

Topic and Vehicle Play Different Roles in Processing of Metaphor: Activation and Inhibition of Semantic Features of Constituent Terms

Keiko Nakamoto (kenakamoto@nifty.com)

Takashi Kusumi (kusumi@educ.kyoto-u.ac.jp)
Graduate School of Education, Kyoto University.
Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan

Abstract

This paper has examined the asymmetric roles of a topic and vehicle in the metaphor comprehension process. We began by proposing a perspective on the roles of topic and vehicle in terms of the sentence and discourse structure. According to this perspective, the topic, together with the preceding context, would convey information regarding the aspects of the topic that are relevant in creating a coherent interpretation of the metaphor with the entire discourse. In contrast, the vehicle would convey information regarding the types of objects or events it would represent. Thus, it is predicted that a prior presentation of a metaphor-relevant feature of the topic would facilitate the comprehension of the corresponding metaphor, while a metaphor-irrelevant feature of the vehicle would interfere with the comprehension. Two experiments were conducted in order to test these predictions, taking a priming paradigm similar to that of McGlone and Manfredi (2001). The obtained results were supportive of our proposal and suggested the importance of considering sentence and discourse structure to reveal the metaphor processing

Key words: metaphor comprehension; priming effects; activation and inhibition of semantic features

Introduction

The purpose of this study is to explore the asymmetric roles of the topic and the vehicle in comprehending metaphors.

The manner in which people comprehend nominal metaphors, such as “*crime is a disease*” is one of great interest in cognitive processes of natural language. In general, it is believed that metaphor interpretation is primarily based on the semantic features that the vehicle (*disease*) and the topic (*crime*) have in common (Gentner, 1983), or the features that the vehicle consists of, and are applicable to the topic (Glucksberg & Keysar, 1990). In this case, the features such as {*harmful, spreading rapidly, ...*} would be used for the interpretation. However, the topic and vehicle have features that are irrelevant to the achieved interpretation. For example, most people would not consider that the metaphor intends to refer to the features of the topic such as *to be punished* or those of the vehicle such as *causing a fever*. Therefore, people must suppress or inhibit those features of the topic and the vehicle that are not relevant to metaphor interpretation; they must activate or focus on the metaphor-relevant features. With reference to this point, one related problem arises: would metaphor-irrelevant and relevant features be treated equally or differently for a topic and a vehicle? More specifically, are suppression and activation processes of topic and vehicle features similar or different?

Among many models of metaphors (e.g., Lakoff & Johnson, 1980; Kintsch, 2000), two major psychological models focus on the asymmetric roles of a topic and a vehicle in comprehension process—the alignment model (Gentner, 1983; Gentner & Wolff, 1997; Wolff & Gentner, 2000) and the class inclusion model (Glucksberg, 2003; Glucksberg & Keysar, 1990). The alignment model assumes that in a nominal metaphor the topic and vehicle terms denote literal concepts, and metaphor processing begins with a bidirectional comparison between the two, and predicts that the two terms are equally processed in the early phase of comprehension. In contrast, the class inclusion model claims that the roles of the topic and vehicle differ even in the initial phase. This model assumes that the vehicle term of a metaphor has dual functions—referring to the conventional literal referent, and denoting the more abstract, metaphoric category. According to this model, we must inhibit the literal meanings of a vehicle and make an appropriate abstraction of it in order to interpret a metaphor. More specifically, the class inclusion model states that the vehicle would first be processed to arrive at an interpretation.

Although both these models have been evaluated using various psychological experiments, which of the models is more suitable for explaining the metaphor comprehension phenomena is still inconclusive. Some researches have demonstrated that both the topic and vehicle play an important role even in the earliest processing stage of metaphors (Gentner & Wolff, 1997; Wolff & Gentner, 2000), while other studies reported that the roles played by the topic and vehicle in metaphor comprehension differs from the commencement of processing (Gernsbacher *et al.*, 2001; McGlone & Manfredi, 2001). On the basis of these findings, Glucksberg and his colleagues have proposed a model that has been modified from the original class inclusion model. The model, called the interactive property attribution model, assumes that the sentence structure of metaphors should be considered in order to explain the manner in which they are understood.

Reconsidering nominal metaphor comprehension in terms of a sentence and discourse structure

In general, assertions would include given and new information (Clark & Haviland, 1977). For example, in the assertion “The first speaker of this session is my colleague,” the noun phrase *the first speaker of this session* would express information that is commonly shared by the speaker to the hearer (i.e., they know that there has been a talking session that has several speakers and that someone will give

his speech first). In this case, however, the hearer would not be aware of who the *first* speaker in the session is. Therefore, (*is my colleague* conveys the new information to the hearer. Similarly, as non-metaphoric statements, metaphors have provided new information (Glucksberg, 1989; Glucksberg *et al.*, 1997). Glucksberg *et al.* have claimed that in metaphoric sentences of the form *X is (like) a Y*, people would prefer to put a relatively less familiar concept in the new sentence position (the subject) and a familiar concept in the existing sentence position (the predicate).

However, what exactly does it mean when we say that the topic conveys given information and the vehicle conveys new information? Glucksberg *et al.* (1997) argued this problem in terms of two types of world knowledge that are used to comprehend metaphors. The first type is knowledge about the topic, particularly which dimensions are relevant or meaningful to it. For example, when talking about *oranges*, the size, taste, price, or smell can be meaningful. In contrast, the distance of the oranges from the ocean or the opaqueness of the oranges would seldom be referred to as meaningful topics. The second type is the knowledge of the kinds of concepts that the vehicle may represent. For example, the term *rocket* could easily be regarded as representative of fast-moving objects, as compared to a *car*. The topic and vehicle of a metaphor provides this differing information, and their meanings are interactively affected to generate a cohesive interpretation of the sentence.

On the basis of these observations, the interactive property attribution model has been proposed and verified by several experiments in recent metaphor literatures (Gernsbacher, *et al.*, 2001; Glucksberg *et al.*, 1997, 2001; McGlone & Manfredi, 2001). This model emphasizes that the metaphor comprehension process can be aptly described as a process in which the vehicle of a metaphor is interpreted as denoting a metaphoric category that has properties which can be attributed to the topic. The model predicts that if the vehicle of a metaphor is regarded as the literal category containing several features that cannot be attributed to the topic, then comprehension of the metaphor will be difficult or even impossible. As suggested by the model, several researches have demonstrated that when the features of the vehicle that are irrelevant for metaphor interpretation are activated before reading a corresponding metaphor, then comprehension becomes relatively more difficult compared with when the features are not activated.

Although the interactive property attribution model provides some interesting suggestions for the metaphor comprehension process, it also has several limitations, particularly when considering the discourse structure. In most cases, metaphors are not used in isolation. They are usually placed in a context consisting of various types of statements other than metaphoric ones. Taking this into account, the information conveyed by the topic and the vehicle must reflect the ordinal discourse structure.

Let us consider the following examples:

- (1) a. The bank at the corner of the street has been attacked three times by a criminal team.
b. The bank at the corner of the street was designed by a famous architect.
- (2) a. The bank is (like) a good prey for robbers.

- b. The bank is (like) a castle in appearance.

Both of (2a) and (2b) can be interpreted as metaphoric statements even without any context. However, when (1a) is presented before (2), (2a) seems to be easier to understand than (2b). On the other hand, when (1b) is presented, (2b) seems to be easier to understand than (2a). This example implies that the topic appears ambiguous even when it is a concrete noun, such as *bank*, and the preceding context provides information that allows a hearer to select what of aspects of the topic are relevant in the discourse. Hence, a metaphoric statement can be easily understood when the metaphor refers to those aspects or properties of the topic that are consistent with the discourse context. In contrast, when the metaphor refers to irrelevant aspects of the topic to the context, understanding may become slightly difficult. However, since we often discuss the various aspects of an object in the same context (for example, talking about the taste, color, and price of an apple in a cooking situation), it is plausible that the interference effect of the preceding context would not be so significant.

In contrast, the vehicle of a metaphor would seldom be the main topic of a given discourse context. For instance, (2a) is not suitable in a context in which the behaviors of predatory animals are described. Therefore, the topic term alone must provide the constraints for disambiguating the vehicle term. In other words, it is suggested that people may not utilize the information in a preceding context to interpret a vehicle term as a metaphoric category, because a discourse in natural settings does not have such structure. If this is the case, it is predicted that the comprehension of a metaphor is not necessarily facilitated by the preceding context, which activates the metaphor-related features of the vehicle term. In contrast, activating the metaphor-irrelevant features of the vehicle term in a metaphor would interfere with comprehension, because these properties must be suppressed in order to generate an appropriate interpretation.

Aims of this study

Taking the reconsideration of the context effect in the metaphor comprehension discussed above, the following predictions have been addressed. First, metaphor comprehension should be facilitated if the relevant feature of a topic term is activated before reading the corresponding metaphor. Second, the comprehension should be interfered with if the irrelevant features of a vehicle are activated prior to the metaphor presentation. Moreover, it is necessary that the features are activated in association with the topic or the vehicle for producing facilitation and interference. In particular, the same features will facilitate or interfere with the metaphor comprehension when they are referred to as predicates of the topic or the vehicle (e.g., *crimes spread rapidly*), but not when they are referred to in isolation (*spread rapidly*).

In order to test these predictions, two experiments were conducted. In Experiment 1, the features were presented as primes for the corresponding target metaphors and as the predicates for the constituent terms. In Experiment 2, the same features were presented without the constituent terms, prior to the target metaphors.

Experiment 1

Experiment 1 was conducted to investigate the roles of activation and inhibition of the topic and vehicle-related features using a priming paradigm similar to that used by McGlone and Manfredi (2001). In order to arrive at specific conclusions, we modified their method in several points. The most important modification was the addition of the literal fillers to the experimental materials; this was done to avoid making participants have processing sets that were unusually adaptive to metaphors. Since there is a possibility that people can adaptively respond to a ratio of trials where the primes and corresponding targets are semantically related to each other during the entire trials (cf., Neely, 1991), this modification may be important to test the findings of McGlone and Manfredi in a more natural environment where the metaphors were mixed with non-metaphorical statements in order to generalize the results. In addition, we presented probe sentences after the target metaphor was comprehended, in order to ensure the understanding of the metaphor. In McGlone and Manfredi's study, the participants were encouraged to wait until they had a well-articulated interpretation before they responded, and were suggested that it might take a few seconds. Although they introduced this procedure to make sure that the participants understand the meaning of the metaphors, it seemed to impose an extra load on the participants. In the present study, instead of their procedure, a probe sentence was presented after the participants read the metaphors, and judgment whether the meaning of the probe matched to that of the metaphors was required. It was expected that these modifications made the experimental setting more similar to natural discourse than that of the previous study. In order to reduce the duration of the experiment, the control primes that did not contain both the constituent terms of a metaphor (XXXX is XXXX) were not used in the experiment.

Method

Participants. Fifty-four students from Waseda University volunteered to participate in the experiment for the partial fulfillment of a course requirement. All participants were native Japanese speakers.

Materials. Forty-two metaphors (e.g., *Loneliness is a desert*¹) were drawn from previous metaphor researches (Kusumi, 1987; Gentner & Clement, 1988; Glucksberg et al., 1997; Nakamoto, 2003) and were used as target stimuli in this experiment (e.g., *Loneliness is a desert*). English metaphors were translated into Japanese, and these were verified to ensure that they were still understandable and retained their original meaning without significant changes.

Six types of primes were created for each target metaphor (e.g., *Loneliness is a desert*) based on a preliminary study where the description of the characteristics or features of the topics and the vehicles and interpretations of the metaphoric sentences were collected from 60 university students. These

participants were divided into three groups and assigned each the topic-term, the vehicle-term, or the metaphor group. First, in order to construct the metaphor-relevant primes, the features which were obtained as responses in all the groups were selected. For example, the feature *empty* was obtained as a response for the topic *loneliness* and the vehicle *loneliness*, as well as for an interpretation of the sentence. These shared features were then combined with the topic (*Loneliness is empty*) and the vehicle (*Desert is empty*). Second, the features that were obtained from the vehicle group but not from the other groups were selected (e.g., *dry*). The features that were obtained from the topic group but not from the others were also simultaneously selected (*sad*). These features were subsequently combined with the vehicle and the topic to make the metaphor-irrelevant primes (*Desert is dry*, *Loneliness is sad*). Term-alone primes were created by replacing the vehicle (*Loneliness is XXXX*) or topic (*XXXX is desert*) in each metaphor with a string of Xs. Six separate stimulus lists were created in which each metaphor was paired with one of the six primes corresponding to it. Each list contained seven metaphors with each of the six prime types. These lists were created to ensure that the participants saw each metaphor and prime only once in the experiment.

In addition to these prime target metaphor pairs, 42 category inclusion statements were created as literal fillers (e.g., *Chocolate is a sweet*, *A sparrow is a bird*). The primes for these literal sentences were also created. In order to equate the ratio of relevant and irrelevant primes to the corresponding target literal fillers, the primes containing the topics of the target sentences were created as the irrelevant primes (*Chocolate melts*), whereas the primes with the predicates were created as the relevant primes (*A bird has wings*). This was done because the topic functioned as an example of the category denoted by each predicate. Hence, the features of each category were inevitably inherited by and shared with the topic. This procedure inevitably resulted in a difference in the nature of the prime target set constructed between the metaphors and the literal fillers. However, the participants could not determine which of the terms were presented in a prime, before the corresponding target was presented. Therefore, we assumed that the difference did not significantly affect the results. In addition to the relevant and irrelevant primes, term alone primes were also created (*Chocolate is XXXX*). The same literal filler pairs were combined with the six stimulus metaphor lists and used in the experiment.

In order to encourage the participants to read the target sentence carefully, probe sentences were created for 14 metaphors and 14 literal fillers. Half the probe sentences were semantically related to the target (e.g., *Loneliness makes a person feel desolate* for *Loneliness is a desert*) and the other half were not related (*Chocolate is made from cocoa beans* for *Chocolate is a sweet*).

Design. A 2 (term: topic or vehicle) × 3 (prime type: metaphor-relevant, metaphor-irrelevant, term-only) within subject design was used.

Procedure. The participants were tested individually. In the experiment, they were required to interpret a metaphor presented on a computer screen, and their reading time was

¹ In Japanese, nouns are given equal treatment in grammar, whether they are countable or uncountable, singular or plural. Therefore, all the target sentences were in the same form (XXX ha XXX da) in Japanese.

recorded. The presentation of the stimuli and the recording of the responses were controlled by Superlab pro (Cedrus corporation) with an AT compatible PC and a response box.

The participants began each trial by pressing one of the buttons on the response box. Before the trial commenced, a message "Ready?" appeared in the center of the screen. When the participants pressed the button, the message disappeared and a fixation cross appeared 8.4 inches from the top edge of the screen, where the first letter of a prime sentence following it would be presented. The fixation cross remained on the screen for 1,000 msec. It was then replaced by one of the six primes (e.g., *Loneliness is XXXX*) for a given target sentence. The participants were required to read the prime carefully, so that they would be able to interpret the subsequent sentence easily and quickly. After 1,800 msec, the prime sentence disappeared and the fixation cross again appeared 5.8 inches from the top of the screen. After 200 msec, the fixation cross was replaced by the correspondence target sentence (*Loneliness is a desert*). The participants were instructed to read the sentence carefully and press the button at the center of the response box when they felt that they understood it. The task consisted of a total of 84 trials—42 trials were experimental trials where the target sentences were the metaphors. The other 42 trials were fillers that contained the literal statements as the target sentences. In 24 of the trials (12 metaphor, and 12 literal filler trials), a probe sentence (*Loneliness makes a person feel desolate*) was presented after the participant responded to the target. This was followed by a string of three question marks (???) which appeared at the center of the screen for 1,500 ms. Probes were introduced to ensure the participants to interpret the target sentence, not just to see it and press the button. When the trial started, the participants were unable to determine whether it contained a probe or not. They were required to judge, as quickly as possible, whether the probe sentence denoted a meaning that was similar to the target. When the probe and target had similar meanings, the participants were instructed to respond "Yes" by pressing the rightmost button of the response box. If not, they were instructed to respond "No" by pressing the leftmost button (for this example, the correct response was "Yes"). After they responded, a feedback message was presented for 1,500 msec to inform them of whether their answer was correct. Then the screen was cleared and remained so for 2,000 msec as an inter-trial interval.

In order to familiarize the participants with the task, 21 practice trials were given before the experimental trials. One third of the practice trials had probes for the targets, in the same manner as the experimental trials.

Results and Discussion

The primary concern of this paper is to reveal the characteristics of activation and inhibition of metaphor-relevant and irrelevant features in the comprehension process. The responses in the metaphor trials have been analyzed and reported here.

Metaphor comprehension times greater than 6,000 msec or less than 500 msec (approximately 2.3%) were excluded from this analysis. The mean comprehension times and SDs were calculated for each condition and for each participant.

The responses that deviated more than 2 SDs from the mean were then discarded as outliers. This resulted in the elimination of approximately 5.5% of the trials. After these preliminary procedures, the mean comprehension times in each of the prime type (metaphor-relevant, irrelevant, control) by each term (topic, vehicle) were re-calculated for all the participants. The mean comprehension times in each condition are presented in Figure 1. As shown in Figure 1, the participants took a longer time to comprehend the target metaphors when the metaphor-irrelevant features were presented before than when they were not. Moreover, this tendency was clearly observed in the vehicle-term condition but was not in the topic-term condition. In contrast, when the metaphor-relevant features were presented in advance, comprehension of the target metaphor tended to be quicker. The difference between the topic and vehicle condition was observed once again for this tendency. The facilitation by the preceding metaphor-relevant features was found only when they were presented with the topic-terms, but not when they were presented with the vehicle-terms.

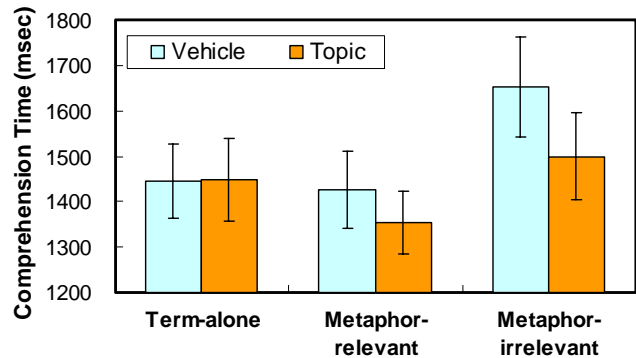


Figure 1 Mean comprehension times by term and prime type. Error bars represent standard errors.

In order to statistically test these tendencies, a 2×3 analysis of variance (ANOVA) was conducted using term (topic or vehicle) and prime type (term-alone, metaphor-relevant feature or metaphor-irrelevant feature) as within-subject factors. The participants were treated as a random variable. The ANOVA revealed that there were significant main effects of term [$F(1, 53) = 7.695, p < .001$] and prime type [$F(2, 106) = 12.202, p < .0001$]. Overall, the metaphor comprehension in the topic-term condition was faster than in the vehicle-term condition. More importantly, the interaction between the two variables was also significant [$F(2, 106) = 3.643, p < .05$]. The simple main effects in both the topic- and vehicle-conditions were shown to be significant [$F(2, 212) = 4.75, p < .01$ in the topic-term condition; $F(2, 212) = 13.542, p < .0001$, vehicle condition]. Subsequently, Ryan's multiple comparison procedure was conducted to compare the means. This analysis indicated that in the topic-term condition the comprehension was much faster when the target was preceded by the metaphor-relevant feature (1354 msec) than when it was preceded by the control (1449 msec; $p < .05$). The difference between the metaphor-irrelevant prime (1499 msec) and the control was not significant. In the vehicle-term condition, the metaphor-irrelevant prime interfered with the target metaphor comprehension (1651 msec) as compared to the control

(1445 msec; $p < .05$). The comprehension time of the target preceded by the metaphor-relevant feature (1425 msec) did not significantly differ from that of the control.

As the present experiment was essentially a replication of that of McGlone and Manfredi (2001) with the literal fillers, the obtained results were similar to theirs for the main part. In particular, our results were identical to theirs, in terms that the interference was observed when a sentence consisting of the vehicle term and the metaphor-irrelevant feature was presented. However, there was also a difference: In our study, the facilitation was observed when the metaphor-related feature was presented with the topic, while McGlone and Manfredi did not find such an effect. This might be due to the modification such as the addition of the literal fillers and the use of the probe sentences, which were made in order to make the experimental setting more natural than the previous study. As a consequence, it made the participants to respond faster. It is suggested that metaphor comprehension is facilitated when the previous sentences mention the same aspect of the topic, when the sentences were embedded in a natural, discourse-like setting.

In general, the results in Experiment 1 were consistent with our proposal. The comprehension of the metaphor was facilitated when the metaphor-relevant feature was activated in association with the topic. In contrast, the comprehension was inhibited when the metaphor-irrelevant feature was actively associated with the vehicle. Moreover, there was no significant facilitation or interference when the metaphor-relevant features were presented with the vehicle terms, or when the metaphor-irrelevant features were presented with the topics prior to the corresponding metaphors.

Although these results could be in agreement with our proposal, there is another possible explanation for them. In Experiment 1, the metaphor-relevant and irrelevant features were presented as the predicates for the constituent terms of the corresponding metaphors. However, it is possible that activating the features alone will make similar effects. In particular, since the metaphor-irrelevant features used in the experiment were different for the topic and vehicle term condition, it is difficult to deny the possibility that the difference between the topic and the vehicle in the condition is simply a matter of the association strength between the features and the metaphors. If this were the case, then the facilitation or interference in this experiment could be the result of the excitatory or inhibitory links between the features and the metaphors that might have been constructed during the comprehension process; these could not be regarded as evidence for the asymmetric roles of the topic and the vehicle, particularly in terms of sentence structure.

Experiment 2

Experiment 2 was conducted in order to exclude the possibility described above. In Experiment 2, the metaphor-relevant and irrelevant features were presented as the primes without the topic and the vehicle terms (i.e., the primes presented a word or phrase denoting only the semantic features). If the effects observed in Experiment 1 disappear when a prime consists of the feature alone, we are able to conclude that they can be regarded as evidence for the asymmetric roles of metaphor constituents.

Method

Participants. Forty students from Waseda University volunteered to participate in this experiment for the partial fulfillment of a course requirement². All were native Japanese speakers and did not participate in Experiment 1.

Materials. The materials in Experiment 1 were used with the following modification of the prime sentences: The topic and vehicle terms were removed and only the predicate phrases were used as the primes (*empty* for the metaphor-relevant prime of *Loneliness is a desert*). Therefore, there was no distinction between the topic and vehicle term condition in the term alone and metaphor-relevant features. The difference in the metaphor-relevant features remained, because the prepared materials were different for the topic and the vehicle (e.g., *sad* for *loneliness* and *dry* for *desert*). Consequently, there were four types of primes for each target metaphors—the metaphor-relevant feature, the metaphor-irrelevant feature of the topic, the metaphor-irrelevant feature of the vehicle, and the neutral.

Design. A one-way within-subject design with four levels of prime types was used.

Procedure. The procedure was identical to Experiment 1, including the ratios of the prime types, because it was better to keep the ratio of the semantically-related prime-target pairs equal to that of Experiment 1. Each participant viewed the metaphor-relevant features 14 times, the controls 14 times, the metaphor-irrelevant of the topic 7 times, and the metaphor-irrelevant of the vehicle 7 times.

Results and Discussion

Outliers were discarded in the same manner as in Experiment 1. The mean comprehension times and the ratio of the excluded trials are shown in Table 1. As shown, the results in Experiment 2 differed from those in Experiment 1. Comprehension was not delayed when the metaphor-irrelevant feature was preceded the target. In addition, there was no facilitation in the metaphor-relevant condition as compared to the neutral. A one-way ANOVA revealed that the main effect of prime types was marginally significant [$F(3, 117) = 2.636, p < .06$]. Subsequently conducted multiple comparisons of Ryan's method showed that there was no condition that significantly differed from the neutral.

TABLE 1
Mean Comprehension times, SDs (in msec) and Ratio of Outliers in Each Condition

Prime type	<i>M</i>	<i>SD</i>	% of outliers
Metaphor-relevant features	1344	598	5.9
Metaphor-irrelevant features of topic	1364	636	5.4
Metaphor-irrelevant features of vehicle	1291	528	4.6
Neutral	1364	619	6.1

In summary, the facilitation and inhibition, produced by presenting the features relevant or irrelevant to the corresponding metaphor, disappeared in Experiment 2. These

² Two additional persons participated in the experiment, but the outliers they made were in excess (more than 20% of the total trials); therefore, they were not included in the data analysis.

results excluded the possibility that the effects observed in Experiment 1 were caused merely by the semantic features, irrespective of the types of terms they predicated.

General Discussion

The results of the two experiments can be summarized as follows: (a) The primes that presented the metaphor-relevant features as the predicate of the topic facilitated metaphor comprehension, while those that presented the metaphor-relevant features with the vehicle did not display such effects. (b) The primes that presented the metaphor-irrelevant features with the vehicle interfered with metaphor comprehension, while those that presented the metaphor-irrelevant features with the topic did not. (c) The effects of the metaphor-relevant and irrelevant features disappeared when they were presented on their own in the primes. These results are completely consistent with our predictions.

The findings in this research suggest that the topic and vehicle play different but critical roles in understanding a metaphor. The topic, together with the prior context, provides information regarding the aspects that are relevant to the intended meaning of a metaphor. In contrast, the vehicle after taking the restriction provided by the topic, would be interpreted as denoting a metaphoric concept that has features attributable to the topic. Clearly, it is necessary for metaphor understanding to inhibit the metaphor-irrelevant aspects of the vehicle, the features related to the literal concept of the vehicle), and to modify or abstract the features that could be candidates for ground of the metaphor interpretation. The present results added a supportive evidence for the interactive property attribution model (Glucksberg *et al.*, 1997; McGlone & Manfredi, 2001).

Although the present study did not conducted in truly natural environment, the experimental procedure was modified to make the settings somewhat more natural than those in the previous study, and provided a possibility to connect the often-used priming paradigm to natural discourse settings. We acknowledge that our modification was a very small step to reveal metaphor comprehension process in natural discourse settings. But, the facilitation effect caused by the metaphor-relevant sentence with the topic term might be observed only with such efforts. If our modification was appropriate for the purpose to bring the experiment to a natural setting, it is implied that it is necessary for revealing the metaphor processing to take into consideration the sentence and discourse structure in which a metaphor appears. In order to take such an approach, we must reconsider the relationship between metaphor and literal expressions, because natural contexts usually include both of them. The previously proposed models have claimed that there is no clear boundary between them and have assumed that there is a common set of cognitive processes for both of them (Bowdle & Gentner, 2005; Glucksberg, 2003; Kintsch, 2000; Wolff & Gentner, 2000). However, they do not seem to provide sufficient explanation about the relationship between metaphor and literal processing. In addition, of course, the analysis of metaphor use in natural discourse is so important to reveal the metaphor comprehension process in more detail.

Acknowledgments

The authors would like to thank Kenpei Shiina, Kow Kuroda, and Hajimu Hayashi for their helpful comments. This research was supported by the 21st Century COE Program (D-2, Kyoto University) from Ministry of Education, Culture, Sports, Science and Technology, Japan.

References

- Bowdle, B., & Gentner, D. (2005). The career of metaphor. *Psychological Review*, **112**, 193-216.
- Clark, H. H., & Haviland, S. E. (1977). Comprehension and the given-new contract. In R. O. Freedle (Ed.), *Discourse production and comprehension*. Norwood, NJ: Ablex.
- Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science*, **7**, 155-170.
- Gentner, D., & Clement, C. (1988). Evidence for relational selectivity in the interpretation of analogy and metaphor. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 22). San Diego: Academic Press.
- Gentner, D., & Wolff, P. (1997). Alignment in the processing of metaphor. *Journal of Memory and Language*, **7**, 331-355.
- Gernsbacher, M. A., Keysar, B., Robertson, R. R. W., & Werner, N. K. (2001). The role of suppression and enhancement in understanding metaphors. *Journal of Memory and Language*, **45**, 433-450.
- Glucksberg, S. (1989). Metaphors in conversation: How are they understood? Why are they used?. *Metaphor and Symbolic Activity*, **4**, 125-143.
- Glucksberg, S. (2003). The psycholinguistics of metaphor. *Trends in Cognitive Science*, **7**, 92-96.
- Glucksberg, S., & Keysar, B. (1990). Understanding metaphorical comparison: Beyond similarity. *Psychological Review*, **97**, 3-18.
- Glucksberg, S., McGlone, M. S., & Manfredi, D. (1997). Property attribution in metaphor comprehension. *Journal of Memory and Language*, **36**, 50-67.
- Kintsch, W. (2000). Metaphor comprehension: A computational theory. *Psychonomic Bulletin and Review*, **7**, 257-266.
- Kusumi, T. (1987). Effects of categorical dissimilarity and affective similarity of constituent words on metaphor appreciation. *Journal of Psycholinguistic Research*, **16**, 577-595.
- Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: Chicago University Press.
- McGlone, M. S., & Manfredi, D. A. (2001). Topic vehicle interaction in metaphor comprehension. *Memory & Cognition*, **29**, 1209-1219.
- Nakamoto, K. (2003). Semantic priming effect of metaphor constituent terms. *Perceptual and Motor Skills*, **96**, 33-42.
- Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition*. Hillsdale, NJ: Erlbaum.
- Wolff, P., & Gentner, D. (2000). Evidence for role-neutral initial processing of metaphors. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **26**, 529-541.