The Role of Event Knowledge in Comprehending Synesthetic Metaphors

Tetsuaki Nakamura (tatnakac@edu.hc.uec.ac.jp)
Department of Human Communication, The University of Electro-Communications
1-5-1, Chofugaoka, Chofushi, Tokyo 182-8585, Japan

Maki Sakamoto (sakamoto@hc.uec.ac.jp)
Department of Informatics, The University of Electro-Communications
1-5-1, Chofugaoka, Chofushi, Tokyo 182-8585, Japan

Akira Utsumi (utsumi@se.uec.ac.jp)
Department of Informatics, The University of Electro-Communications
1-5-1, Chofugaoka, Chofushi, Tokyo 182-8585, Japan

Abstract

A synesthetic metaphor (e.g., "*sweet touch*") is a metaphor that results from a combination of a modifier and a head, where they express different perceptual qualities. Most of the existing studies examine how the acceptability of synesthetic metaphors can be explained by the pairing of adjective modifier's and head noun's modalities. However, little attention has been paid to how people comprehend synesthetic metaphors. This paper explores how people comprehend Japanese synesthetic metaphors. In our psychological experiment we collected 10388 words associated with 62 synesthetic metaphors and classified them into the following four kinds of features: common (features listed for the metaphor, the vehicle and the topic), vehicle-shared (features listed for both the metaphor and the vehicle, but not listed for the topic), topic-shared (features listed for both the metaphor and the topic, but not listed for the vehicle), and emergent (features listed for the metaphor, but not listed for either the vehicle or the topic). The result showed that there were significantly more emergent features than the other kinds of features in the comprehension of synesthetic metaphors. This result suggests that we do not so directly comprehend synesthetic metaphors based on salient features of the vehicle or the topic. In this paper we focus on event knowledge which is assumed to play a crucial role in comprehending synesthetic metaphors. We analyzed how many words associated with synesthetic metaphors could be classified into those based on event knowledge. The results showed that there were significantly more words based on event knowledge than those which could not be classified as words based on event knowledge. This result suggests that event knowledge play an important role in comprehending synesthetic metaphors.

Keywords: synesthetic metaphors; Japanese language; event knowledge; words association; emergent features.

Introduction

Synesthetic metaphors such as "*sweet touch*" or "*sweet voice*" are one kind of adjective metaphor, in which an adjective denoting the perception of some sense modality modifies a noun's modality. Metaphor studies in the domain of cognitive science have paid little or no attention to adjective metaphors. Many existing studies have paid much attention to nominal metaphors such as "*My job is a jail*" (e.g., Bowdle & Gentner, 2005; Glucksberg, 2001; Jones & Estes, 2006; Utsumi, 2007) and predicative metaphors such as "*He shot down all of my arguments*" (e.g., Lakoff & Johnson, 1980; Martin, 1992).

Many studies focusing on synesthetic metaphors, including Werning et al. (2006), have examined how the acceptability of synesthetic metaphors can be explained by the pairing of adjective modifier's and head noun's modalities. Ullmann (1951), in a very early study on synesthetic metaphors, proposes a certain hierarchy of lower and higher perceptual modalities. He claims that qualities of lower (e.g., tactile) senses should preferentially occur in the source domain (i.e., adjective), while qualities of higher (e.g., optic) senses should be preferred in the target domain (i.e., noun). After Ullmann, Williams (1976) makes a more differentiated claim of directionality, in which a similar order of sense modalities is proposed. Werning et al. (2006) explores the factors that enhance the cognitive accessibility of synesthetic metaphors for the German language. Very few studies, however, have attempted to explore how people comprehend synesthetic metaphors.

Utsumi & Sakamoto (2007a) is one of the few studies to have explored how people comprehend synesthetic metaphors. They proposed a two-stage categorization theory and argued that the comprehension process of adjective metaphors including synesthetic metaphors could be explained as a two-stage categorization process. The intuitive idea behind two-stage categorization is that correspondences between the properties literally expressed by the adjective and the properties to be mapped onto the noun would be indirect, mediated by an intermediate category. In the case of "*red voice*", for example, the adjective "*red*" first evokes an intermediate category "*red things*," to which "*blood*," "*fire*," "*passion*," "*apple*" and "*danger*" typically belong. Then exemplars relevant to the noun "*voice*" are selected and they evoke a final abstract category of property like "*scary*," "*screaming*" and "*dangerous*." However, they did not mention the relationship between the intermediate category and the noun and the detailed process in which certain exemplars are selected as those relevant to the noun was left unexplored.

In this study we focus on experience-based event knowledge to explain how people comprehend synesthetic metaphors.

Event knowledge has been recognized to be important for metaphor comprehension process by many scholars. For instance, Lakoff & Johnson (1980) argue that metaphors like HAPPY IS UP as in "*She is in high spirits*" and ANGER IS HEAT as in "*boil with anger*" are grounded in correlations in our experience. The HAPPY IS UP metaphor is grounded in the experience that a person in a positive emotional has an erect posture, and the ANGER IS HEAT metaphor is grounded in the experience that the angry person feels hot.

As for synesthetic metaphors, Taylor (2003) argues that they cannot be reduced to correlations. He argues that synesthesic metaphors are based on perceived similarity across different domains. Unlike Taylor (2003), Sakamoto & Utsumi (2008) point out that there are a number of synesthetic metaphors which seem to be based on correlations in experience. For example, a metaphor "*sweet smell*" ("*amai nioi*" in Japanese) is based on correlations in experience. "*Sweet smell*" is the smell you feel when you eat something sweet. A metaphor "*delicious autumn*" ("*oishii aki*") is also based on correlations in experience because you can eat lots of delicious meals in autumn (especially in Japan). However, Sakamoto & Utsumi (2008) did not verify their argument based on psychological experiment.

To sum up, we propose the following comprehension process: an intermediate category is evoked by the adjective to which various things belong. Then exemplars correlated in experience with the noun are selected as those mapped onto the noun and they evoke a final abstract category of property. The experience-based event knowledge plays an important role in the process of relating the intermediate category evoked by the adjective to the concept expressed by the noun.

Experiment

Participants

Participants were recruited through Macromill, Inc., an organization that maintains a panel of more than 533579 people who have agreed to participate in web-based online survey research. 3266 Japanese males and females, aged 20-78, agreed to participate in our experiment.

Materials

Materials used for our experiment (i.e., 62 Japanese synesthetic metaphors) were made by combining 24 Japanese adjectives with 5 Japanese nouns. The adjectives were "*light*" ("*karui*" in Japanese), "*hot*"(in temperature) ("*atsui*"), "*cold*" ("*tsumetai*"), "*hard*" ("*katai*"), "*soft*" ("*yawarakai*"), "*tasty*" ("*oishii*"), "*sweet*" ("*amai*"), "*sour*" ("*suppai*"), "*bitter*" ("*shibui*"), "*hot*"(in taste) ("*karai*"), "*fragrant*" ("*koubashii*"), "*smelly*" ("*namagusai*"), "*sweet-smelling*" ("*kaguwashii*"), "*stinking*"(1) ("*kusai*"), "*stinking*"(2) ("*kinakusai*"), "*red*" ("*akai*"), "*blue*" ("*aoi*"), "*yellow*" ("*kiiroi*"), "*white*" ("*shiroi*"), "*black*" ("*kuroi*"), "*quiet*" ("*shizukana*"), "*noisy*"(1) ("*urusai*"), "*noisy*"(2) ("*yakamashii*"), "*noisy*"(3) ("*sawagashii*"). The nouns were "*color*" ("*iro*"), "*touch*" ("*tezawari*"), "*voice*" ("*koe*"), "*taste*" ("*aji*"), "*smell*" ("*nioi*") .

Procedure

3266 participants were classified into 20 groups. 3-8 linguistic expressions were assigned to each group. The linguistic expressions assigned to one group were randomly assigned to each participant in that group (e.g., linguistic expressions assigned to group 1 were randomly assigned to each participant belonging to group 1).

Participants of group 1-4 were each assigned 7-8 adjectives or nouns, and the remaining 16 groups were assigned 3-4 metaphorical expressions per participant. They were asked to list 3 words associated with each linguistic expression.

Japanese is written with a mixture of hiragana, katakana, and kanji. Hiragana, katakana, and kanji of the same concept (e.g., rose can be written as "ばら," "バラ," or "薔薇") were regarded as the same feature. This feature combination procedure was completed by three judges. Features regarded as the same by at least two judges were unified into one expression, and we got 8594 features. After this combination procedure, all features listed by at most 1 participant were dropped. The following analyses were based upon these amended feature lists.

Analysis 1

According to Becker (1997), when a person interprets a novel metaphor such as "*A child is a sponge*," that interpretation has the potential to contain information from four logically possible sources. The first is a feature which is salient only for the vehicle (i.e., "*sponge*"). Thus, this feature appears in the interpretation for the vehicle and the metaphor. She refers to such a feature as a "vehicle-shared feature." The second is a feature which is salient only for the topic (i.e., "*child*"). Thus, this feature appears in the interpretation for the topic and the metaphor. She refers to such a feature as a "topic-shared feature." The third is a feature which is salient for both the vehicle and the topic. Thus, this feature appears in the interpretation for the vehicle, the topic and the metaphor. She refers to such a feature as a "common feature." The fourth is a feature which is not salient either for the vehicle or for the topic. Thus, this feature appears in the interpretation only for the metaphor. She refers to such a feature as an "emergent feature."

Becker (1997) conducted a psychological experiment for "*A is a B*" metaphors. Participants were divided into two groups. One group of participants listed features of metaphors. The other group of participants listed features of the topic or the vehicle presented alone. Features from metaphor interpretations were compared with features listed for vehicle interpretations and topic interpretations in order to identify the four kinds of features: common, vehicle-

shared, topic-shared, or emergent. These features are shown in Table 1.

Table 1: Features.

features	detail
common	features listed for the metaphor, the vehicle and the topic
vehicle-shared	features listed for both the metaphor and the vehicle, but not listed for the topic
topic-shared	features listed for both the metaphor and the topic, but not listed for the vehicle
emergent	features listed for the metaphor, but not listed for either the vehicle or the topic

The result of her experiment showed that metaphor interpretations contained larger numbers of vehicle-shared and emergent features than either common or topic-shared features. In Particular, there were significantly more vehicle-shared features than the other kinds of features. Furthermore, she found that altering a metaphor's vehicle produced greater changes in emergent content than did altering the topic and suggested that emergent features were influenced primarily by salient features of the vehicle.

In Analysis 1 we compare what Becker (1997) says for the comprehension of nominal metaphors with the comprehension of synesthetic metaphors.

Features listed by participants were classified into one of the four kinds as in Table 1. For each metaphor, the frequency of each of the four kinds was counted. Features were counted both as types (i.e., counted only once no matter how often the feature was listed) and as tokens (i.e., counted as often as the feature was listed). The result was 1198 types and 10388 tokens.

The mean value of common, vehicle-shared, topic-shared, and emergent features are presented in Figure 1 (type counts) and Figure 2 (token counts).

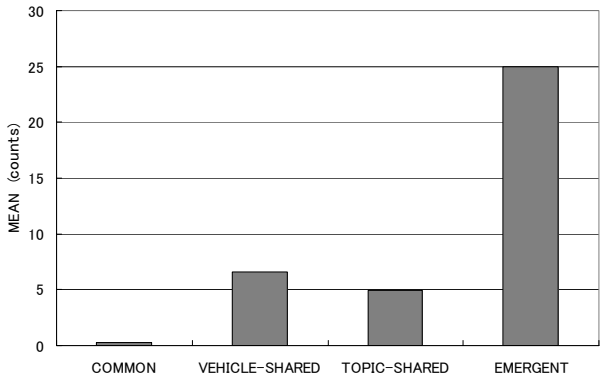

Figure 1: The mean value of the four kinds of features (type counts).

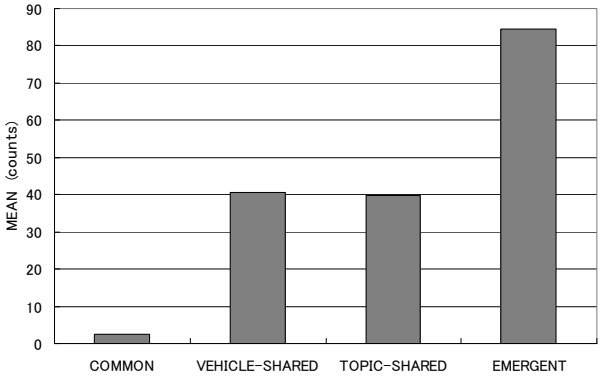

Figure 2: The mean value of the four kinds of features (token counts).

As can be seen from the two figures, regardless of whether one counts features as types or as tokens, participants produced more emergent features than the other kinds of features.

Analyses of variance (ANOVAs) among the four kinds (common, vehicle-shared, topic-shared, emergent) were conducted for both type and token counts. The type count analysis revealed a significant feature type main effect, $F(3, 183) = 456.82$, $p < .001$. Post hoc analyses (Ryan's method) to explore the interaction revealed that significantly more emergent features were produced than the other kinds of features ($p < .05$) and significantly less common features were produced than the other kinds of features ($p < .05$). The token count analysis also produced a significant main effect, $F(3, 183) = 74.79$, $p < .001$. Post hoc analyses (Ryan's method) to explore the interaction revealed that significantly more emergent features were produced than the other kinds of features ($p < .05$) and significantly less common features were produced than the other kinds of features ($p < .05$). In the type count analysis significantly more vehicle-shared features were produced than topic-shared features ($p < .05$), but in the token count analysis this difference was not significant.

These results are different from the results of Becker (1997) which analyzed nominal metaphors. According to Becker (1997), in the interpretation of nominal metaphors there were significantly more vehicle-shared features than the other kinds of features, and nominal metaphors were influenced primarily by salient features of the vehicle. Our results show that in the interpretation of synesthetic metaphors there were significantly more emergent features than the other kinds of features. Thus, our results suggest that we do not so directly comprehend synesthetic metaphors based on salient features of the vehicle or the topic.

Analysis 2

If, as shown in Analysis 1, synesthetic metaphors were not so directly comprehended by salient features of the vehicle

or the topic, where do the emergent features come from? We address this question based on the assumption that the influence of salient features of the vehicle or the topic in the comprehension process of synesthetic metaphors is indirect, mediated by experience-based event knowledge. As we described in the introduction, Sakamoto & Utsumi (2008) suggest that synesthetic metaphors such as "*sweet smell*" ("*amai nioi*" in Japanese) is based on correlations in experience. Thus, in Analysis 2 we explore whether features listed for synesthetic metaphors could be explained by experience-based event knowledge.

Considering experience-based event knowledge and the fact that the vehicle and the topic of a synesthetic metaphor are an adjective and a noun, respectively, we can elaborate the claim of Sakamoto & Utsumi (2008) as follows:

[Hypothesis]
Synesthetic metaphors are interpreted based on event knowledge in which we typically perceive a property denoted by the vehicle (i.e., adjective) and an object denoted by the topic (i.e., noun) simultaneously.

According to this hypothesis, words associated with synesthetic metaphors reflect the process shown in Figure 3; we understand the metaphorical expression as "an object of perception readily evoked by an event in which an entity characterized by the adjective figures prominently." Then we evoke a concrete event in which we typically perceive a property denoted by the adjective and an object denoted by the noun simultaneously. Therefore, words associated with the synesthetic metaphor reflect the evoked concrete event. That is, words associated with the synesthetic metaphor are either feature 1 (hereafter, F1), feature 2 (F2) or feature 3 (F3) in Figure 3.

a synesthetic metaphor
↓
an object of perception readily evoked by an event in which an entity characterized by the adjective figures prominently
↓
a concrete event in which we typically perceive a property denoted by the adjective and an object denoted by the noun simultaneously
↓
feature 1: an entity with a property denoted by the adjective
feature 2: an object denoted by the noun
feature 3: other salient entities or objects in the event

Figure 3: comprehension process of synesthetic metaphors

For example, in the comprehension of "*red taste*" ("*akai aji*" in Japanese), as shown in Figure 4, an event in which we eat chili peppers is evoked as an event in which we perceive "*red*" and "*taste*" simultaneously. This comprehension process is verified when features such as "*chili peppers* (F1)," "*hot* (F2)" and "*sweat* (F3)" are listed for "*red taste*" in the experiment.

"*red taste*"
↓
taste in events including red things
↓
an event in which we eat chili peppers
↓
feature 1: "*chili peppers*"
feature 2: "*hot*"
feature 3: "*sweat*"

Figure 4: comprehension process of "*red taste*"

If this hypothesis is valid, the ratio of features corresponding to either F1, F2 or F3 against all the features collected in the experiment will be very high. Therefore, in Analysis 2, we explore the ratio of features corresponding to either F1, F2 or F3 against all the features collected in the experiment. This exploration is based on the following procedure.

Step 1: Labeling features

This step is a preparation for Step 2 and Step 3. Step 2 and Step 3 are procedures for identifying features corresponding to either F1 or F2.

In this step, features satisfying either of the condition shown in Table 2 are labeled either X or Y. This labeling procedure is conducted based on majority decision of three judges. Hereafter, WXs denote features labeled X and WYs denote features labeled Y. For example, features such as "*chili peppers*" or "*tomato*" listed for "*red taste*" are WXs, and features such as "*hot*" listed for "*red taste*" are WYs.

Notice that at this step we cannot yet determine whether WXs and WYs correspond to either F1 or F2.

Table 2: Labels and Conditions.

label	condition
X	an entity with a property denoted by the adjective
Y	an object denoted by the noun

Step 2: Identifying F1

One situation (hereafter, S1) in which we perceive properties denoted by the adjective (hereafter, PA) and objects denoted by the noun (hereafter, ON) simultaneously is one situation in which there is an entity satisfying both a PA and an ON. In S1, if an entity satisfying both a PA and an ON is a WX, the expression "the ON of a WX" is natural. For example, since "*chili peppers*" for "*red taste*" is a WX, "the ON of a WX" is "*the taste of chili peppers*." This expression is natural.

In this step, therefore, the three judges mentioned in Step 1 consider whether "the ON of a WX" is natural for each synesthetic metaphor. If two or more judges find this

expression natural, the WX is regarded as F1. So, "*chili peppers*" for "*red taste*" is regarded as F1.

Step 3: Identifying F1 and F2

If an entity satisfying both a PA and an ON is evoked as shown in Step2, a possibility, in which our participants will very likely list not only WXs but also a concrete ON of a WX as a feature, is very high. Features corresponding to concrete ONs of WXs are WYs.

Another situation in which we perceive a PA and an ON simultaneously (hereafter, S2) is one situation in which an entity with a PA is different from an object of a category ON. In S2, if an entity with a PA is listed as a feature, the entity is a WX. In S2, if an object of a category ON is listed as a feature, the object is a WY.

If a synesthetic metaphor evokes S1 or S2 for our participants, that will indicate that WXs are strongly connected with WYs. This in turn will make it easy for the three judges mentioned in Step 1 to imagine a concrete event based on the closely associated WXs and WYs.

In this step, the three judges combine all WXs with all WYs for each synesthetic metaphor. If two or more judges can easily imagine concrete events, a WX and a WY comprising the combination are regarded as F1 and F2 respectively.

For example, the features "*chili peppers*" and "*hot*" are listed for "*red taste*." "*Chili peppers*" and "*hot*" are a WX and a WY respectively. The judges make a pair "*chili peppers*, *hot*." Then, they consider whether they can easily imagine an event on the basis of the pair. Since they can imagine an event easily (e.g., eating chili peppers), "*chili peppers*" and "*hot*" are regarded as F1 and F2 respectively.

Step 4: Identifying F3

In this step, we identify F3. Features unlabeled in Step 1 may correspond to F3. If unlabeled features correspond to F3, concrete events are most likely to have already been evoked. Thus, there is a strong possibility that F1 and F2 are included in the features listed by our participants.

In this step, based on this line of reasoning and the rationale presented in Step 3, we conduct the following procedure; the three judges mentioned in Step 1 combine features regarded as either F1 or F2 in Step 2 and Step 3 with unlabeled features. If two or more judges can imagine concrete events easily, the unlabeled feature included in the combination is regarded as F3.

For example, "*chili peppers*", "*hot*" and "*sweat*" are listed for "*red taste*." "*Chili peppers*" and "*hot*" are F1 and F2, respectively, in Step 3. Thus, the judges combine "*sweat*" with the pair "*chili peppers*, *hot*." Since the judges can imagine an event easily (e.g., eating chili peppers), "*sweat*" is regarded as F3.

Result of Analysis 2

All the features regarded as either F1, F2 or F3 are those based on experience-based event knowledge. Table 3 shows the total number of token counts and the mean value of token counts when the features are classified into either those based on event knowledge or those not based on event knowledge. The proportion of the token counts classified as the features based on event knowledge was significantly higher than those which could not be classified as the features on event knowledge, $\chi 2$ (1, N = 10388) = 804.01, p < .01. Furthermore, the T-test using the mean value of token counts revealed that there were significantly more features based on event knowledge than those which could not be classified as features based on event knowledge, $t(61)$ = 3.28, p < .01.

This result shows that synesthetic metaphors tend to be understood based on event knowledge.

Table 3: Classification Result.

	event knowledge	not event knowledge
total	6639 (63.91%)	3749 (36.09%)
mean	107.08	60.47

General Discussion

Indication for the theory of metaphor

Analysis 1 showed that in the interpretation of synesthetic metaphors there were significantly more emergent features than the other kinds of features. The result of Analysis 1 suggests that we do not so directly comprehend synesthetic metaphors based on salient features of the vehicle or the topic.

Utsumi & Sakamoto (2007a, 2007b) proposed a two-stage categorization theory. In the two-stage categorization theory, correspondences between the properties literally expressed by the adjective and the properties to be mapped onto the noun would be indirect, mediated by an intermediate category. Utsumi & Sakamoto (2007a, 2007b) tested their argument by means of computer simulation in which the meanings of adjective metaphors including synesthetic metaphors are computed in a multidimensional semantic space. In the simulation, three theories for adjective metaphor comprehension, i.e., two-stage categorization theory, categorization theory (Glucksberg, 2001; Glucksberg & Keysar, 1990) and comparison theory (Bowdle & Gentner, 2005), were compared in terms of how well they mimic human interpretation of adjective metaphors. The simulation result was that the two-stage categorization theory is a more plausible theory of adjective metaphors than the other kinds of theory.

As for the fact that we do not so directly comprehend synesthetic metaphors based on salient features of the vehicle or the topic, the result of Analysis 1 is consistent with the two-stage categorization theory. Thus, our results support the arguments by Utsumi & Sakamoto (2007a, 2007b). Furthermore, while Utsumi & Sakamoto (2007a, 2007b) left unsolved the detailed process in which certain exemplars are selected as those relevant to the noun, the result of Analysis 2 showed that experience-based event knowledge played an important role in that process.

Importance of Event Knowledge

We showed that experience-based event knowledge play an important role in the comprehension process of synesthetic metaphors. How we use knowledge to interpret new experiences is an important topic in cognitive science. Since 1970's many studies have been conducted based on the concepts of "frame" (Minsky, 1975), "schema" (Rumelhart, 1980) and "script" (Schank & Abelson, 1977). Recent studies such as Bicknell & Rohde (2009) also argue the important role of real-world event knowledge in processing linguistic expressions. Our study showed that experience-based event knowledge also play an important role in the comprehension process of metaphorical expressions.

Conclusion

This paper explored how people comprehend synesthetic metaphors, to which previous studies had paid little attention. The results of psychological experiments showed that there were significantly more emergent features than the other kinds of features. This suggests that we do not so directly comprehend synesthetic metaphors based on salient features of the vehicle or the topic. We argued that experience-based event knowledge played an important role in the comprehension process of synesthetic metaphors.

In our future work we are planning to confirm this finding by different psychological experiments. Since the tendency of synesthetic metaphors to evoke negative images was pointed out by Sakamoto and Utsumi (2009), it would also be interesting for further work to investigate how those negative images were evoked in the comprehension process of synesthetic metaphors using experience-based event knowledge.

Acknowledgments

This research was supported by Grant-in-Aid for Scientific Research (C) (No. 20520350) from Japan Society for the Promotion of Science. The authors wish to thank Yoshiki Nishimura and the anonymous reviewers for their very helpful suggestions.

References

Becker, A. H. (1997). Emergent and common features influence metaphor interpretation. *Metaphor and Symbol*, 12(4), 243–259.

Bicknell, K., & Rohde, H. (2009). Dynamic integration of pragmatic expectations and real-world event knowledge in syntactic ambiguity resolution. In *Proceedings of the 31st annual meeting of the cognitive science society* (pp. 1216–1221).

Bowdle, B. F., & Gentner, D. (2005). The career of metaphor. *Psychological Review*, 112(1), 193–216.

Glucksberg, S. (2001). *Understanding figurative language: From metaphors to idioms*. Oxford: Oxford University Press.

Glucksberg, S., & Keysar, B. (1990). Understanding metaphorical comparisons: Beyond similarity. *Psychological Review*, 97(1), 3–18.

Jones, L. L., & Estes, Z. (2006). Roosters, robins, and alarm clocks: Aptness and conventionality in metaphor comprehension. *Journal of Memory and Language*, 55, 18–32.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: The University of Chicago Press.

Martin, J. H. (1992). Computer understanding of conventional metaphoric language. *Cognitive Science*, 16, 233–270.

Minsky, M. (1975). A framework for representing knowledge. In P. H. Winston (Ed.), *The psychology of computer vision* (pp. 211–277). New York: McGraw-Hill.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension: Perspectives from cognitive psychology, linguistics, artificial intelligence, and education* (pp. 33–58). Philadelphia, PA: Lawrence Erlbaum Associates.

Sakamoto, M., & Utsumi, A. (2008). Semantic diversity revealed by a comparison between two types of adjective metaphors: Correlation vs. resemblance. In *Proceedings of the 6th international conference of cognitive science* (pp.309–393).

Sakamoto, M., & Utsumi, A. (2009). Cognitive effects of synesthetic metaphors evoked by the semantic interaction. In *Proceeding of the 31st annual meeting of the cognitive science society* (pp. 1593–1598).

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals and understanding*. Philadelphia, PA: Lawrence Erlbaum Associates.

Taylor, J. R. (2003). *Linguistic categorization*. Oxford: Oxford University Press.

Ullmann, S. (1951). *The principles of semantics*. Oxford: Blackwell.

Utsumi, A. (2007). Interpretive diversity explains metaphor-simile distinction. *Metaphor and Symbol*, 22(4), 291-312.

Utsumi, A., & Sakamoto, M. (2007a). Computational evidence for two-stage categorization as a process of adjective metaphor comprehension. In *Proceedings of the 2nd european cognitive science conference* (p. 77-82).

Utsumi, A., & Sakamoto, M. (2007b). Predicative metaphors are understood as two-stage categorization: Computational evidence by latent semantic analysis. In *Proceedings of the 29th annual meeting of the cognitive science society* (pp.1587–1592).

Werning, M., Fleischhauer, J., & Beşeoğlu, H. (2006). The cognitive accessibility of synaesthetic metaphors. In *Proceedings of the 28th annual conference of the cognitive science society* (pp. 2365–2370).

Williams, J. M. (1976). Synesthetic adjectives: A possible law of semantic change. *Language*, 52(2), 461–478.