Predicative Metaphor Comprehension as Indirect Categorization

Akira Utsumi (utsumi@se.uec.ac.jp)   **Maki Sakamoto (sakamoto@hc.uec.ac.jp)**

Department of Informatics, The University of Electro-Communications,
1-5-1, Chofugaoka, Chofushi, Tokyo 182-8585, Japan

Abstract

In this paper, we address the problem of how people understand predicative metaphors such as "The rumor flew through the office," and argue that predicative metaphors are understood as indirect categorizations. In the indirect categorization process, the verb (e.g., *fly*) of a predicative metaphor evokes an intermediate entity, which in turn evokes a metaphoric category of actions or states (e.g., "to spread rapidly and soon disappear") to be attributed to the target noun (e.g., *rumor*), rather than directly creating a metaphoric category as argued by Glucksberg's (2001) categorization theory. We test our argument using two experiments, offline comprehension and online priming. The two experiments provided convergent evidence for our argument. The psychological validity of indirect categorization as a process of predicative metaphor comprehension was confirmed.

Keywords: Metaphor comprehension; Predicative metaphor; Categorization; Priming; Verb

Introduction

Predicative metaphors are figurative expressions that involve the metaphorical use of a verb, such as "*The rumor flew through the office*" and "*His fame echoes throughout the world*." Despite their frequent use in everyday communication, predicative metaphors have been paid little attention in metaphor research. Particularly, the cognitive mechanism underlying predicative metaphor comprehension has never been examined, although a considerable number of studies have been made on the comprehension mechanism of nominal metaphors such as "*My job is a jail*" (e.g., Bowdle & Gentner, 2005; Glucksberg, 2001; Jones & Estes, 2006; Utsumi, 2007). Given the differences in what is being processed metaphorically between predicative metaphors (i.e., actions, states) and nominal metaphors (i.e., objects), together with a recent neuroanatomical finding (Chen, Widick, & Chatterjee, 2008) that predicative and nominal metaphors may be processed differently, it is obviously crucial to explore the cognitive mechanism of predicative metaphor comprehension.

Cognitive linguists may argue that the cognitive linguistics research on metaphor (e.g., Kövecses, 2002; Lakoff & Johnson, 1980) has addressed predicative metaphors as manifestations of the conventionalized, conceptual metaphors. However, these studies do not explore how the conceptual metaphors are constructed, i.e., how a set of correspondences or mappings is made between the source domain and the target domain. This problem becomes more serious when we consider how people comprehend novel predicative metaphors.

Glucksberg (2001, 2003) argues that people comprehend predicative metaphors via a categorization process as they do for nominal metaphors. Just as nominal metaphors use the source concepts that epitomize certain categories of objects or situations, predicative metaphors use verbs that epitomize certain metaphoric categories of actions (e.g., the cat-egory of *speedy travel* evoked by the verb "fly"). However, no clear empirical evidence has been provided for his argument. Although Torreano, Cacciari, and Glucksberg (2005) demonstrated that the level of abstraction of a verb's referent was related to the metaphoricity of a predicative metaphor, this finding does not necessarily imply that the verb directly evokes a metaphoric category in metaphor comprehension.

In this paper, we propose *indirect categorization* as the comprehension process of predicative metaphors (Utsumi & Sakamoto, 2007b). Indirect categorization is a two-stage process of categorization in which evocation (or creation) of metaphoric categories is indirect and mediated by intermediary entities, rather than direct as predicted by the categorization theory. Utsumi and Sakamoto (2007b) suggested a possibility of indirect categorization using a computer simulation, but no clear empirical evidence has been provided. Therefore, in this paper we conducted two psychological experiments to obtain empirical evidence for our indirect categorization theory. In these experiments, we manipulated metaphor aptness and vehicle conventionality because recent metaphor studies (e.g., Bowdle & Gentner, 2005; Glucksberg & Haught, 2006; Jones & Estes, 2006) have demonstrated that these properties play an important role in comprehension of nominal metaphors.

In Experiment 1, we examined what proportion of interpretations of predicative metaphors were derived directly from the verb and what proportion of interpretations were indirectly associated with the verb. For this purpose, we assessed a concordance rate between words listed as metaphorical interpretation and those associated with the verb or associated with the verb associates. In Experiment 2, we used a priming paradigm to assess the online availability of direct and indirect categories for predicative metaphor comprehension. In this experiment, a metaphorical sentence was presented as a prime and its effect on the speed of lexical decision about a subsequent target word was measured. The target conditions were a word related to the metaphorical meaning, a word directly associated with the verb, a word indirectly associated with the verb, and a control word unrelated to the metaphor.

Direct versus Indirect Categorization

As we mentioned above, Glucksberg's (2001, 2003) categorization theory argues that people understand predicative metaphors as direct categorizations. Just as nominal metaphors use vehicles (or source concepts) that epitomize certain superordinate categories of objects, which include a target concept as a member, predicative metaphors use verbs that epitomize certain categories of actions. According to this theory, for example, the predicative metaphor "The rumor flew through the office" is comprehended so that the verb *fly* evokes an ad hoc
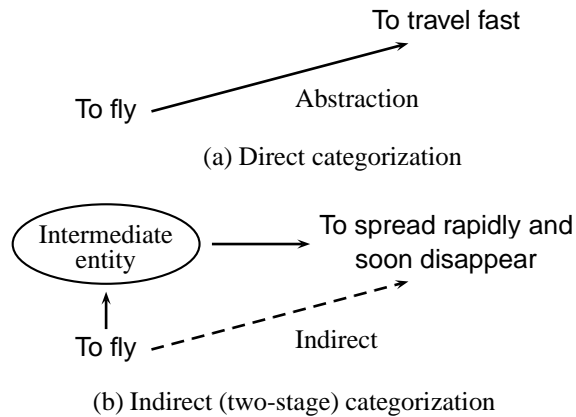
(a) Direct categorization

(b) Indirect (two-stage) categorization

Figure 1: Direct and indirect categorization for the metaphor "The rumor flew through the office."

Figure 2: Two possibilities of an intermediate entity in indirect categorization.

superordinate category of an action "to travel fast" and such the action is attributed to the target *rumor*, as illustrated in Figure 1 (a).

However, it is doubtful that predicative metaphors are processed in the same way as nominal metaphors. A primary reason for this doubt is that many empirical findings on semantic representation demonstrate that the semantic structure of verbs, which refer to events or actions, differs from that of nouns, which refer to objects, in many respects (Vigliocco & Vinson, 2007). For example, the hierarchical organization for objects and events is different; event categories are represented by fewer levels (generally two) and with fewer distinctions at the superordinate level than object categories. The role of hierarchical relations also differs between nouns and verbs. For nouns, the most important roles are played by the hierarchical relations including superordination and coordination, whereas the dominant relations for verbs are nonhierarchical ones such as entailment, causation, and antonymy. Some evidence compatible with the different role of hierarchical relations is provided by the analysis of semantic substitution errors; Garrett (1992) reported that for nouns the large majority of substitutions involve category coordinates (i.e., words in the same level of the hierarchical structure), while for verbs the preferred semantic relationship between target and intruding words is opposition (e.g., go/come). Furthermore, a neuroanatomical difference appears to exist between nouns and verbs (Shapiro & Caramazza, 2004; Vigliocco & Vinson, 2007) and between nominal metaphors and predicative metaphors (Chen et al., 2008). These findings indicate that hierarchical relations are less activated in the processing of verbs, and thus it is less likely that verbs directly evoke superordinate categories of events or actions; this contradicts Glucksberg's categorization theory.

Furthermore, the categorization theory does not address the richness of the metaphorical meanings expressed by predicative metaphors. For example, people can derive more meanings from the metaphor "The rumor flew through the office" than supposed in the categorization theory (e.g., *to travel fast*); the rumor spreads rapidly and suddenly, the rumor is dispersed or disseminated, the rumor disappears or is forgot-
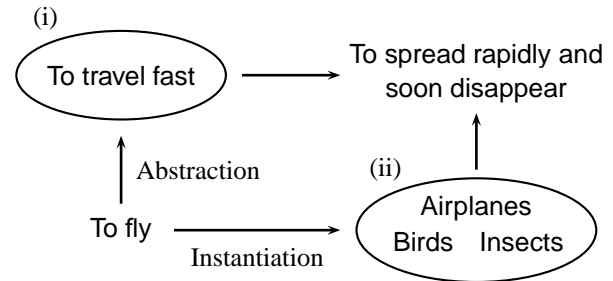
ten very soon, and so on. These rich interpretations are unlikely to be derived directly from the verb *fly*, given that the semantic structure of verbs is hierarchically less rich.

To overcome the difficulties of the categorization theory of predicative metaphors, we propose an indirect categorization theory. The intuitive idea behind indirect categorization is that a correspondence between the actions or events literally expressed by the verb and the actions or events to be attributed to the target noun would be indirect, rather than direct as predicted by the categorization theory; constructing a correspondence is mediated by an intermediate entity. As illustrated in Figure 1 (b), in the case of "fly" metaphor, the verb *fly* first evokes some sort of an intermediate entity and the intermediate entity then evokes a final abstract category of "to spread rapidly and soon disappear," which is attributed to the target *rumor* being described.

One important question that arises here is what kind of entities are involved in the intermediate step. Two possible answers can be provided: (i) abstract actions or states produced by generalization from the verb, and (ii) objects produced by instantiation of the verb. In the case of "fly" metaphor, as illustrated in Figure 2, people may think of a very abstract action "to travel fast" by abstracting the verb *fly*, and this abstract intermediate entity is then specified to refer to *rumor*. A perhaps more likely explanation would be that people may consider a set of objects "things that fly" or "flying objects," which contains airplanes, birds, and insects, by instantiating the argument of the verb *fly*. Some actions or events that are relevant to both the "flying" objects and the target *rumor* are then extracted. These two types of intermediate entities may be activated simultaneously during comprehension, rather than selectively. The preference for instantiated objects (ii) may be determined depending on the difficulty in deriving an abstract category from a verb.

Experiment 1

In Experiment 1, we tested our indirect categorization theory by comparing people's interpretations of predicative metaphors (i.e., $I(M)$ in Figure 3), with words or phrases associated directly or indirectly with the verb of predicative metaphors (i.e., $A(w_v)$ or $A(S)$ in Figure 3). If a metaphoric category is evoked indirectly in predicative metaphor comprehension, the interpretation of predicative metaphors $I(M)$ would have greater overlap with indirectly associated words $A(S)$ than with directly associated words $A(w_v)$. If a metaphoric
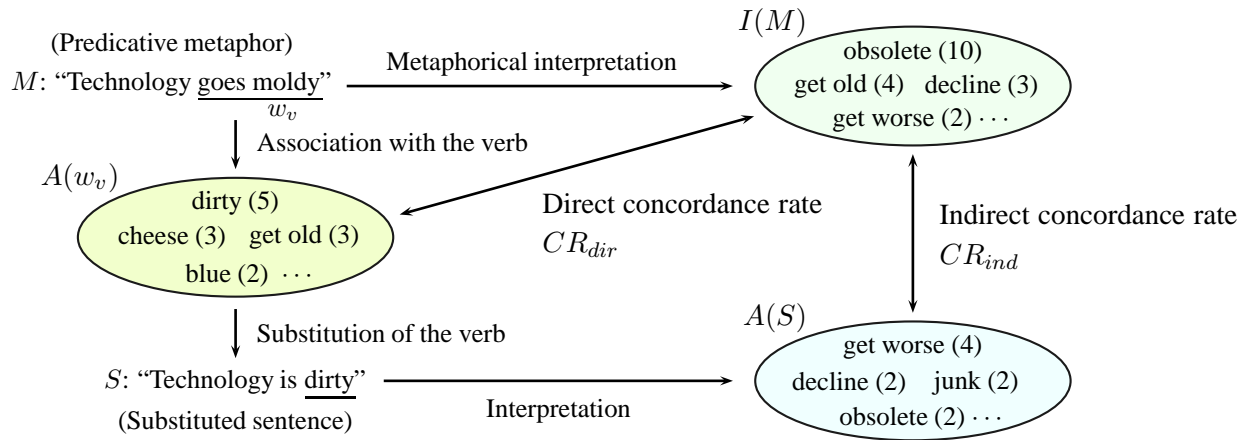
Figure 3: Direct concordance rate and indirect concordance rate as measures of the degree of overlap between the metaphorical interpretation and the direct or indirect associates.

category is evoked directly from the verb, the percentage of overlap between the metaphorical interpretation $I(M)$ and a set of directly associated words $A(w_v)$ would be greater than, or at least equal to, that between the interpretation and a set of indirectly associated words $A(S)$.

Our indirect categorization view therefore predicts that, regardless of metaphor aptness and vehicle conventionality, the interpretation of predicative metaphors has greater overlap with indirectly associated words $A(S)$. On the other hand, Glucksberg's categorization view predicts that, regardless of vehicle conventionality, the interpretation of predicative metaphors (in particular apt metaphors) has greater (or equal) overlap with directly associated words $A(w_v)$.

Method

Participants Eighty-eight people (78 undergraduate and graduate students and 10 working persons) participated as volunteers. All participants were native speakers of Japanese.

Materials Forty Japanese predicative metaphors were used for the experiment. These metaphors were selected from 80 metaphors in a pilot study.

Pilot study For a pilot study, we used 80 Japanese predicative metaphors. They included 20 intransitive verbs (e.g., "go moldy" ["*kabiru*" in Japanese] [1] or "echo" ["*hibiku*"]) and each verb was paired with four abstract nouns (e.g., "Technology goes moldy" ["*Gijutsu ga kabiru*"], "His fame echoes" ["*Meisei ga hibiku*"])., In order to eliminate the possibility that the generated sentences were interpreted as personification metaphors, in which the subject of the sentence, rather than the verb, was used metaphorically, we did not use verbs that literally refer to human actions or experiences.

In this pilot study, we collected the aptness and conventionality ratings to select 40 metaphors used in the main study. Because the conventionality rating task requires the salient meaning of predicative metaphors, the pilot study was conducted separately in two parts. In the first part of the pilot

study, 50 participants were assigned 40 metaphors such that each metaphor was assigned to 25 participants. They were asked to write down at least three interpretations of each metaphor and to rate the aptness of the metaphor on a 7-point scale (1 = *not at all apt*, 7 = *extremely apt*). A list of generated interpretations for each metaphor was used as a set $I(M)$. In the second part, 15 participants were given a list of 80 verbs used in the metaphors with the most salient meaning of the metaphors, i.e., the meaning listed by the largest number of participants in the first part of the pilot study. They were asked to rate how conventional each meaning was as an alternative sense of the verb on a 7-point scale of 1 (*very novel*) to 7 (*very conventional*).

After the pilot study, we chose 40 metaphors for the main study in the following way. First, we calculated the mean aptness rating and the mean conventionality rating for each metaphor. We then classified the 80 metaphors into four groups — conventional and high apt, conventional and low apt, novel and high apt, and novel and low apt — according to whether the mean aptness or conventionality was more than the midpoint 4. Finally, we chose 10 metaphors from each group such that metaphors in the same group had as different verbs as possible and their variance of aptness and conventionality was as low as possible.

Procedure In the experiment, we collected words or phrases associated directly or indirectly with the verb. The experiment was conducted separately in two parts because direct verb associates $A(w_v)$ were required for substituted sentences, from which indirect verb associates $A(S)$ were collected, as shown in Figure 3.

In the first part of the experiment, 12 participants were assigned all 16 verbs which were used in the 40 chosen metaphors, and asked to list at least two words or phrases that they associated with each verb. A list of generated words for each verb was used as a set $A(w_v)$ of direct verb associates.

The second part was performed by other 11 participants. They were assigned 40 substituted sentences and asked to list at least two words or phrases that they thought were involved in the interpretation of substituted sentences. A list

---

[1]Note that the original Japanese verb "*kabiru*" is a verb, although its English translation "go moldy" is a verb phrase.

Table 1: Means (*M*) and standard deviations (*SD*) of concordance rates between metaphor interpretation and direct or indirect association.

Metaphor group	CR_{dir} (Direct)		CR_{ind} (Indirect)	
	M	*SD*	*M*	*SD*
Conventional, High-Apt	.256	.202	.391	.279
Conventional, Low-Apt	.172	.135	.408	.318
Novel, High-Apt	.201	.171	.354	.240
Novel, Low-Apt	.125	.103	.368	.167
All	.189	.159	.380	.248

of generated words for the substituted sentences was used as a set $A(S)$ of indirect verb associates. Substituted sentences were generated by substituting three words in $A(w_v)$ listed by the largest number of participants for the verb w_v of the metaphor. For example, when three words "dirty" ["*kitanai*"], "cheese" ["*chīzu*"], and "get old" ["*furuku-naru*"] were listed by the largest number of participants for a verb "go moldy," the substituted sentence of a predicative metaphor "Technology goes moldy" was "Technology is dirty," "Technology is cheese," and "Technology gets old."

After the experiment, we generated three sets of words for each metaphor, namely $I(M)$, $A(w_v)$, and $A(S)$ in the following way. First, closely related words or phrases were accepted as the same word if they belonged to the same deeper category of a Japanese thesaurus. After that, any word that was mentioned by only one participant was eliminated from the set of words.

Results and Discussion

As shown in Figure 3, in order to assess the degree of overlap between the metaphorical interpretation and the direct or indirect verb associates, we calculated the direct concordance rate CR_{dir} and the indirect concordance rate CR_{ind} for each metaphor M:

$$CR_{dir} = \frac{\sum_{x \in I(M) \cap A(w_v)} n_I(x) + n_A(x)}{\sum_{x \in I(M)} n_I(x) + \sum_{x \in A(w_v)} n_A(x)} \quad (1)$$

$$CR_{ind} = \frac{\sum_{x \in I(M) \cap A(S)} n_I(x) + n_S(x)}{\sum_{x \in I(M)} n_I(x) + \sum_{x \in A(S)} n_S(x)} \quad (2)$$

where $n_I(x)$, $n_A(x)$ and $n_S(x)$ respectively denote the number of participants who listed a word x as a metaphorical interpretation, a verb associate, and an associate of the substituted sentences. (The numbers in parentheses in Figure 3 represent these values.) The direct concordance rate CR_{dir} defined by Equation 1 evaluates the degree of overlap between metaphorical interpretation and direct verb association, while the indirect concordance rate CR_{ind} defined by Equation 2 evaluates the degree of overlap between metaphorical interpretation and indirect association. For example, the direct concordance rate of the example shown in Figure 3 is calculated as $CR_{dir} = (4+3)/\{(10+4+3+2)+(5+3+3+2)\} =$

$7/32 = 0.219$, and the indirect concordance rate is calculated as $CR_{ind} = \{(10+2)+(3+2)+(2+4)\}/\{(10+4+3+2)+(4+2+2+2)\} = 23/29 = 0.793$.

Table 1 shows the mean concordance rates for direct and indirect categorization. Overall, as shown in the last row of Table 1, the mean indirect concordance rate CR_{ind} across the 40 metaphors was higher than the mean direct concordance rate CR_{dir}. This result is consistent with our indirect categorization theory and inconsistent with Glucksberg's categorization theory.

To confirm this difference statistically, we conducted a three-way ANOVA of Categorization (direct or indirect) $\times$ Conventionality (conventional or novel) $\times$ Aptness (high or low). In the analysis, the data were analyzed only by items (F_i) because the concordance rates could not be calculated for each participant. The factor of Categorization was within items and other two factors were between items. The predicted difference between the direct and indirect concordance rate was confirmed; the main effect of Categorization was significant, $F_i(1, 36) = 22.19$, $p < .001$, and the effect size was also large, $\eta^2 = .18$. None of the other main effects and interactions were significant. Hence it is concluded that the result of Experiment 1 supports the indirect categorization theory.

Furthermore, in order to examine which kind of entities were involved in the intermediate step of indirect categorization, we roughly estimated the preference for abstract actions as an intermediate entity by calculating the percentage of verbs and adjectives (i.e., verb rate) that were involved in the set of direct verb associates $A(w_v)$ for each metaphor. The mean verb rate across 40 metaphors was 0.46 ($SD = 0.17$), ranging from 0.20 to 0.77. The correlation between the verb rate and the indirect concordance rate CR_{ind} was far from significant, $r = .06$. This finding suggests that there may be no preferred process (generalization or instantiation) that leads to an intermediate entity; people understand predicative metaphors both by abstracting the verb and by enumerating entities typically expressed by the verb.

Experiment 2

In Experiment 2, we tested the indirect categorization view using a priming paradigm, in which a metaphorical sentence was presented first and the task was to make a lexical decision about a target word presented after the metaphorical sentence. The target conditions were a word related to the metaphorical meaning, metaphor target (MT); a word directly associated with the verb, direct associate target (DAT); a word associated with the substituted sentence, indirect associate target (IAT); and a control target (CNT) unrelated to the metaphor.

Faster lexical decisions in comparison with the CNT indicate on-line activation. If predicative metaphors are comprehended by the direct categorization process, the DAT would be faster to make a lexical decision than the CNT, but the IAT would not be faster. Hence, Glucksberg's categorization theory predicts facilitation of the DAT and no facilitation of the IAT. On the other hand, if predicative metaphors are comprehended by the indirect categorization process, the IAT would be faster than the CNT. Hence, our indirect categorization theory predicts facilitation of the IAT. The DAT may also

Table 2: Means (*M*) and standard deviations (*SD*) of correct lexical decision times in milliseconds for Experiment 2

Metaphor type	MT (Metaphor)			DAT (Direct associate)			IAT (Indirect associate)			CNT (Control)	
	M	*SD*	*DIF*	*M*	*SD*	*DIF*	*M*	*SD*	*DIF*	*M*	*SD*
Conventional, High Apt	799.3	210.2	50.1	781.6	194.3	67.8	768.2	169.8	81.2	849.4	205.0
Conventional, Low Apt	864.1	203.2	10.4	859.7	199.4	14.9	797.1	220.5	77.4	874.5	264.9
Novel, High Apt	821.3	236.2	−2.8	856.0	233.8	−37.6	807.4	197.3	11.1	818.4	165.7
Novel, Low Apt	810.7	233.8	31.9	832.4	183.4	10.2	832.7	219.0	9.9	842.6	270.4
All	823.8	182.7	22.4	832.4	170.1	13.8	801.3	168.2	44.9	846.3	195.8

Note. *DIF* = difference from control target.

be activated, but to a lesser degree than the IAT. Concerning the MT, both theories predict facilitation of the MT.

Method

Participants Forty-five undergraduate and graduate students participated as volunteers. All participants were native speakers of Japanese.

Materials The 40 predicative metaphors used in Experiment 1 were employed as prime sentences. The other 40 metaphors that were not selected in the pilot study of Experiment 1 were used as filler sentences for nonword targets.

For each prime metaphor, the MT, DAT, and IAT were selected from among the set of metaphorical interpretations $I(M)$, the set of direct verb associates $A(w_v)$, and the set of indirect verb associates $A(S)$ respectively. For an MT, we selected the word in $I(M)$ that was listed by the largest number of participants. For a DAT and an IAT, we selected the word that was listed by the largest number of participants in $A(w_v)$ or $A(S)$, excluding the MT word. The CNT was selected randomly from a dictionary such that it was not related to the metaphor. For example, the metaphor "Technology goes moldy" was combined with the MT "obsolete" ["*furuku-naru*"], the DAT "dirty" ["*kitanai*"], the IAT "get worse" ["*waruku-naru*"], and the CNT "vanish" ["*toozakaru*"].

Procedure A within-participants design was used with each participant comprehending all the 80 metaphors under all conditions. Participants, who were run individually, were seated in front of a computer screen. They were first given an overall instruction of the experiment and then presented with six practice trials followed by the 80 experimental trials presented in a random order. On each trial, they were presented with a predicative metaphor on the screen for 3000 ms and asked to interpret the metaphor. A target word (MT, DAT, IAT, CNT, or nonword) was then presented 500 ms after the offset of the predicative metaphor. Participants were asked to decide whether the target word was a word or a nonword as quickly as possible; they indicated decision by pressing the appropriate key on the keyboard. Reaction times were measured from the onset of the target word until the appropriate key was pressed.

Results and Discussion

A total of seven participants were eliminated from the analysis because they did not reach the decision error criterion

of 90% correct. Only reaction times of correct decision were used in the analysis. Following metaphor priming research (Blasko & Connine, 1993), reaction times greater than 1750ms were eliminated from the analysis. This elimination caused the further elimination of two participants' data because the data of some conditions were missing.

Table 2 shows mean lexical decision times and standard deviations for the correct "yes" responses. The time difference (DIF) from the CNT indicates the extent of the priming effect. Although the pattern of DIF differs depending on conventionality and aptness, the overall result was that the IAT produced the greatest priming effect (44.9ms faster than the CNT), but the DAT showed the smallest priming effect (only 13.8ms faster). The MT showed a moderate priming effect (22.4ms faster). This result is consistent with the indirect categorization theory and inconsistent with the direct categorization theory.

A three-way ANOVA of Target (MT, DAT, IAT, or CNT) × Conventionality (conventional or novel) × Aptness (high or low) was conducted on lexical decision times. In the analysis, the data were analyzed by participants (F_p) and by items (F_i). The factor of Target was within participants and within items, while other two factors were within participants and between items. The main effect of Target was significant by the participant analysis, $F_p(3, 105) = 3.21$, $p < .05$, although its effect size was small, $\eta^2 = .01$. The main effect of Target was not significant by the item analysis, $F_i(3, 108) = 1.55$, $p = .21$, but a small effect size was found, $\eta^2 = .03$. Post-hoc pairwise comparisons ($p < .05$) revealed that the IAT (M=801.3ms) was significantly faster than the CNT (M=846.3ms); this indicates a significant activation of indirectly associated meanings during metaphor comprehension. In addition, the difference between the IAT (M=801.3ms) and the DAT (M=832.4ms) was marginally significant ($p < .10$). Again, the result is consistent with the indirect categorization theory but inconsistent with the direct categorization theory; predicative metaphors are understood via the indirect categorization process, in which constructing the correspondence between the actions or events literally expressed by the verb and those expressed metaphorically is mediated by intermediate entities. A little surprisingly, the priming effect of the MT was not statistically significant.

In addition, the interaction between Conventionality and Aptness was significant by the participant analysis, $F_p(1, 35) = 4.32$, $p < .05$. The nature of this interaction

was that, when predicative metaphors were high apt, decision times to all targets were faster for conventional metaphors (M=799.6ms) than for novel metaphors (M=848.8ms), but such the difference disappeared when metaphors were low apt (M=825.8ms for conventional metaphors; M=829.6ms for novel metaphors). The main effect of conventionality was also significant, $F_p(1, 35) = 4.91$, $p < .05$; $F_i(1, 36) = 3.80$, $p = .06$. Mean decision times to all targets were shorter for conventional metaphor primes (M=812.7ms) than for novel metaphor primes (M=839.2ms). These results suggest that vehicle conventionality facilitates comprehension of predicative metaphors, in particular when they are highly apt, but the comprehension process remains unchanged.

General Discussion

The two experiments reported in this paper provided empirical evidence in favor of the proposed view that predicative metaphors are understood as indirect categorizations.

As we mentioned previously, the most important problem with the indirect categorization view is what entities are involved in the intermediate step of indirect categorization. We provide two possible answers, i.e., abstract actions obtained by abstracting the verb, and objects typically expressed by the verb. Experiment 1 suggested that there seemed to be no preference between two possibilities, but we point out that objects typically expressed by the verb are really involved in the comprehension process.

> *"Float like a butterfly, sting like a bee."*

These are the words of Muhammad Ali, a famous American boxer who won World Heavyweight Champion three times. This predicative metaphor expresses Ali's boxing style by describing his swift footwork as "float" and lightning-quick punch as "sting." At the same time, this metaphor clearly conveys a kind of gorgeousness and sharpness in his behavior, which cannot be derived solely from these verbs. It is more likely that such the interpretation would be derived when people call to mind "things that float" and "things that sting," and in the case of this metaphor they are verbalized in "like a butterfly" and "like a bee." In other words, these phrases suggest the psychological reality of the intermediate entities that are typically expressed by the verb for indirect categorization.

We have also argued that the indirect categorization view explains adjective metaphor comprehension (Utsumi & Sakamoto, 2007a). Because the semantic structure of adjectives is not at all hierarchical, intermediate entities only include objects with the property referred to by the adjective of a metaphor (i.e., "things that are red" in the case of the metaphor "red taste"). Some evidence for the predominance of intermediate objects is provided by Nakamura, Sakamoto, and Utsumi (2010).

At any rate, it would be vital for future research to explore in more detail the internal process of indirect categorization.

Acknowledgments

References

Blasko, D., & Connine, C. (1993). Effects of familiarity and aptness on metaphor understanding. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*(2), 295–308.

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

Chen, E., Widick, P., & Chatterjee, A. (2008). Functional-anatomical organization of predicate metaphor processing. *Brain and Language*, *107*(3), 194–202.

Garrett, M. (1992). Lexical retrieval processes: Semantic field effects. In E. Kittay & A. Lehrer (Eds.), *Frames, fields and contrasts: New essays in semantic and lexical organization* (pp. 377–395). Erlbaum.

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

Glucksberg, S. (2003). The psycholinguistics of metaphor. *Trends in Cognitive Sciences*, *7*(2), 92–96.

Glucksberg, S., & Haught, C. (2006). On the relation between metaphor and simile: When comparison fails. *Mind & Language*, *21*(3), 360–378.

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

Kövecses, Z. (2002). *Metaphor: A practical introduction*. Oxford University Press.

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

Nakamura, T., Sakamoto, M., & Utsumi, A. (2010). The role of event knowledge on comprehending synesthetic metaphors. In *Proceedings of the 32nd Annual Meeting of the Cognitive Science Society (CogSci2010)*.

Shapiro, K., & Caramazza, A. (2004). The organization of lexical knowledge in the brain: The grammatical dimension. In M. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 803–814). MIT Press.

Torreano, L., Cacciari, C., & Glucksberg, S. (2005). When dogs can fly: Level of abstraction as a cue to metaphorical use of verbs. *Metaphor and Symbol*, *20*(4), 259–274.

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 Second European Cognitive Science Conference (EuroCogSci2007)* (pp. 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 (CogSci2007)* (pp. 1587–1592).

Vigliocco, G., & Vinson, D. P. (2007). Semantic representation. In M. G. Gaskell (Ed.), *The Oxford handbook of psycholinguistics* (pp. 217–234). Oxford University Press.