The 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. We leave further study of the light noun *hoo* and its connection to the SSR for future work.

4.4 Alternative approaches

In this section we will expand our discussion of alternative proposals in the literature. There are broadly two previous approaches to the compositional syntax/semantics of Japanese HIRCs: the E-type analysis of Hoshi (1995) and Shimoyama (1999) and the quantificational disclosure approach of Grosu (2010) and Grosu & Landman (2012).

We already noted in Section 2 that the denotations of Japanese HIRCs do not straightforwardly correlate with the interpretations of their paraphrases with cross-sentential anaphora, casting doubt on the E-type analysis of Hoshi (1995) and Shimoyama (1999). The HIRC with the internal numeral 'three' can refer to the three apples peeled, but also has a salient set reading available, denoting a salient set within which Ayaka peeled three apples (16). In the context with two groups, this will be the first set of six apples; in the context with no grouping, this will be all twelve apples in the context. This contrasts with the cross-sentential paraphrase in (17), which speakers interpreted as unambiguously referring to the three apples that were peeled, in either context. The HIRC with internal 'half' also shows this reliance on salient set information, referring to the first group of apples, half of which have been peeled, in the context with two groups (8). This too differs from the corresponding cross-sentential paraphrase, which is judged as either infelicitous or as clearly referring to the three apples that were peeled (10). See the table in (18) above for a summary of these differences.

These readings where HIRCs refer to a salient set – specifically here, a salient set of apples that satisfies the description of Ayaka having peeled three or half of them, rather than simply those apples that have been peeled – are also problematic for the event-semantic "quantificational disclosure" approach of Grosu (2010) and Grosu & Landman (2012). Grosu and Grosu & Landman propose a null functional head, *Choose Role*, that modifies the event-description-denoting VP and "reopens" a designated role of that event description so that the extension of that argument can be abstracted over. The semantics for Choose Role is given in (60) below.

(60) **Choose Role** (Grosu & Landman 2012: 169):
$[\![\text{Choose Role}]\!] = \lambda E \,.\, \lambda x \,.\, \lambda e \,.\, E(e) \wedge \boldsymbol{C}_E(e) = x$
where e is an event, E is an event description, and $\boldsymbol{C}_E$ stands in for the appropriate role to be "reopened", based on the context

The variable x introduced by Choose Role in (60) is abstracted over, after existential closure of the event variable e, to form the domain of a definite description. This approach predicts HIRCs to refer strictly to the (maximal) individual that satisfies the $\boldsymbol{C}_E$ role of the event in question. For the HIRCs we considered in Section 2, for example, $\boldsymbol{C}_E$ will be the *Theme* role and our HIRCs from Section 2 will therefore be predicted to consistently denote *the apples that Ayaka peeled*, the theme of the peeling event. As noted above, this is not in general what these HIRCs denote.

While these previous authors have concentrated on the structure and interpretation of Japanese HIRCs as a *sui genesis* construction, we have shown in Sections 2 and 4.3 above that the patterns of interpretation of HIRCs with internally quantified heads are also reflected in DHRCs and HERCs with internally stranded quantifiers. This parallel with other relative clause types – especially that of HERCs with internal stranding – unpredicted by the E-type approach of Hoshi (1995) and Shimoyama (1999), as well as the quantificational disclosure approach of Grosu (2010) and Grosu & Landman (2012). In contrast, the parallel interpretations of these different relative clause forms are predicted and derived compositionally through our unified approach.

Here we note that there were two speakers that we consulted whose responses did not line up cleanly with any other speakers, and whose behavior was not included in the discussion of the dominant patterns in Sections 2 and 4.3 above. One speaker consistently interpreted all relative clauses considered above as denoting the three apples that Ayaka peeled; except for the HIRC, DHRC, and HERC with internal quantifier 'half' for examples (8, 11, 12) in the context with no groups, which were judged as infelicitous. This speaker's behavior could be consistent with the quantificational disclosure approach, but could also be the result of an E-type approach, given that they also interpreted the cross-sentential paraphrases in (10) and (17) as referring unambiguously to the three peeled apples.[26] Another speaker gave a more complex pattern of judgments: their responses to some examples are incompatible with our approach and compatible with the alternatives, but their responses to other examples are only compatible with our approach. We consider these two speakers to be outliers, given the otherwise strongly uniform patterns of judgments across speakers, described in Sections 2 and 4.3 above. Nevertheless, their judgments lead us to conclude that it is possible that this is a point of ideolectal variation, with the E-type approach or the quantificational disclosure approach active for some speakers.

In addition to the empirical difficulty faced by the theory of Grosu (2010) and Grosu & Landman (2012) for the behavior of most speakers, described in Section 2 above, our approach is also conceptually advantageous on a number of fronts. First, our copy-theoretic approach introduces a variable in the lower copy of the head DP through the independently motivated process of Variable Insertion (Fox 2002). Grosu & Landman (2012) comment that this need to "reopen" an argument of the relative clause is the primary motivation for their Choose Role functional head and there is no independent motivation for its existence.[27] The existence of an alternative approach to "opening up" a variable in an apparently gapless clause, presented here, makes Choose Role an unnecessary theoretical construct.

Second, our approach explains why HIRCs with internally quantified heads are necessarily interpreted as a definite description, and similarly for DHRCs and HERCs with internal stranding, not considered together by other authors. In our approach, the process of Inverse Trace Conversion (Erlewine 2014) applies Determiner Replacement (Fox 2002)

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[26] We believe one of the anonymous *Glossa* reviewers also shares this pattern of judgments, based on their detailed comments. This speaker consistently reports the 'three peeled apples' as the preferred interpretation for our felicitous examples, while stating that the 'six apples in the first group' interpretation is possible with a concessive or counterexpectational reading for the content of the relative clause: "Junya ate all six apples [in the first group], *even though* Ayaka peeled three/half of them". We believe the source of this reading for this reviewer comes from interpreting the *no*-marked clause, which we parse as a HIRC (see footnote 16 above), as a counterexpectational *-no-o* adjunct clause. This is related to structures discussed in Kuroda (1999: 61ff.), following earlier discussion by Tsubomoto (1995; 1998). Notably, none of our speakers consulted reported a counterexpectational interpretation for our HIRC examples, which we tested by contextual manipulations.

This reviewer also suggested additional manipulations which, to their ear, make the 'three peeled apples' reading (or equivalent) even more salient, including the following example:

(i) [$_{\text{HIRC}}$ Ayaka-ga *unagi-o* *hanbun* yai-ta -no]-o Junya-wa zenbu tabe-ta.
Ayaka-NOM eel-ACC half grill-PAST -NO-ACC Junya-TOP all eat-PAST
Literally: 'Junya ate all of [that Ayaka grilled *half of the eels*].'

The reviewer invites us to consider (i) in a context akin to our context (9), where there are two salient groups of eels, with half of the first group of eels grilled by Ayaka. Here the relevant world knowledge that we do not normally eat raw eels is meant to block the reading we predict, that Junya ate all of the eels in the first group. We leave open for future research to what extent such contextual manipulations may affect the readings available.

[27] Grosu & Landman (2012: 166): "Although we do not have, at the moment, other cases where ChR [= Choose Role] is required, we think neither that ChR is an *ad hoc* stipulation nor that it is a *sui generis* mechanism. ChR constitutes a 'salvaging' mechanism whose primary *raison d'être* is to make available a suitable interpretation for an otherwise closed sentence…"

to the higher copy DP, replacing its quantificational material with a definite determiner. In contrast, Grosu (2010: Section 6) stipulates that the HIRC CP has an uninterpretable [MAX] feature, which must be checked by the application of a definite (maximalizing) determiner.

Third and finally, as discussed in detail in Grosu & Landman (2012: Section 5), the analysis of HIRCs with additional quantifiers becomes quite complicated in their approach, due to its heavy reliance on event semantics. Grosu & Landman state, "the standard mechanisms for creating scopal dependencies (like quantifying-in or QR) interact with the Choose Role mechanism with detrimental effects, giving wrong readings for examples where the internal head is in the scope of a quantifier" (*ibid*: 178). Grosu & Landman then offer a complex approach to such examples that involves translating nominal quantification into quantification over events and reference to the participants of event sums with cumulative interpretation; see Grosu & Landman (2012: Section 5) for details. In contrast, our approach can handle such examples straightforwardly, using standard scope-taking mechanisms.

We will demonstrate how our approach handles such complex cases by briefly discussing two examples raised at the end of Shimoyama (1999), without an analysis, which Grosu & Landman analyze using their complex event quantification formalism in their Sections 5.5 and 5.6. The first example is (61):

(61) **Three children, two apples each** (Shimoyama 1999: 176):

Wasaburo-wa	$[_{\text{HIRC}}$ san-nin-no	kodomo-ga	sorezore		
Wasaburo-TOP	three-CL-GEN	child-NOM	each		
ringo-o	*futa-tsu-zutu*	katte-ki-ta	-no]-o	tana-ni	oi-ta.
apple-ACC	two-CL-each	buy-come-PAST	-NO-ACC	shelf-on	put-PAST

Shimoyama's translation: 'Three children bought *two apples each* and Wasaburo put *them* on the shelf.'

As Shimoyama notes, the HIRC in (61) denotes the *six* apples such that three children each bought two of them. Our analysis allows us to straightforwardly model the relationship between the higher quantifier 'three children' and the internal head 'apple two' in its scope.[28] The structure and interpretation we propose is sketched in (62) below:

(62) **Derivation and interpretation of HIRC in (61):**

a. Proto-relative after Copy and Late Merge (cf. (31)):
$[_{\text{DP}i}$ $[_{\text{NP}}$ $[_{\text{CP}}$ [[three children] [$[_{\text{DP}i}$ apple two] bought]] λ_i] apple] two]

b. HIRC after Inverse Trace Conversion (cf. (33)):
$[_{\text{DP}}$ $[_{\text{NP}}$ $[_{\text{CP}}$ [[three children] [$[_{\text{DP}}$ [apple $\sqsubseteq \boldsymbol{X}$] two] bought]] $\boldsymbol{\lambda X}$] apple] **THE**]

c. Denotation of HIRC DP (cf. (46c)):
$[\![\text{DP}]\!] = [\![\text{THE}]\!](\lambda X$. X apple(s) and there are three children Y, such that for each child y in Y, y bought two apples in X)

Assuming that there is a context where indeed three children bought two apples each, that sum of six apples will satisfy the restrictor of (62c) here.[29] This sum of six apples will be identified as the maximally informative true member, because any sum of apples satisfying this restrictor predicate entails that a superset of apples will satisfy the restrictor as well.

[28] We do not illustrate the 'each' particles *sorezore* and *-zutu* here, which we take to have the function of ensuring that the head DP 'apple two' will take scope under the subject 'three children'.

[29] This HIRC is infelicitous if it is not *exactly* three children who brought *exactly* two apples each. This is predicted by our account: if there are additional children who brought two apples or if some of these children brought more than two apples, our semantics for definiteness as maximal informativeness will not be able to identify a maximally informative sum of six apples. Because definiteness is not simple Sharvy-Link maximality, it will also not return the sum of all apples (two or more each) that the three or more children brought.

The second complex example given by Shimoyama is (63) below. Grosu & Landman (2012) describe such examples as "the most challenging examples for the analysis of internally headed relatives" (*ibid*: 178) and claim that, under their Choose Role analysis of HIRCs, "if we apply a standard scope mechanism [in (63)], we will get a wrong interpretation" (*ibid*: 187). Again, under our proposal, the interpretation of this HIRC is completely straightforward using standard treatments for quantifier scope. This is illustrated in (64).

(63) **Every student, three papers** (Shimoyama 1999: 176):

Wasaburo-wa	$[_{\text{HIRC}}$	dono-gakusei-mo	*peepaa*-o	*san-bon*
Wasaburo-TOP		every student	term paper-ACC	three-CL

dashi-ta	-no]-o	ichi-nichi-de	yon-da.
submit-PAST	-NO-ACC	one-day-in	read-PAST

Shimoyama's translation: 'Every student turned in *three term papers* and Wasaburo read *them* in one day.'

(64) **Derivation and interpretation of HIRC in (63):**

a. Proto-relative after Copy and Late Merge (cf. (31)):
$[_{\text{DP}i}$ $[_{\text{NP}}$ $[_{\text{CP}}$ [[every student] [$[_{\text{DP}i}$ paper three] submitted]] λ_i] paper] three]

b. HIRC after Inverse Trace Conversion (cf. (33)):
$[_{\text{DP}}$ $[_{\text{NP}}$ $[_{\text{CP}}$ [[every st.] [$[_{\text{DP}}$ [paper $\sqsubseteq \boldsymbol{X}$] three] submitted]] $\boldsymbol{\lambda X}$] paper] **THE**]

c. Denotation of HIRC DP (cf. (46c)):
$[\![\text{DP}]\!] = [\![\text{THE}]\!](\lambda X\,.\,X$ paper(s) and for every st. y, y submitted three papers in $X)$

Again, given a context where every student has submitted three papers each, our maximal informativeness semantics for the definite description in (53c) will pick out exactly those (3 * *n*) papers that the *n* students submitted, as is the interpretation described by Shimoyama. No special quantificational mechanisms are necessary for the interpretation of such examples with the internal head scoping under other quantifiers inside the relative clause.

5 Conclusion

In this paper we have investigated the interpretation of head-external, head-internal, and doubly-headed relative clauses in Japanese. By focusing on the subtle interplay between quantification and context, we introduced a rich set of data that reveals the underlying semantics of these types of relatives. These data are especially problematic for existing semantic analyses of HIRCs in Japanese. We accounted for the data by proposing a novel head-raising analysis of relative clauses, which combines the following independently motivated components: (i) the Copy Theory of movement and strategies for copy-chain interpretation; (ii) late-merger of relative clauses; (iii) a maximal informativeness semantics for definiteness; and (iv) a pragmatic constraint on interpretation, viz. the Salient Sets Restriction.

Our treatment of relative clauses is unique in that it exploits to a high degree both the interpretive and phonological possibilities made possible through the Copy Theory of movement (Chomsky 1993; 1995). This allows for a straightforward unification of the syntax of head-external, head-internal, and doubly-headed relative clauses in Japanese, including those with quantifier stranding. We derived the systematic correspondence observed between the interpreted and pronounced positions of quantificational material by allowing the semantic chain-resolution operations of Trace Conversion and Inverse Trace Conversion to apply either before Spell-Out, feeding both PF and PF, or after Spell-Out, combined with the constraint Minimize Mismatch (Bobaljik 1995; et seq.). Further, we proposed that applying these operations before Spell-Out allows for the possibility of multiple full copies in a copy chain to be pronounced because these operations modify copies in a chain, making them formally distinct for linearization purposes (cf. Nunes 2004). Finally, we showed that the resulting LFs accurately derive the range of interpretations of these relative clauses in different contexts.

We hypothesize that the novel Copy and Late Merge derivation for head-raising relative clauses presented here is also applicable to relativization in other languages. The flexibility offered by this structure in both LF and PF interpretation brings certain questions to the fore – for example, why are head-internal or doubly-headed relatives unattested in so many languages? – while at the same time offering potential solutions to other puzzles. For example, derivationally relating the head DP, including its quantificational material, to a lower copy within the relative clause may offer a new approach to instances of relativization that have been analyzed as involving reconstruction of the head's quantificational material; see e.g. Bhatt (2002) and Aoun & Li (2003). We hope to explore such questions and applications of this new framework for relativization in future work.

Abbreviations

ACC = accusative, CL = classifier, GEN = gentive, NO = the morpheme *-no*, NOM = nominative, SIMA = the morpheme *-sima-*, TOP = topic

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Competing Interests

The authors have no competing interests to declare.

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