Holistic interpretation in locative alternation: Evidence from self-paced reading

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Abstract
In English and Japanese, verbs like smear and load can appear in two alternate variants while expressing nearly the same meaning. It has been argued that there is a semantic difference between locatum-as-object variant and location-as-object variant: location-as-object variant imposes holistic interpretation, but locatum-as-object variant allows both partitive interpretation and holistic interpretation. In this paper, a self-paced reading experiment was conducted to investigate whether there is a preference of interpretation (partitive / holistic) in locatum-as-object variant. The results indicate that the processing difficulty occurs when the holistic interpretation is canceled regardless of the variant type, but the interaction between VARIANT TYPE and CANCELLATION OF HOLISTIC INTERPRETATION was not found. The results suggest that the holistic interpretation is preferred not only in the location-as-object variant but also in the locatum-as-object variant. Furthermore, besides the preference of interpretation, the significant main effect observed at the verb region demonstrates that the processing of locatum-as-object variant is easier than location-as-object variant, which aligns with the argument in Aoki (2019).

1 Introduction
As shown in (1) and (2), verbs like smear and load can appear in two alternate variants while expressing nearly the same meaning. The phenomenon is called locative alternation, which can be found across languages (Fukui et al., 1985; Pinker, 1989; Levin, 1993; Goldberg, 1995; Maruta, 1997; Okutsu, 1981; Iwata, 2008 among others).

(1) a. Bill smeared paint onto the wall
(b) Bill smeared the wall with paint
(2) a. John loaded hay onto the wagon
(b) John loaded the wagon with hay

Pinker (1989) argues that a necessary criterion for a verb to participate in the locative alternation is that the verb allows the description of both a type of motion of the locatum argument and an end state of the location argument. Sentences like (1a) and (2a), in which the locatum (paint, hay) is the direct object of the verb (smear, load) are called locatum-as-object variant. Sentences like (1b) and (2b), in which the location (wall, wagon) is the direct object of the verb (smear, load) are called location-as-object variant. These differences in the presentation of the arguments also affect the meaning of the constructions. Anderson (1971) first argued that there is a semantic difference between the two variants: whether the whole of something is affected by the action described by the sentence, or just a part of it is affected. To denote the difference, he coined the terms holistic interpretation and partitive interpretation (Anderson, 1971: 389). For instance, (1b) imposes the interpretation that the whole wall was painted but (1a) doesn’t. Therefore, we can say that (1b) has holistic interpretation and (1a) allows both holistic and partitive interpretations.
Previous studies

Apart from English, according to Kageyama (1980), Kishimoto (2001; 2011), Ito (2015) among others, the same semantic difference is observed in Japanese locative alternation.

In (4), the sentence kare-wa kabe-zenmen-o aka-ku nut-ta wakedewaarimasen ‘he didn’t smear the whole wall red’ is used to cancel the holistic interpretation in the location-as-object variant. As a result, when the holistic interpretation is canceled, the locatum-as-object variant (4a) is still a good sentence, but the location-as-object variant (4b) turns out to be a bad sentence. Accordingly, a semantic difference between the two variants and the fact that holistic interpretation imposed by the location-as-object variant can be confirmed.¹

To sum up, it has been argued in the previous studies that the locative alternation verbs specify the description of both a type of motion and an end state. Furthermore, the location-as-object variant imposes the holistic interpretation, while the locatum-as-object variant allows both partitive and holistic interpretation.

Research question

As mentioned above, the locatum as-object variant allows both holistic and partitive interpretations, but the preference of the interpretation still needs to be further investigated. The acceptability judgments in the previous studies like (4) are based on introspection, and likely to be the result of time-consuming judgment. Even if the two interpretations can be acceptable under the time-consuming judgments, there still remains a possibility that the parser is first committed to one of the two interpretations during online processing. In order to investigate this possibility, a self-paced reading was chosen to explore the preference of the interpretation in locatum-as-object variant.

2 Methods

In the present study, a self-paced reading experiment was conducted to examine how the VARIANT TYPE interacts with the CANCELLATION OF HOLISTIC INTERPRETATION when participants process locative alternation sentences with Japanese alternating verbs. The procedure and materials will be shown in the following sections.

¹It should be noted that the holism effect is in fact an epiphenomenon: the verb in the location-as-object construction specifies a change of state of the referent of the location argument, and the holistic interpretation is simply one of the most salient change-of-state interpretations (Rappaport and Levin, 1985; Pinker, 1989; Jackendoff, 1990; Tsuboi and Nishimura, 1991). In the present experiment, holistic interpretation is used as a representative change-of-state interpretation.
### 2.1 Participants and procedure

42 Japanese native speakers (undergraduate students) from the University of Tokyo participated in the present study. They were asked to do the task by accessing *Ibex Farm*, which is an experimental platform website.

Sentences were presented region by region, and every sentence was preceded by a ‘+’ symbol to signal where the sentence started. And participants were asked to press the space bar to bring up the next region and to read the sentence as fast as possible while understanding the sentence. The duration from when the space bar was pressed to when it was pressed again was recorded as the reading time (RT) for each region. After reading the sentence, participants answered a yes / no comprehension question related to the sentence they just read. The purpose of answering the comprehension question is to make the participants concentrate on reading the experimental sentences. Also, there were practice trials to help participants get familiar with the testing procedure before the experiment was conducted.

### 2.2 Stimuli

This experiment had a two-by-two factorial design crossing the VARIANT TYPE factor (locatum-as-object variant / location-as-object variant) and the CANCELLATION OF HOLISTIC INTERPRETATION factor (cancellation / non-cancellation).

The item sentences were made based on (4), an alternating construction followed by a clause in which the holistic interpretation is either canceled or not. The following is an example of the sets, with slashes indicating region boundaries. And the critical region is the last region, in which the holistic interpretation was canceled as in the previous examples (4) repeated here as (5b) and (5d), or was irrelevant in (5a) and (5c). To keep the processing difficulty of the last region consistent, both cancellation and non-cancellation clauses are negative or affirmative sentences, and the word count is either the same or close to each other.

Sixteen sets of the target sentences were distributed into 4 lists with the Latin Square design so that each participant can only read one token of each set. 132 filler sentences were used in this experiment. and the various types of sentences were included to prevent participants from adapting to the alternate variants. Both the experimental sentences and fillers were followed by a yes / no comprehension question. For instance, for (5a) and (5c) the comprehension question was ‘Did he smear the ceiling red?’, for (5b) and (5d) the comprehension question was ‘Did he smear the whole wall red?’.

(5)

a. Locatum/Non-cancellation condition

| Taro-wa/ kabe-ni/ akai penki-o/ | Taro-TOP/ wall-LOC/ red paint-ACC/ |
| nut-ta-ga,/ kare-wa tenjo-made smear-PAST-AC/ he-TOP ceiling-up to |
| aka-ku nut-ta wakedewaarimasen red-KU smear-PAST not |

‘(lit.) Taro smeared red paint on the wall, but he didn’t smear the ceiling red.’

b. Locatum/Cancellation condition

| Taro-wa/ kabe-ni/ akai penki-o/ | Taro-TOP/ wall-LOC/ red paint-ACC/ |
| nut-ta-ga,/ kare-wa kabe-zennen-o smear-PAST-AC/ he-TOP/ wall-all-ACC |
| aka-ku nut-ta wakedewaarimasen red-KU smear-PAST not |

‘(lit.) Taro smeared red paint on the wall, but he didn’t smear the whole wall red.’

c. Location/Non-cancellation condition

| Taro-wa/ kabe-o/ akai penki-de/ | Taro-TOP/ wall-ACC/ red paint-with/ |
| nut-ta-ga,/ kare-wa tenjo-made smear-PAST-AC/ he-TOP ceiling-up to |
| aka-ku nut-ta wakedewaarimasen red-KU smear-PAST not |

‘(lit.) Taro smeared the wall with red paint, but he didn’t smear the ceiling red.’

d. Location/Cancellation condition

| Taro-wa/ kabe-o/ akai penki-de/ | Taro-TOP/ wall-ACC/ red paint-with/ |
| nut-ta-ga,/ kare-wa kabe-zennen-o smear-PAST-AC/ he-TOP/ wall-all-ACC |
| aka-ku nut-ta wakedewaarimasen red-KU smear-PAST not |

‘(lit.) Taro smeared the wall with red paint, but he didn’t smear the whole wall red.’
2.3 Predictions

The holistic interpretation is the only possibility for the location-as-object variant, but two alternative interpretations are available for the locatum-as-object variant. If the locatum-as-object variant prefers the partitive interpretation, when the holistic interpretation is canceled, processing difficulty would occur at the critical region of (5d), which is the Location-as-object variant / Cancellation condition. Concretely, the reading time for (5d) will be longer than the reading time for (5c), the difference in reading times between (5c) and (5d) will be greater than the difference in reading times between (5a) and (5b), and the interaction between the CANCELLATION OF HOLISTIC INTERPRETATION and VARIANT TYPE can be observed.

If, on the other hand, it prefers the holistic interpretation, when the holistic interpretation is canceled, the processing difficulty would occur at the critical region of (5b) and (5d). Specifically, the reading time for (5d) will be longer than the reading time for (5c), the reading time for (5b) will be longer than the reading time for (5a).

3 Results

3.1 Statistical Analysis

For the statistical analysis, Linear Mixed Effect Model (LME) was used with the lmer function in the lme4 package. In the analysis of the reading time data, the trials with wrong answers in the comprehension task and trials with reading times shorter than 80ms or longer than 2000ms were excluded. The models included VARIANT TYPE (locatum-as-object variant/location-as-object variant) and the CANCELLATION OF HOLISTIC INTERPRETATION (cancellation/non-cancellation) as fixed factors. For VARIANT TYPE, locatum-as-object variant was coded as 0 and location-as-object variant as 1. For CANCELLATION OF HOLISTIC INTERPRETATION, cancellation was coded as 0 and non-cancellation as 1. Both participants and items were included as random factors. The dependent variable was reading time. Reading times outside of the mean ±2.5 standard deviation were excluded. The selection of the optimal model was based on the backward stepwise method (Bates et al., 2015). Estimated reading times based on the optimal models will be shown in the next result section.

3.2 Results

The specific reading time for each region is shown in Table 1, and Figure1 was made according to it. Locatum / Location stands for locatum/location-as-object variant, and C / NC stands for cancellation/non-cancellation of holistic interpretation.

| Region1 | Region2 | Region3 | Region4 | Region5 |
|---------|---------|---------|---------|---------|
| a       | 566.29  | 575.26  | 526.03  | 588.50  | 1083.98 |
| b       | 564.56  | 539.52  | 490.06  | 556.37  | 1323.67 |
| c       | 568.21  | 537.26  | 537.89  | 647.10  | 1014.97 |
| d       | 570.16  | 549.66  | 569.23  | 633.23  | 1227.22 |

Table 1 Mean reading times for each region (ms)
The mean reading times in the critical region are shown in Figure 2. And a significant main effect of the CANCELLATION OF HOLISTIC INTERPRETATION was observed ($p < 0.001$) in the critical region (Table 2). That is to say, the Non-cancellation conditions were read faster than the Cancellation conditions. However, neither the main effect of VARIANT TYPE ($p = 0.933$) nor the interaction between the CANCELLATION OF HOLISTIC INTERPRETATION and VARIANT TYPE was observed ($p = 0.422$).

Furthermore, the significant main effect of the CANCELLATION OF HOLISTIC INTERPRETATION can also be found in locatum-as-object variant ($p < 0.001$) and location-as-object variant ($p = 0.007$) respectively (as shown in Table 3). The simple main effect test was achieved by changing the coding scheme of the sentence type as follows: for estimating the simple main effect of CANCELLATION in the LOCATUM condition, the LOCATUM condition was coded as 0 and the LOCATION condition as 1, and for the simple effect of CANCELLATION in the LOCATION condition, the LOCATION condition was coded as 0 and the LOCATUM condition as 1. Additionally, even though the difference (212.25ms) in reading times between (5c) and (5d) is smaller than the difference (239.69ms) in reading times between (5a) and (5b) numerically, no significant difference was found ($t(274) = 1.968, p = 0.573$).

Meanwhile, besides the critical region, a significant main effect of VARIANT TYPE was observed ($p = 0.049$) in the verb region *mutta ‘smear’* (Table 4; Figure 3). Specifically, the locatum-as-object variants were read faster than location-as object variants. However, no significant effect of the CANCELLATION OF HOLISTIC INTERPRETATION ($p = 0.421$) nor the interaction between the CANCELLATION OF HOLISTIC INTERPRETATION and VARIANT TYPE ($p = 0.356$) was observed at the verb region.

### Table 2 Summary of fixed effects estimates on RT data from the LME model in the critical region.

|                          | $\beta$  | SE    | $t$    | $p$      |
|--------------------------|----------|-------|--------|----------|
| (Intercept)              | 1020.245 | 43.792| 23.298 | <0.001***|
| VARIANT TYPE             | -2.579   | 30.535| -0.084 | 0.933    |
| CANCELLATION             | -141.375 | 30.436| -4.645 | <0.001***|
| VARIANT TYPE $\times$ CANCELLATION | 49.411   | 61.459| 0.804  | 0.422    |

**Significance markers:** * = $p < .050$, ** = $p < .010$, *** = $p < .001$.

### Table 3 Summary of simple main effect estimates on RT data from the LME model in the critical region.

|                          | $\beta$  | SE    | $t$    | $p$      |
|--------------------------|----------|-------|--------|----------|
| CANCELLATION (LOCATUM)   | -166.080 | 43.737| -3.797 | <0.001***|
| CANCELLATION (LOCATION)  | -116.669 | 42.759| -2.729 | 0.007**  |

**Significance markers:** * = $p < .050$, ** = $p < .010$, *** = $p < .001$.
4 Discussion

As motioned in the result section, there was no interaction between the CANCELLATION OF HOLISTIC INTERPRETATION and VARIANT TYPE found (Table 2), and at the same time there was no evidence to show that the difference in reading times between (5c) and (5d) is greater than the difference in reading times between (5a) and (5b), so that the first prediction cannot be supported. That is to say, it is not proved that locatum-as-object variant prefers partitive interpretation.

As a significant main effect of CANCELLATION OF HOLISTIC INTERPRETATION was observed at the critical region in each variant respectively (Table 3), it showed that Non-cancellation conditions were read faster than Cancellation conditions (Figure2) no matter in which variant. Specifically, the reading time for (5d) was longer than the reading time for (5c), and the reading time for (5b) was longer than the reading time for (5a). Which is to say, in both variants, if the holistic interpretation was canceled, processing difficulty occurs at the critical region. This result strongly suggests that the second prediction is correct, that is, locatum-as-object variant prefers the holistic interpretation too. In other words, both variants prefer the change-of-state meaning.

However, there may be another possible reason for the processing difficulty in locatum-as-object variant -- topic shifting. Pinker (1989) argues that in the locatum-as-object variant, the motion of the locatum is the focus. While, in the location-as-object variant, the state-change of the location is the focus. In the current experiment, in locatum-as-object variants like (5b), the cancellation clause (region 5) would shift the focus from locatum to location, thus the processing difficulty may occur during this process. This still needs to be further investigated.

Furthermore, for the verb region, the result (Table 4; Figure3) showed that locatum-as-object variants were read faster than location-as-object variants, which indicates that there is a processing difference between the two variants at the verb region. Specifically, the processing of locatum-as-object variant is easier than location-as-object variant. In the previous studies, Christensen and Wallentin (2011) and Aoki (2019) argued that there is a processing difference between the locatum-as-object variant and the location-as-object variant, and the processing of location-as-object variant is more difficult. Especially in Aoki (2019), 4 self-paced reading experiments with Japanese alternation verbs were conducted and her results showed that the locatum-as-object variant was read faster than the location-as-object variant at the preverbal region where the verb had not appeared yet. In this paper, the results align with Aoki (2019).

|                      | $\beta$  | SE     | $t$    | $p$     |
|----------------------|----------|--------|--------|---------|
| (Intercept)          | 536.901  | 35.657 | 15.056 | <0.001*** |
| VARIANT TYPE         | 31.072   | 15.744 | 1.974  | 0.049*  |
| CANCELLATION         | 12.539   | 15.573 | 0.805  | 0.421   |
| VARIANT TYPE $\times$ CANCELLATION | -29.094  | 31.490 | -0.924 | 0.356   |

Table 4 Summary of fixed effects estimates on RT data from the LME model in verb region. Significance markers: * = $p < .050$, ** = $p < .010$, *** = $p < .001$. 

Figure 3 Mean reading times in verb region (ms)
5 Conclusion

It is argued in the previous studies that the locatum-as-object variant allows both partitive and holistic interpretations. Even if the two interpretations can be acceptable under the time-consuming judgments, the previous studies did not investigate whether or not the parser is first committed to one of the two interpretations during online processing. In the present study, a self-paced reading was conducted to investigate this possibility. The results indicate that the processing difficulty would occur when the holistic interpretation is canceled in the locatum-as-object variant. In other words, the results suggest that the holistic interpretation is preferred not only in the location-as-object variant but also in the locatum-as-object variant. However, as mentioned in the discussion section, whether or not the processing difficulty in the locatum-as-object variant is due to the topic shifting still needs to be further investigated. Furthermore, besides the preference of interpretation, a significant main effect of VARIANT TYPE at the verb region was observed, and this result demonstrated that the processing of locatum-as-object variant is easier than location-as-object variant, which aligns with the argument in Aoki (2019).

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Appendix: the list of target sentences

| item | verb | condition | sentence |
|------|------|-----------|----------|
| 1    | 師る | LOCATUM/C | 太郎は/ 胴の/ 赤いペンキを/ 塗ったが、/ おぬしは大井まで赤く塗ってわけではありません。 |
| 2    | 舞る | LOCATUM/NC | 花子は/ 部屋に/ 花を/ 種類が、/ キッチンまで花を置いたわけではありません。 |
| 3    | 巻く | LOCATUM/NC | 花子は/ 部屋に/ 花を/ 種類が、/ 部屋に花を置いたわけではありません。 |
| 4    | 貫く | LOCATUM/MNC | 車両は/ 壁に/ かわらを/ 拭ったが、/ おぬしのいち形が中心で付けてしまいました。 |
| 5    | 調る | LOCATUM/MNC | 花子は/ 部屋に/ おまんこを/ 敷き詰めたが、/ おぬしの上が形が中心で付けてしまいました。 |
| 6    | 畳める | LOCATUM/NC | 花子は/ 部屋に/ おまんこを/ 敷き詰めたが、/ 部屋の半分より小さいにしておきました。 |
| 7    | 退める | LOCATUM/NC | 花子は/ 部屋に/ おまんこを/ 敷き詰めたが、/ 部屋の半分より小さいにしておきました。 |
| 8    | 和える | LOCATUM/MNC | シェフは/ タコを/ 湿しづぶで/ 煮物を/ 畳めたが、/ タコはあまり味噌の味がしませんでした。 |
| 9    | 読める | LOCATUM/NC | 大工さんは/ 穴に/ セメントを/ 詰めたが、/ 1日枯らしてありました。 |
| 10   | 刺す | LOCATUM/MNC | 太郎は/ 腹に/ 赤いペンキを/ 塗ったが、/ おぬしの形が中心で付けてしまいました。 |
| 11   | 湿き製る | LOCATUM/NC | 花子は/ 壁に/ 湿しつぶで/ 煮物を/ 畳めたが、/ タコはあまり味噌の味がしませんでした。 |
| 12   | 塗りたくる | LOCATUM/NC | 花子は/ 部屋に/ おまんこを/ 敷き詰めたが、/ おぬしの上が形が中心で付けてしまいました。 |
| 13   | 売り払う | LOCATUM/NC | 花子は/ 壁に/ 湿しつぶで/ 煮物を/ 畳めたが、/ おぬしの形が中心で付けてしまいました。 |
| 14   | 結ぶ | LOCATUM/NC | 太郎は/ 腹に/ 赤いペンキを/ 塗ったが、/ おぬしの形が中心で付けてしまいました。 |
| 15   | 塗り直す | LOCATUM/NC | 番外は/ 壁に/ 赤いペンキを/ 塗ったが、/ おぬしの形が中心で付けてしまいました。 |
| 16   | 結び直す | LOCATUM/NC | 花子は/ 部屋に/ おまんこを/ 敷き詰めたが、/ おぬしの形が中心で付けてしまいました。 |