

A Continuation-based Analysis of Contrastive *Wa* in Japanese

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Abstract

This paper proposes an analysis of contrastive *wa* in Japanese using continuations. In this paper *wa* is treated as a type-shifter, which “continuizes” the element attached to it. Semantically and pragmatically, *wa* does not do anything when it is used as a thematic *wa*. However, it gives a special focus semantic value when it is used as so-called contrastive *wa*: a set of sets of propositions. The proposed analysis can also handle multiple contrastive topics (CTs) and *wa*-phrases appearing in the designated topic position.

1 Introduction

This paper proposes an analysis of contrastive *wa* in Japanese (Kuno, 1973) using continuations (Barker, 2001; Barker & Shan, 2015). The particle *wa* is treated as a type-shifter that works to separate a sentence into two parts: the *wa*-phrase and the rest of the sentence. This continuation-based analysis is not only useful for deriving the special focus semantic value associated with contrastive *wa* used as a contrastive topic (CT), but also has several merits in explaining empirical facts observed about this particular item.

The rest of the paper is structured as follows. In the next section, I will describe the basic behavior of the particle of our interest, *wa*. Then, some basic concepts of continuations will be introduced. Given that, the semantic calculation of the sentence with contrastive *wa* will be examined. In Section 3, I will demonstrate how the proposed analysis can account for some of the unique behaviors of contrastive *wa*.

Section 4 offers conclusions and how this approach can be extended further.

1.1 Introduction – Contrastive *wa*

The particle *wa* is a well-known topic marker in Japanese. When used as a thematic topic (i.e., without accompanying an F-marked element), it usually refers back to a referent that is already introduced in the discourse, as shown in (1).

- (1) Taroo-*wa* kita.
T-TOP came
'Taro came.'

This thematic *wa* cannot occur with new information. Therefore, it cannot mark a phrase that corresponds to an answer to the question as shown in (2b). However, when the phrase *wa* is attached to bears phonological focus, the *wa*-phrase can be used as an answer to the question, as in (2c).¹

- (2) a. Dare-*ga* kita?
who-NOM came
'Who came?'
b. Taroo-(*ga*/?/? *wa*) kita.
T-(NOM/TOP) came
'Taro came.'

¹More concretely, when a *wa*-phrase is used contrastively as would be the case in (2c), we can observe post-focal reduction (Ishihara, 2003). I appreciate an anonymous reviewer's pointing out that just referring to bearing phonological focus is not sufficient.

- c. [F Taroo]-wa kita.
 T-TOP came
 ‘(At least) Taro came’
 ~> I’m sure Taro came but not sure about
 other people.
 ~> Taro came but there are people who
 didn’t come.

Note that (2c) has *at least* in the translation. As an answer to question (2a), (2c) is marked and conveys more information than the literal meaning of the sentence does. Depending on context, the addressee of the utterance in (2c) can draw different inferences. For instance, the speaker could have limited knowledge about who actually came (i.e., ignorance inferences). It is also possible that the speaker is suggesting that there are people who did not come but worth mentioning.

The extra information conveyed by contrastive *wa* has been keenly discussed in the literature (Hara, 2006; Kuroda, 2005; Oshima, 2002; Tomioka, 2009; Yabushita, 2017). These analyses vary in what kind of extra information is focused on and how the contribution of *wa* is treated. For the sake of space, the extensive review of all alternative analyses cannot be done here. The extra information conveyed by contrastive *wa* itself is not the main focus of the analysis given in this paper. Rather, the focus will be the special focus semantic value of this lexical item, assuming that the function of contrastive *wa* is just like the CT.² A CT is treated as a strategy that interlocutors can employ and that refers to the discourse structure that they entertain in the immediate context (Büring, 2003; Constant, 2014).

The questions to be addressed about the behavior of contrastive *wa* can be largely divided into two: (i) How is the discourse structure entertained by the interlocutors built? and (ii) How can inferences available with the use of this lexical item be explained?

²Recently Oshima (in press) discusses the reasons not to treat contrastive *wa* as a contrastive topic in Büring’s sense. I agree with him in that contrastive *wa* cannot be treated as functioning exactly in the same way as CTs in English. Nevertheless, I would argue that contrastive *wa* is a realization of a CT in Japanese and refers to the discourse structure that is entertained by the interlocutors. This approach is useful to see how the structured discourse is utilized in a case of questions involving contrastive *wa*. See Chapter 4 of Hirayama (2019) for the discussion.

This paper will be mainly concerned about the first question by proposing an analysis using continuations. The next subsection is intended to provide a brief overview of the system used in the analysis.

1.2 Introduction – Continuations

Ordinary Semantic Value

The analysis given in this paper is based on the continuation hypothesis (Barker & Shan, 2015) given below.

(3) *The continuation hypothesis*

Some natural language expressions denote functions on their continuations, i.e., functions that take their own semantic context as an argument.

For instance, we can treat quantifiers as functions that take their surrounding context as their argument and give us a truth value. Let us examine how it works with a simple example in (4a). This sentence has a quantifier, *everybody*. If we treat *everybody* as a function on its surrounding context, it will take the boldfaced part as its argument. Such a surrounding context is called a continuation. The continuation of *everyone*, which is the boldfaced part in (4a), should semantically be of type *et* given that we treat an NP argument as of type *e*. As shown in (4b), the boldfaced part lacks an NP to become an S and provide a truth value. (4b) is an argument of *everybody*. After taking this argument, *everybody* needs to provide a truth value. As a result, we can see *everybody* ends up with being of type $(et)t$, as shown in (4c). This is the semantic essence of continuations.

- (4) a. **Taro saw** everybody **yesterday:** *t*
 b. **Taro saw** ___ **yesterday:** *et*
 c. everybody: $(et)t$

Quantifiers are not only categories that can be thought of in terms of continuations. We can continue any category. Continued categories (\overline{XP}) take their surrounding context (i.e., continuations, c_{XP}) and give back a truth value. (5) offers a list of some continued words.

$S \rightarrow NP VP$:	$\lambda c_S. \underline{VP}(\lambda P_{et}. \underline{NP}(\lambda x_e. c_S(P(x))))$	[The object takes scope over the subject]
$S \rightarrow NP VP$:	$\lambda c_S. \underline{NP}(\lambda x_e. \underline{VP}(\lambda P_{et}. c_S(P(x))))$	[The subject takes scope over the object]

Table 1: Two possible rules for an S

$$VP \rightarrow NP Vt: \lambda c_{VP}. \underline{NP}(\lambda x. \underline{Vt}(\lambda R_{e(et)}. c_{VP}(R(x))))$$

Table 2: Syntactic rule for a VP with a transitive verb (in Japanese)

$[S_{[NP \text{ Taro}]} [VP \text{ came}]]$	
\rightsquigarrow (by a syntactic rule for an S)	$\lambda c_S. \underline{VP}(\lambda P_{et}. \underline{NP}(\lambda x. c_S(P(x))))$
\rightsquigarrow ($\underline{VP} = \lambda c_{VP}. c_{VP}(\lambda x. \text{come}(x))$)	$\lambda c_S. [\lambda c_{VP}. c_{VP}(\lambda x. \text{come}(x))] (\lambda P_{et}. \underline{NP}(\lambda x. c_S(P(x))))$
\rightsquigarrow (β -reduction)	$\lambda c_S. \underline{NP}(\lambda x. c_S(\lambda x. \text{come}(x)))$
\rightsquigarrow ($\underline{NP} = \lambda c_{NP}. c_{NP}(t)$)	$\lambda c_S. [\lambda c_{NP}. c_{NP}(t)] (\lambda x. c_S(\lambda x. \text{come}(x)))$
\rightsquigarrow (β -reduction)	$\lambda c_S. c_S(\text{come}(t))$

Table 3: The derivation of the ordinary semantic value of ‘Taro came’

(5) *Continuized lexicon in the ordinary dimension*

- a. Taro $\rightarrow \lambda c_{NP}. c_{NP}(t)$
- b. everybody $\rightarrow \lambda c_{NP}. \forall x : c_{NP}(x)$
- c. come $\rightarrow \lambda c_{VP}. c_{VP}(\lambda x. \text{come}(x))$
- d. invite $\rightarrow \lambda c_{Vt}. c_{Vt}(\lambda x. \lambda y. \text{invite}(y, x))$

In terms of the composition of a sentence, we assume ordinary binary branching rules. A crucial difference between a usual binary branching rule and the rules used here is that the relation between the function and its argument is determined by syntactic rules as shown in Table 1. One possible way to see a binary branching S is to regard the VP as a function that takes the rest of the sentence (i.e., the subject) as its argument. In this case, the object ends up taking wide scope over the subject. If we switch the relation between the subject and object, the scope relation also changes. What is notable here is that there is no Quantifier Raising or covert movement necessary to derive the inverse scope reading. In the semantic computations given from now on, everything stays in situ. That is the same as the rule for a VP with a transitive verb, shown in Table 2. Now, given the lexicon in (5) and syntactic rules given in Tables 1–2, we can derive the ordinary semantic value of simple sentences such as *Taro came*.³ The deriva-

³There is no difference between syntactic rules for an S between English and Japanese. A rule for VP is different, however, due to the word order between the head and its complements.

tion is given in Table 3.⁴

Note that in the last step in Table 3, we have $\lambda c_S. c_S(\text{come}(t))$. This is because everything including a sentence is continuized. Therefore, at the last stage of the derivation we need to feed a trivial continuation of a sentence in order to obtain a usual semantic denotation for a sentence. In the ordinary dimension, such a trivial continuation of a sentence, c_S , is $\lambda p. p$ which is of type tt .

Focus Semantic Value

The basic notion of continuations is now in order. The process introduced above is, however, not enough to account for contrastive *wa* in Japanese. Recall that contrastive *wa* accompanies an F-marked element. As a result, the focus semantic value rather than the ordinary one is, in fact, a crucial component for the analysis. In this paper, I simply extend the mechanism introduced in the previous section to derive the focus semantic value using continuations.⁵

In the focus dimension, everything is to be treated as sets. As a result, everything has a higher type in the focus dimension. When an element is not F-marked, it is treated as a singleton set while when an element bears F-marking, it denotes a set of alternatives in the relevant domain. The lexicon in the

⁴The semantic derivation of Japanese sentences will be shown using English words for the sake of readability.

⁵This is not the only way to achieve the same result, however. For instance, using monads (Charlow, 2014) would bring us the results of the same kind.

S → NP VP: $\lambda_{c_S}.\underline{\text{NP}}(\lambda X_{et}.\underline{\text{VP}}(\lambda \mathcal{P}_{(et)t}.\underline{c_S(\mathcal{P}(X))}))$
 The shaded part is computed via PFA

Table 4: A rule for an S in the focus dimension

$[s_{[\text{NP Taro}]_{[\text{VP came}]}}$	
\rightsquigarrow (by a syntactic rule for an S)	$\lambda_{c_S}.\underline{\text{NP}}(\lambda X_{et}.\underline{\text{VP}}(\lambda \mathcal{P}_{(et)t}.\underline{c_S(\mathcal{P}(X))}))$
\rightsquigarrow ($\underline{\text{NP}} = \lambda c_{\text{NP}}.c_{\text{NP}}(\{t\})$)	$\lambda_{c_S}.[\lambda c_{\text{NP}}.c_{\text{NP}}(\{t\})](\lambda X_{et}.\underline{\text{VP}}(\lambda \mathcal{P}_{(et)t}.\underline{c_S(\mathcal{P}(X))}))$
\rightsquigarrow (by β -reduction)	$\lambda_{c_S}.\underline{\text{VP}}(\lambda \mathcal{P}_{(et)t}.\underline{c_S(\mathcal{P}(\{t\}))})$
\rightsquigarrow ($\underline{\text{VP}} = \lambda c_{\text{NP}}.c_{\text{NP}}(\{\lambda x.\text{come}(x)\})$)	$\lambda_{c_S}.[\lambda c_{\text{VP}}.c_{\text{VP}}(\{\lambda x.\text{come}(x)\})](\lambda \mathcal{P}_{(et)t}.\underline{c_S(\mathcal{P}(\{t\}))})$
\rightsquigarrow (by β -reduction)	$\lambda_{c_S}.\underline{c_S(\{\lambda x.\text{come}(x)\}(\{t\}))}$
\rightsquigarrow (by PFA)	$\lambda_{c_S}.\underline{c_S(\{\text{come}(t)\})}$

Table 5: The derivation of the focus semantic value of ‘Taro came.’

focus dimension can be given as in (6). The shaded part is to be computed via Pointwise Functional Application (Rooth, 1985, 1996), given in (7).

(6) *Continuized lexicon in the focus dimension*

- a. Taro → $\lambda c_{\text{NP}}.\underline{c_{\text{NP}}(\{t\})}$
- b. Taro_F → $\lambda c_{\text{NP}}.\underline{c_{\text{NP}}(\{x : x \in D_e\})}$
- c. come → $\lambda c_{\text{VP}}.\underline{c_{\text{VP}}(\{\lambda x.\text{come}(x)\})}$
- d. invite → $\lambda c_{\text{VT}}.\underline{c_{\text{VT}}(\{\lambda x.\lambda y.\text{invite}(y, x)\})}$

(7) *Pointwise Functional Application (PFA):*

If $\beta \subseteq D_{\sigma\tau}$ and $\gamma \subseteq D_\sigma$,
 then $\beta(\gamma) = \{f(x) \in D_\tau : f \in \beta \ \& \ x \in \gamma\}$

The syntactic rules are to be defined in terms of sets as well. A possible rule for an S in the focus dimension is given in Table 4. Again, the shaded part is computed via PFA. Using the rule in Table 4 and the lexicon, we can derive the focus semantic value of the sentence *Taro came.* as in Table 5. In the last line, we have $\lambda_{c_S}.c_S(\{\text{come}(t)\})$. The trivial continuation of a sentence in the focus dimension is $\{\lambda p.p\}$. Once this trivial continuation is fed to the final result in Table 5 via PFA, we can get $\{\text{come}(t)\}$, which is the semantic denotation desired as the focus semantic value.

What has been introduced above is very basic, but it allows us to proceed to an analysis of contrastive *wa* using continuations in the next section.

2 How the Continuation-based Analysis Works

2.1 A Rough Sketch of the Analysis

Before providing a full analysis, I will describe how the proposed analysis works to analyze the lexical item of our interest: *wa*. First, continuations are primarily used to derive a special ‘focus’ semantic value of a sentence involving a contrastive *wa* phrase. The computation of the ordinary semantic value of a sentence can be done using continuations, but the denotation of *wa* does not play a special role. That is reflected in the denotation of *wa* that takes an NP, given below as (8).⁶

(8) *Wa with an NP in the ordinary dimension*
 $\llbracket wa \rrbracket^o = \lambda x_e.\lambda c_{\text{NP}}.c_{\text{NP}}(x)$

This *wa* just type-shifts an NP (type *e*) so that it would have type $(et)t$, which is typically a type assigned to a quantifier. Notably, the type-shift triggered by *wa* does not change the final result of the computation but only the way of computation.

In the focus dimension, on the other hand, *wa* does do a special job. The denotation of contrastive *wa* is given below in (9).⁷

⁶For the sake of space, only *wa* attached to an NP is discussed in this paper. The particle *wa* can be used with other kinds of phrases such as quantifier phrases, and it is possible to have a denotation of *wa* that is generalized so that it could handle any category, XP: $\llbracket wa \rrbracket^o = \lambda x_\sigma.\lambda c_{\text{XP}}.c_{\text{XP}}(x)$, where c_{XP} is of type σt .

⁷The denotation of non-contrastive *wa* (i.e., *wa* used with an NP without F-marking) in the focus dimension looks exactly the same as (8) except that everything is treated as a set and

$[_S[_{NP} \text{ Tar}_F\text{-}wa][_{VP} \text{ came}]]$	
\rightsquigarrow (by a syntactic rule for an S)	$\lambda c_S. \underline{VP}(\lambda \mathcal{P}_{(et)t}. \underline{NP}_{F\text{-}wa}(\lambda X_{et}. c_S(\mathcal{P}(X))))$
\rightsquigarrow ($\underline{VP} = \lambda c_{VP}. c_{VP}(\{\lambda x. \text{come}(x)\})$) and β -reduction)	$\lambda c_S. \underline{NP}_{F\text{-}wa}(\lambda X. c_S(\{\lambda x. \text{come}(x)\}(X)))$
\rightsquigarrow ($\underline{NP}_{F\text{-}wa} = \lambda F_{(et)t}. \{F(\{x\}) \mid x \in D_e\}$) and β -reduction)	$\lambda c_S. \{ c_S(\{\lambda x. \text{come}(x)\}(\{x\})) \mid x \in D_e \}$
\rightsquigarrow (by PFA)	$\lambda c_S. \{ c_S(\{\text{come}(x)\}) \mid x \in D_e \}$
\rightsquigarrow (by $c_S = \{\lambda p. p\}$) and PFA)	$\{\{\text{come}(x)\} \mid x \in D_e\}$
	$\rightsquigarrow \{\{\text{come}(t)\}, \{\text{come}(j)\}, \{\text{come}(h)\}\}$

Table 6: The derivation of the focus semantic value of ‘Tar_F-wa came.’

- (9) *Semantics of Contrastive wa with an NP_F*
 $\llbracket \text{NP}_{F\text{-}wa} \rrbracket^f = \lambda F_{(et)t}. \text{NP}_F \supset \{ \llbracket \text{NP} \rrbracket^o \} \wedge$
 $F(\text{NP}_F) = S. \{ F(\{x\}) \mid x \in D_e \}$

The denotation in (9) has two parts. First, it has two presuppositions about the attached NP: (i) it needs to have an F-marking, as expressed by showing that the denotation of NP in the focus dimension needs to be a strict superset of that in the ordinary dimension ($\text{NP}_F \supset \{ \llbracket \text{NP} \rrbracket^o \}$), and (ii) the result obtained by combining the NP and its continuation must match a strategy to be employed in context (S). Second, as the focus semantic value of a sentence, $\text{NP}_{F\text{-}wa}$ produces a set of sets of propositions rather than a set of propositions. The operation in (9) is essentially the same as Topic Abstraction in (10).

- (10) $\llbracket \text{CT-}\lambda_i \phi \rrbracket^f = \{ \lambda x. \llbracket \phi \rrbracket_{g[i \rightarrow x]}^f \}$
(Constant, 2014)

Both *wa* and a CT project a structured discourse and indicate a particular strategy that the interlocutors are entertaining at the time of the utterance.

2.2 Special Focus Semantic Value for Contrastive *wa*

Let us assess how this continuation-based analysis works to derive a special focus semantic value. One of the most important factors to be captured is that contrastive *wa* or a CT indicates a particular strategy. Let us take up a simple example, *Tar_F-wa came*. When *wa* is used with Focus as seen in this case, what is indicated is that other alternatives such as *Jiro-wa came*. are possible answers that the speaker could have used. The derivation of the focus semantic value of the sentence *Tar_F-wa came*. is given in Table 6.

computation involves PFA.

The final result of the focus semantic value given in Table 6 is different from that of a sentence without *wa*. When *wa* is present, each individual proposition is packed in a set. In other words, we get a set of sets of propositions. By contrast, when *wa* is not used with the F-marked phrase (i.e., when phonological focus only indicates so-called information focus), the result is a set of propositions. This special focus value is the discourse effects associated with contrastive *wa*. Through its discourse effects, *wa* indicates that those alternatives could also be relevant to the Question under Discussion (QuD: Roberts (2012)) entertained at the time of utterance.

Another thing to be captured is the interaction between CTs and informational focus. For example, to answer an overarching QuD, ‘‘Who invited whom?’’ there are two ways to approach the answers, as shown in (11): (i) looking for answers by hosts and (ii) answering by guests. The assignment of a CT and an informational focus (henceforth Focus) varies depending on which strategy the speaker wants to adopt. In English, a different intonational contour is used to distinguish a CT and Focus (Jackendoff, 1972), while *wa* is used to indicate a CT in Japanese.

- (11) Who invited whom?
- a. A: What about Taro? Who did he invite?
B: Taroo_{CT}-wa Hanako_F-o yonda.
TAROO_{CT} invited HANAKO_F.
- b. A: What about Hanako? Who invited her?
B: HANAKO-wa TAROO-ga yonda.
TAROO_F invited HANAKO_{CT}.

What we need to have here is two different focus semantic values for the two different ways of answering the question in (11).

Using a continuized grammar and the semantics of contrastive *wa* given in (9), it is possible to capture such a contrast. For the sake of space, only the final results after feeding a trivial continuation of a sentence are provided below as (12).

- (12) a. TARO_{CT} invited HANAKO_F
 $\{\{\text{invite}(x, y) | y \in D_e\} | x \in D_e\}$
 $=\{\{\text{invite}(t, t), \text{invite}(t, j), \text{invite}(t, h)\},$
 $\{\text{invite}(j, t), \text{invite}(j, j), \text{invite}(j, h)\},$
 $\{\text{invite}(h, t), \text{invite}(h, j), \text{invite}(h, h)\}\}$
- b. TARO_F invited HANAKO_{CT}.
 $\{\{\text{invite}(x, y) | x \in D_e\} | y \in D_e\}$
 $=\{\{\text{invite}(t, t), \text{invite}(j, t), \text{invite}(h, t)\},$
 $\{\text{invite}(t, j), \text{invite}(j, j), \text{invite}(h, j)\},$
 $\{\text{invite}(t, h), \text{invite}(j, h), \text{invite}(h, h)\}\}$

As we can see, the structures of the two focus semantic values are different. In (12a) it is organized by subject first and then object, while (12b) indicates that a guest-by-guest strategy is employed in the discourse. Note that we have a CT-marked phrase *Hanako* in the object position in (12b). The continuation-based approach pursued here requires no movement of this phrase and can derive the desired focus semantic value in-situ.

We have seen that this continuation-based analysis can give us the desired result — contrastive *wa*, which is a realization of a contrastive topic in Japanese, plays an important role in projecting a particular type of structured discourse. Any analysis needs to explain the behavior of this item. We have seen that the proposed analysis can derive the special focus semantics value without issue, but this analysis can explain more, as will be shown in the next section.

3 Empirical Facts Explained by the Analysis

3.1 Two Kinds of CTs

Typically contrastive *wa* phrases appear at the beginning of the sentence as shown in (11b). This kind of *wa*-phrase seems to occupy a designated topic position. However, this is not the only possible position in which a contrastive *wa*-phrase can appear. It can also appear in the middle of the sentence (in-situ). As Hoji (1985, 131) pointed out, these two kinds of *wa*-phrases present different behaviors when they

contain *zibun*. In (13), a *wa*-phrase appears in the designated topic position, and the sentence is ungrammatical under the reading that *zibun* refers to John.

- (13) **sono zibun nituite-no hon-wa John-ga*
that self about book-*wa* John-NOM
suteta.
threw away
‘As for that book about himself, John threw it away.’

The ungrammaticality of (13) indicates that the *wa*-phrase in (13) is base-generated in the topic position. Otherwise, the sentence would be grammatical thanks to reconstruction. In (13), it is reasonable to assume that a *pro* occupies the object position of *suteta* ‘threw away’ and the topic phrase binds the *pro*. Schematically we have two patterns of *wa*-phrases as shown below in (14).

- (14) a. *Wa appears in the root clause*
[S ... XP_F-*wa* ...]
- b. *Wa appears in the topic position*
XP_{F_i}-*wa* [S ... *pro*_{*i*} ...]

We have seen continuations can handle (14a) without movement. Now, do we need to have a different lexical entry for the *wa*-phrase in the topic position (14b)? The answer is no, as long as we adopt the treatment of binding with continuations, as discussed in Barker & Shan (2015). It is possible to keep the lexical entry for NP-*wa* untouched by incorporating pronouns in the grammar and assuming that the presence of an unbound pronoun is reflected in the syntactic category. In (14b), the root clause involves *pro*. This sentence is an open proposition (Dowty, 2007), which requires an NP for a complete interpretation. Following Jacobson (1999), I assume this kind of clause has a different semantic type from a clause that does not have any pronouns (e.g., *Taro sneezed.*). An open proposition is of type *et* since it needs to take the referent of the pronoun for a full interpretation. Pronouns are expressed as identity functions as in (15).

- (15) $\underline{\text{NP}} \rightarrow \text{pro}: \lambda c_{\text{NP}}. \lambda y. c_{\text{NP}}(y)$

With this semantics of pronouns, we can obtain an appropriate denotation for an open proposition. For instance, the ordinary semantic value of *Taro pro in-*

vited is computed as (16).

$$(16) \ [_{S}[_{NP} \text{Taro}][_{VP}[_{NP} \text{pro}] \text{invited}]] \\ \rightsquigarrow \lambda c_S. \lambda y. c_S(\text{invite}(t, y))$$

To (16), we need to feed a trivial continuation of a sentence, $\lambda p.p$. As a result, we get $\lambda y.\text{invite}(t, y)$, which is exactly what we want — it is of type *et*. Remember that NPs with *wa* are of type $(et)t$, which is a function from a continuation of NP to the truth value. As a result, *wa*-NP ends up taking an open proposition as its argument and offers a truth value. The same mechanism works in the focus dimension, too. Overall, it is not necessary to have two different semantic denotations for *wa*-phrases in the topic position and those in-situ. As a result, we can capture the fact that these two kinds of *wa*-phrases function almost in the same way. I said “almost” because their behaviors are not exactly the same. The proposed analysis can provide an explanation of how they could be different. Before discussing it, let us present another relevant behavior of Japanese contrastive *wa*-phrases.

3.2 Multiple CTs

It is well known that contrastive *wa* phrases can appear multiple times in a sentence, as shown in (17) if appropriate context is set. This example is from Yabushita (2017, 25).⁸

$$(17) \ \text{John}_F\text{-wa} \quad \text{Mary}_F\text{-wa} \quad \text{Bob}_F\text{-ni-wa} \\ \text{John-wa} \quad \text{Mary-wa} \quad \text{Bob-DAT-wa} \\ \text{syookai-si-ta.} \\ \text{introduce-do-PAST}$$

‘John_{CT} introduced Mary_{CT} to Bob_{CT}.’

An utterance in (17) would be possible when the speaker is asked who introduced whom to whom and trying to answer by looking at the list of people under discussion, for example.

However, this is not a unique characteristic of contrastive *wa* in Japanese. As Constant (2014, 76) pointed out, in English we can have multiple CTs in

⁸If all of the three *wa*-phrases are contrastive as expected in the context given in the text, prosodic prominence would be observed at each *wa*-phrase and only the predicate would undergo post-focal reduction. Yabushita mentions that the first *wa*-phrase can be a thematic, but as an anonymous reviewer pointed out to me, the second *wa*-phrase can also be non-contrastive depending on context. I appreciate their feedback on this.

a sentence as well when appropriate context is set. Constant does offer an analysis of multiple CTs in a sentence, but the analysis requires modifying the basic operation he uses, Topic Abstraction. Furthermore, depending on the number of CTs in a sentence, different rules apply. The proposed analysis of contrastive *wa* in Japanese does not require such modified rules. As long as the multiple *wa* phrases occur in a sentence in canonical word order, it is possible to get a heavily nested focus semantic value without any ado. For the detailed discussion on this issue, please refer to Chapter 3 of Hirayama (2019).

In addition, if we adopt the assumption that evaluation order is left-to-right, we can also assume that the word order also reflects how the heavily nested focus semantic value is organized. In other words, in (17), questions are first ordered by the subject, then the direct object, and finally the indirect object. Such a focus semantic value of a sentence with multiple contrastive *wa* phrases can be derived without adding anything to our denotation of contrastive *wa*. However, our semantic mechanism only works when multiple contrastive *wa* phrases appear in canonical word order. Empirically, this seems to be the case. If we try to scramble the indirect object of (17), for example, the sentence becomes degraded. In the next subsection, I will demonstrate why multiple contrastive *wa* phrases only work in canonical word order from the difference of the semantic roles of two kinds of *wa* phrases discussed in the last subsection.

3.3 Type-mismatch in Split CTs

When we have multiple contrastive *wa*-phrases in a sentence and they appear in canonical word order, we can keep computing nested focus semantic value without encountering any type-mismatches. Contrastive *wa* phrases can successfully take $(et)t$ in the derivation. However, a type-mismatch can happen when a contrastive *wa* phrase is moved to the designated topic position, and the root clause has another CT. Remember that when a contrastive *wa* phrase occupies a designated topic position, the root clause is treated as an open proposition. When there is another CT in the root clause, the type of the root clause and what the contrastive *wa* phrase attempts to take as its argument do not match. For instance, imagine that we are trying to compute the focus se-

semantic value of the sentence in (18). The root clause that involves a CT and *pro* ends up with the focus semantic value given in (18a). This is of type $((et)t)t$. Recall that a *wa*-phrase in the focus dimension takes something of type $(et)t$ as its argument. This is how type-mismatch occurs.

(18) *Hanako*_{F-wa} [_S *Taro*_{F-wa} *pro* invited.]
Hanako_{CT}, Taro_{CT} invited her.

- a. The final result of the root clause after feeding c_S
 $\{\lambda Y_{et}.\{\text{invite}(x, y)|y \in Y\}|x \in D_e\}$
- b. The semantic denotation of *Hanako*_{F-wa}
 $\text{NP}_{F-wa} = \lambda F_{(et)t}.\{F(\{x\})|x \in D_e\}$

What does this type-mismatch tell us? A strong prediction is we cannot have split CTs. That is, we cannot have a CT in the topic position and other CTs in the root clause. Note that as far as the root clause does not contain any CTs, the computation can be carried out smoothly. For instance, having informational focus in the root clause is not a problem, for there would be no type-mismatch. Further empirical investigations are required to determine whether having split CTs is really impossible, but it seems that multiple CTs often occur in the canonical word order in a sentence. This empirical fact can be accounted for by the different semantic roles of *wa*-phrases in-situ and those in the topic position. The *wa*-phrase in-situ only works as a function on its continuation, while that in the topic position needs to bind a pronoun in the root clause, in addition to working as a function on its continuation.

However, the hypothesis given above might be too rough. It is true that the computation clashes if there is a type-mismatch. However, natural languages are also equipped with tools that can handle such a problem — type-shift. In fact, the type-shift that would be necessary here is not that complicated. The denotation of NP with contrastive *wa* after type-shift (NP-*wa*₂) can be given using what we have in (9) as in (19).

(19) $\llbracket \text{NP-}wa_2 \rrbracket^f = \lambda \mathcal{F}.\{\llbracket \text{NP-}wa \rrbracket^f(F) \mid F \in \mathcal{F}\}$
where \mathcal{F} is of type $((et)t)t$

The result in (19) is mathematically related to the semantics of NP-*wa*; What is given in (19) can be characterized as an image of \mathcal{F} under g , which is the

function denoted by NP-*wa*. Generally, the image of a subset $A \subseteq X$ under f is defined as in (20). Using this notation, the function given in (19) can be expressed more simply using g , as in (21). In other words, it is an image of \mathcal{F} under the semantics of contrastive *wa* in-situ.

(20) Image of a subset: $f[A] = \{f(a)|a \in A\}$

(21) $\llbracket \text{NP-}wa_2 \rrbracket^f = \lambda \mathcal{F}.g[\mathcal{F}]$ where \mathcal{F} is of type $((et)t)t$ and g is $\llbracket \text{NP-}wa \rrbracket^f$

Remember that when we have multiple CTs, the first one is ambiguous between a CT and a thematic topic. Even when *wa*-phrases are split between the topic position and the root clause, it can always be interpreted as a thematic topic. In such a case, a type-shift such as that illustrated in (21) is necessary, too. As such, a more plausible reason for the ban of split CTs is not just a type-mismatch but the complexity of the operation after type-shift.

As mentioned earlier, an investigation into exactly how these split CT examples are bad is required. However, the proposed analysis has the potential to provide reasoning for the ban of split CTs.

4 Conclusions

In this paper, I showed how we can derive the special semantic values indicated by the use of contrastive *wa* using continuations. It was shown that not only can this continuation-based analysis give us the desired results so as to account for the basic behavior of *wa*-phrases but also it covers a wider range of empirical facts.

This analysis can be extended in order to handle interrogative sentences with contrastive *wa* as well. What to be done is to add words, operators, and syntactic rules necessary to form interrogative sentences. It is well known that Japanese contrastive *wa* can appear in various kinds of sentences (Tomioka, 2009) and sometimes has an important pragmatic effect (Schwarz & Shimoyama, 2010). This continuation-based analysis has potential in that it can be used to explain those other interesting behaviors of contrastive *wa* as well.

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