Processing Emergent Features in Metaphor Comprehension

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Abstract

This study examines the processing of emergent features in metaphors. Emergent features are metaphoric interpretations that are characteristic neither of the target nor the vehicle. In the first experiment, participants were asked to respond as to whether a verbal feature is an appropriate interpretation of the metaphor, which was presented as a prime. They are asked to respond immediately after a tone is presented which has a variable temporal lag after the feature. The timing of each tone controlled the participants' response times. The results show that the response deadline given to the participants only slightly affected their judgments. In a second experiment, the time to interpret a metaphor was controlled by varying the presentation time of the metaphor. The results showed that emergent features require more time for recognition as a metaphoric interpretation than do non-emergent features. The results support the hypothesis that interaction among features causes feature emergence. **Keywords:** Metaphor comprehension; Feature Emergence; Interaction.

Introduction

In this research, we examined the process of feature emergence, which is realized in comprehension of metaphors taking the form of " TARGET is VEHICLE. " Previous papers indicate that interpretations of these metaphors consist of four types of features. These features include common features, target features, vehicle features and emergent features (Becker 1997, Gineste et al. 2000, Nueckles and Janetzko 1997). When an interpretation is thought of in relation to both the target and the vehicle, it is regarded as a common feature. When an interpretation is thought of as a characteristic of the target (or of the vehicle), it is referred to as a target feature (or a vehicle feature). Finally, emergent features are not typically thought of in relation to either the target or the vehicle alone but do come to mind when the target and vehicle enter into a metaphoric comparison. For example, for the metaphor " Stars are Diamonds, " the feature " white " is a target feature, " rare " is a vehicle feature, " beautiful " is a common feature because it is listed as a feature when given either " stars " or " diamonds " by themselves, and " amazing " is an emergent feature because it is not listed for either word by itself, but is listed when the words are paired.

Previous research (Gineste et al., 2000) has reported that over 60% of metaphoric interpretations were emergent features. Emergent features are thus prevalent and play an important role in metaphor comprehension. Emergent features required a longer response time to be regarded as a feature of the prime than target or vehicle features, when the features were tested with target-term or vehicle-term primes. When the features were tested with the metaphor as the prime, both the emergent features and non-emergent features required a longer response time than did the target-term or the vehicle-term primes. The emergent features did not change their duration from one prime condition to another. As a result of these experiments, it was concluded that the results are consistent with the interaction theory of metaphor (Black 1962). However, previous results have not examined a difference between processes of emergent features and non-emergent features in metaphor understanding.

The interaction theory (Black 1962) suggests that metaphor comprehension is a product of an interaction between the target and the vehicle concepts. The created new meanings by the metaphoric comparison are thought to be the emergent features. In addition, Nueckles and Janetzko (1997) introduce the idea that metaphor comprehension proceeds in analysis-based and synthesis-based stages. According to their idea there must first be an analysis of the lexical meanings of the target and vehicle in analysis-based stage. If the target and vehicle have enough similarity, the metaphor comprehension does not proceed to synthesis-based stage.8 For cases in which the target-vehicle similarity is not sufficient, a shift to synthesis-based processing occurs. Then the metaphor comprehension is achieved through a construction of new components of meaning by synthesis of the target and the vehicle. It is during this second phase that emergent features would be generated.

Furthermore, previous computational models of metaphor understanding have proposed that emergent features are emphasized more than non-emergent features through interactions among features in metaphor understanding (Utsumi 2000, Terai and Nakagawa 2007, 2008). These models are able to simulate activation of emergent features under this assumption. However, these researches did not examine the experimental validity of this assumption that interaction among features causes emergent features. If the assumption is correct, then there should be differences between processes that generate emergent features and non-emergent features during the interpretation of metaphors. Therfore, one difference would be related to processing times. Emergent features are expected to require more time to be recognized during a metaphoric interpretation than non-emergent features.

This study employed two experiments to test the processing time of emergent features within metaphor interpretation. The first experiment was conducted using a cue-to-respond

method to elucidate how much time emergent and non-emergent features require to be generated during metaphoric interpretation. In the first experiment, participants were presented a metaphor. Participants were then presented with an emergent feature or a non-emergent feature for either a short or long period of time. Participants were then cued by a tone to respond as to whether the feature was appropriate to the metaphor which had been presented before. In the second experiment, participants were primed with a metaphor for either a short or long period of time. After the metaphor was presented, an emergent or non-emergent feature was presented and participants were asked to respond as to whether the feature is appropriate to the metaphor. The aim of these experiments was to determine whether emergent and non-emergent features have different time courses of processing.

Experiment 1

In this experiment, we examined the processing of emergent and non-emergent features in metaphor comprehension using a cue-to-respond method.

Method

34 undergraduates participated in this experiment. All participants were native English speakers. We selected 50 metaphors of the form "TARGET is VEHICLE": 38 metaphors were used in Becker (1997) and 12 metaphors were used in Gentner and Clement (1988). For each of these 50 metaphors, 1 to 5 features were selected. From Becker's and Gentner and Clement's results, 63 emergent features and 92 non-emergent features (20 features are common features, 22 features are target features and 50 features are vehicle features) were identified. Becker (1997) listed features and categorized them into 4 types of features (emergent, common, target, and vehicle features). Based on her categorization, 56 emergent features and 76 non-emergent features were selected. Gentner and Clement's results describe the properties of the metaphor, either the target or the vehicle. We extracted features from the descriptions and selected 7 emergent features and 16 non-emergent features. The features were categorized according to the rule used in Becker (1997). That is, if a feature which is included in the description of the metaphor is not included in either a description of the target or vehicle, then the feature is regarded as an emergent feature. On the other hand, if the feature, which is included in the description of the metaphor, is included in a description of the target or the vehicle, the feature is regarded as a non-emergent feature[1]. There is no significant difference between the numbers of participants who responded positively ("the feature is the property that the metaphor represents") for emergent compared to non-emergent features. In order to preclude the participants from responding "Yes" to all features, we also included 25 metaphors and 2 features for each metaphor that are irrelevant to either the target or to the vehicle. These items were selected from McGlone and Manfredi (2001) as a distractor pair of a metaphor and a feature.

The procedures were as follows. First, the fixation point "+" was presented for 3 seconds on the computer screen. Then, participants were presented with a metaphor for 1 second. They were asked to interpret the metaphor. After presentation of the metaphor, a feature was presented. While the feature was displayed, at 0.5 seconds in the short-time condition or at 5 seconds in the long-time condition, after the starting point of the feature's presentation, a brief tone (2000Hz, for 0.05 seconds) sounded. Participants were cued by the brief tone to respond "yes" or "no" depending on whether the feature was related to the metaphor or not. Participants were instructed to respond by pressing the "p" key ("Yes") or "q" key ("No") within 1 second. They were asked to respond as quickly as they could after the tone. If response time took longer than 1 second after the tone, the feature disappeared and the sign "Your response is too slow" appeared on the screen. The combination of times and features was randomized. Each combination was proportionally equal. After every 30 trials, the participants were given a break. In the short-time condition, 0.5 seconds after the presentation of the feature, the participants had to respond, presumably near the beginning of their interpretation process. In the long-time condition, they were assumed to complete more of the metaphor interpretation process.

Results

The average rate at which the participants responded within the limited time is 91.9% in the short-time condition and 97.9% in the long-time condition.

Response times The averages of response times after the tone under the condition that participants responded "Yes" are shown in Figure 1. There is a main effect of time condition ($F(1,33) = 76.2$, $p < .001$) and a main effect of feature types ($F(1,33) = 6.07$, $p < .05$). In the short-time condition, the average response time for emergent features is 519.9 milliseconds and that of non-emergent features is 529.0 milliseconds. In the long-time condition, the average response time for emergent features is 415.5 milliseconds and that of non-emergent features is 434.6 milliseconds. The response time after the tone in the short-time condition is longer than in the long-time condition. And, the response time of emergent features is significantly shorter than that of non-emergent features at 5% level. The response times under the condition that participants responded "Yes" are analyzed concerning 4 types of features: emergent, common, target, and vehicle. These are shown in Table 1. There is main effect of time condition ($F(1,33) = 34.9$, $p < .001$), but there is neither a main effect of feature types nor interaction between time and feature type.

[1]It might be some concern that there is difference between the sets of features from Becker's and Gentner and Clement's results. Thus, we analyzed the results separately for Becker's results because they represented a larger data set. The results show the same tendency that are indicated when all data are analyzed. Therefore, in this paper, we combine the two data sets.

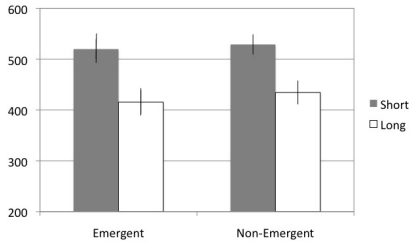

Figure 1: The response time when they responded ”Yes” in Experiment 1 (millisecond).

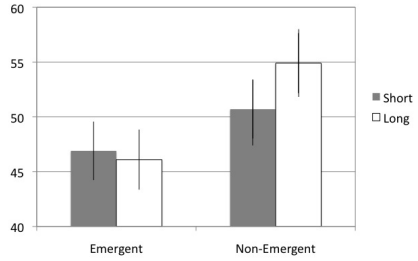

Figure 2: Average proportions of ”Yes” responses (%) in Experiment 1.

Table 1: Averages of the response times when participants responded ”Yes” (millisecond) in Experiment 1. Standard deviations are shown in parentheses.

Feature Type	Time Condition	
	Short-time	Long-time
Emergent Features	519.9 (180.3)	415.5 (113.4)
Common Features	521.1 (179.0)	432.0 (126.4)
Target Features	527.8 (172.8)	441.2 (136.2)
Vehicle Features	533.0 (188.0)	432.7 (134.3)

Table 2: Average proportions of ”Yes” responses (%) in Experiment 1. Standard deviations are shown in parentheses.

Feature Type	Time Condition	
	Short-time	Long-time
Emergent Features	46.9 (15.4)	46.1(15.8)
Common Features	50.9 (22.5)	55.3 (18.6)
Target Features	54.3 (21.3)	53.0 (19.0)
Vehicle Features	49.0(18.5)	55.7 (17.1)

Proportions of Appropriate Features as Interpretation of the Metaphor A ”Yes” response indicates that the participant recognized the feature as a valid metaphoric interpretation. The proportion of ”Yes” responses for emergent features and non-emergent features are shown in Figure 2. In the short-time condition, the average proportion of ”Yes” responses of emergent features is 46.9% and that of non-emergent features is 50.7%. In the long-time condition, the average proportion of emergent features is 46.1% and that of non-emergent features is 54.9%. An arcsine transformation was applied to the proportion data because of the restriction of these data to a 0-1 range. After transformation, the proportions were analyzed using a two-way ANOVA. There was a main effect of feature type ($F(1,33) = 34.0$, $p < .001$) and an interaction between feature types and time condition ($F(1,33) = 4.51$, $p < .05$). The proportions of ”Yes” judgments for the 4 types of features are shown in Table 2. There is a main effect of the 4 feature types ($F(3,99) = 6.73$, $p < .001$). The proportions of the 3 non-emergent features are significantly higher than that of emergent features ($p < .01$). However, there is no main effect of time condition and no interaction.

Discussion

In Experiment 1, the response time was controlled using the cue-to-respond method. Participants had enough time to judge if the feature was an interpretation of a metaphor in the long-time condition. They ware able to respond significantly earlier than in the long-time, compared to short-time, condition. This difference is predicted if participants were not finished with their interpretation process by the time the early, short-time tone was sounded. Response time of emergent features is significantly shorter than non-emergent features. No significant differences in response times were found among 4 feature types. However, the 3 types of non-emergent features (common, target and vehicle features) required slightly longer response time after the tone than the emergent features.

The proportions of ”Yes” responses for emergent features were significantly lower than that of the non-emergent features. Even when participants had 5 seconds to respond in the long-time condition, they responded ”Yes” to less than 50% of the emergent features. Apparently, it is more difficult to recognize emergent features as metaphoric interpretations. Furthermore, it is shown that there is a weak interaction between feature types and time condition. Participants regarded more non-emergent feature as a metaphoric interpretation in the long-time condition. These results suggest that it takes more time to recognize non-emergent features as a metaphoric interpretation than emergent features. However, the results are open to alternative accounts. In particular, if the emergent features are indeed fairly subtle, then even the longer response deadline may not have been sufficient to appreciate their aptness. In this case, participants may subscribe to more non-emergent features during the longer response deadline because even these more straightforward interpretations require a substantial processing period. In addition, when the proportions concerning 4 types of features were analyzed, there was no interaction. With respect to comparisons within the 3 types of non-emergent features, there were no differences in how often participants subscribed to their aptness.

In this experiment, the participants were shown a metaphor

for the same duration (one second) regardless of response deadline. Instead, the response deadline time during the presentation feature was controlled. During the presentation of the metaphor, participants presumably interpreted the metaphor. However, while the feature was present on the screen, they had to think about whether the feature was related to the metaphor or not. It is possible that the process during presentation of the feature is different from the process of metaphor comprehension. Therefore, a second experiment was conducted to examine the influence of the time for metaphor comprehension on the processing of the emergent features.

Experiment 2

In this experiment, the metaphor presentation time was controlled instead of the response deadline. We examined the influence of metaphor presentation time on the process of emergent and non-emergent features in metaphor comprehension.

Method

56 undergraduates participated in this experiment. All participants were native English speakers. The sets of metaphors and features were the same as those used in Experiment 1. The procedures are as follows. First, participants were presented with a metaphor on a computer screen. The metaphor presentation time was 3 seconds in the short-time condition and 12 seconds in the long-time condition. They were asked to interpret the metaphor. After presentation of the metaphor, a feature was presented. The participants were asked to respond "yes" or "no" depending on whether the feature was related to the metaphor or not. Participants responded by pressing "p" key ("Yes") or "q" key ("No") within 6 seconds. They were asked to respond as fast as possible without sacrificing accuracy. If they could not respond within 6 seconds, the feature disappeared and the text "Your response is too slow" appeared on the screen. The combination of times and features was randomized. Each combination was proportionally equal.

Results

Response times The averages of response times under the condition that participants responded "Yes" are shown in Figure 3. There is main effect of time condition on response time ($F(1,55) = 34.2$, $p < .001$). In the short-time condition, the average response time for emergent features is 2052.7 milliseconds and that of non-emergent features is 2033.5 milliseconds. In the long-time condition, the average time for emergent features is 2249.0 milliseconds and that of non-emergent features is 2283.7 milliseconds. Irrespective of type of features, the response times in the long-time condition were longer than that in the short-time condition. There is neither a main effect of type of feature nor an interaction between type of feature and time. Furthermore, the response times were analyzed for all 4 types of features: emergent, common, target, and vehicle. These are shown in Table 3. There is main effect of time condition ($F(1,104) = 5.14$, $p < .05$) but there is neither a main effect of feature type nor an interaction between type of feature and time.

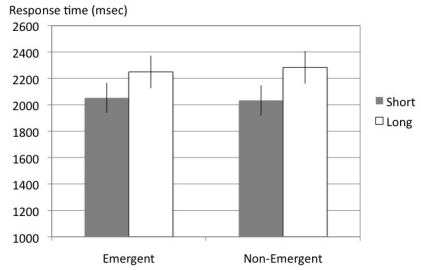

Figure 3: The response time when they responded "Yes" in Experiment 2 (millisecond).

Table 3: Averages of the response times when participants responded "Yes" (millisecond) in Experiment 2. Standard deviations are shown in parentheses.

Feature Type	Time Condition	
	Short-time	Long-time
Emergent Features	2100.9 (994.6)	2281.7 (1030.3)
Common Features	2050.0 (948.0)	2289.0 (1023.8)
Target Features	2116.3 (963.1)	2276.3 (1020.8)
Vehicle Features	2120.7 (959.7)	2306.8 (1029.6)

Proportions of Appropriate Features as Interpretation of the Metaphor Measuring proportions of "Yes" responses for emergent and non-emergent features, there is a main effect of feature types ($F(1,55) = 47.0$, $p < .001$) and an interaction between feature types and time condition ($F(1,55) = 13.2$, $p < .001$), as shown in Figure 4. In the short-time condition, the average proportion of "Yes" responses for emergent features is 46.7% and that of non-emergent features is 50.4%. In the long-time condition, the average proportion of emergent features receiving a "Yes" response is 54.7% and that of non-emergent features is 50.3%. The results show that non-emergent features are more often regarded as metaphoric interpretations than emergent features, and that emergent features require more time to be regarded as an interpretation of the metaphor than non-emergent features.

The proportions of approved metaphor interpretations for the 4 types of features are shown in Table 4. There is a main effect of time condition ($F(1,55) = 7.50$, $p < .01$) and a main effect of feature type ($F(3,165) = 10.1$, $p < .001$). The results show that the proportions of the 3 types of non-emergent features (common, target and vehicle features) are significantly higher than that of emergent features ($p < .001$). Furthermore, with respect to the 3 types of non-emergent features, the proportions of approved interpretations in the short-time condition are higher than those in the long-time condition. Conversely, the proportions of approved interpretations for emergent features in the short-time condition are lower than for the long-time condition.

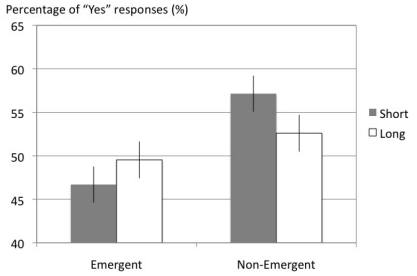

Figure 4: Average proportions of "Yes" responses (%) in Experiment 2.

Table 4: Average proportions of "Yes" responses (%) in Experiment 2. Standard deviations are shown in parentheses.

Feature Type	Time Condition	
	Short-time	Long-time
Emergent Features	46.7 (15.8)	49.5 (15.6)
Common Features	58.0 (19.9)	51.8 (20.8)
Target Features	55.5 (19.2)	51.9 (18.5)
Vehicle Features	57.6 (19.2)	53.3 (16.9)

The trials were divided into 3 groups based on when they occurred during the experiment (beginning, middle, ending) and the proportions were analyzed concerning these 3 groups (Figure 5). There is a main effect of type of features ($F(1,55) = 41.0$, $p < .001$) and an interaction between feature type and time condition ($F(1,55) = 14.8$, $p < .001$). In the short-time condition, the average proportion of "Yes" responses of emergent features is 44.7% at the beginning, 47.4% at the middle and 48.0% at the ending. The results show that participants learned that the emergent features are the metaphoric interpretations in the short-time condition, however, the proportion of the emergent features in the long-time condition decreases.

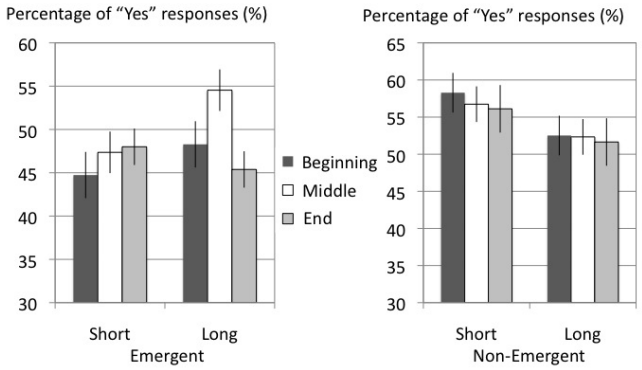

Figure 5: Change of the average proportions of "Yes" responses (%) in Experiment 2.

Discussion

The response time results show that participants responded significantly faster in the short-time condition than in the long-time condition. In Gineste et al. (2000), each metaphor was shown for around 1 second (they used a presentation time of 40 milliseconds per character). After each metaphor was presented, there was 2 second delay and then a feature was presented. Their results showed that the average response time for non-emergent features (the target or the vehicle features) was 1201 milliseconds. For the emergent features, the response time was 1173 milliseconds. These response times are shorter than our results in either the short or long-time condition. In our experiment, the metaphor was presented for 3 seconds in the short-time condition. Therefore, it could be argued that the shorter presentation time of a metaphor made participants' respond more quickly. Perhaps the short display duration implicitly served as a prompt for participants to decide quickly. The long presentation of the metaphor triggers association more widely. The wide association would cause the long response times in the long-time condition. Furthermore, non-emergent features are either properties of the target or the vehicle or both. The proportion of "Yes" responses for non-emergent features in the short-time condition is higher than in the long-time condition. The results show that the shorter presentation of a metaphor made participants interpret the metaphor based on more the properties of the target and that of the vehicle.

The proportions of "Yes" responses for emergent features were significantly lower than that of non-emergent features. This shows that it is more difficult to recognize emergent features as metaphoric interpretations. At the beginning, the proportion of "Yes" responses for emergent features in the short-time condition is only 44.7%. However, this proportion gradually increased during the experiment. The results imply the possibility that the participants learned how to recognize an emergent feature as an interpretation in the short-time condition.

General Discussion

In Experiment 1, the proportions of "Yes" (approved metaphor interpretation) responses doesn't show that the emergent features require more time to be recognized as a metaphoric interpretation than non-emergent features. Experiment 2 shows that the emergent features require more time for metaphor presentation be recognized. The difference between these experiments is likely caused by the difference between processes during the controlled time in Experiment 1 and 2. The time to find relationship between a feature and a metaphor was manipulated in Experiment 1, and the time to interpret metaphors was manipulated in Experiment 2. The former process can be regarded as the process of metaphor comprehension. This occurs when a particular interpretation of a metaphor is tested. For example, the interpretation " white " is tested to see whether it is a valid interpretation of the metaphor " Stars are diamonds. " On the

other hand, the latter process occurs when only the metaphor itself is presented, and participants need to build an understanding of the metaphor from internal evidence within the metaphor itself. Furthermore, all of the total interpretation/ decision/response times in Experiment 1 were less than those in Experiment 2. That is, even the long response deadline of Experiment 1 is less than that used in Experiment 2. So, I suspect that participants have not had time to find emergent interpretations in Experiment 1. In short, subjects CAN develop emergent interpretations, but it takes more than the five seconds allowed in Experiment 1. By the end of those five seconds, participants have only succeeded in reliably finding the more straight-forward (non-emergent), less emergent interpretations. And the cue-to-respond task is too stressful for participants to find emergent interpretations. Thus, the results in Experiment 2 reflect how to process emergent features in metaphor comprehension without a context.

The proportions of "Yes" responses in Experiment 2 imply that at first, the meanings of the target and the vehicle are emphasized as non-emergent features, but then, emergent features are discovered as valid interpretations. These results support the assumption that interactions among the features of the terms used in a metaphor can cause emergent features to be formed (Terai and Nakagawa 2007, 2008). Furthermore, the proportion of "Yes" responses for non-emergent features in the long-time condition is lower than in the short-time condition. This result suggests that features that are true of one metaphor term but not the other are inhibited in the long-time condition. This inhibition of the non-emergent features supports the premise that the interactions among features include activation and inhibition processes. In the long-time condition, the proportions of " Yes " responses for emergent features change non-monotonously. At the ending, the proportion reduced. It can be considered that the participants learned that the emergent features are the metaphoric interpretations in the long-time condition from the beginning to the middle. However, their learning proceeded and the emergent features might be targeted in the inhibition process at the ending.

The results in Experiment 1 show that the response times for the emergent features are faster than those of the non-emergent features. On the surface, this result appears to contradict the results from the proportion of "Yes" responses, but if we accept that response times indicate activation level, then it may be that after an interactive comparison process has been accomplished, emergent features are more activated than non-emergent features. The interpretation approval rates show that recognizing an emergent interpretation is harder than a non-emergent interpretation. Therefore, the emergent features require more time to be regarded as a metaphoric interaction, however, when they are recognized, they were more salient than the non-emergent features.

To elucidate the mechanism of feature emergence during metaphor interpretation, we manipulated the time allowed for comprehending a metaphor and/or its interpretation. The results support a protracted process of interaction among features. However, we have not yet elucidated a detailed mechanism of the interaction. A next step will be to apply existing interactive process models of metaphor comprehension (Terai and Nakagawa 2007, 2008) to the observed time course results.

Acknowledgments

We are deeply grateful to Dr. Angela H. Becker and Dr. Dedre Gentner for allowing us to use their valuable data. This research is supported by MEXT's program "Promotion of Environmental Improvement for Independence of Young Researchers" and National Science Foundation REESE grant 0910218. We want to thank Akshat Gupta and Rachel Selonick for assistance with the experiments.

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