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An Experimental Examination of Emergent Features in Metaphor Interpretation Using Semantic Priming Effects

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Abstract

In comprehension of the metaphor “*TOPIC is VEHICLE*,” emergent features in the interpretation of metaphors are characteristic neither of the topic nor the vehicle. An experiment examines the hypothesis that new features emerge as metaphoric interpretations through association with non-emergent features connected with the topic, vehicle, or both. In the experiment, participants were presented with a non-emergent feature as a prime, a metaphor, and an emergent feature, sequentially. Participants were then asked to respond as to whether the emergent feature is an appropriate interpretation of the metaphor. The results showed that primed non-emergent features derived from the vehicle facilitate the recognition of emergent features. The results support an account in which new features emerge through two processes – non-emergent features are recognized as interpretations of the metaphor and then these non-emergent features facilitate the recognition of emergent features. **Keywords:** Metaphor comprehension; Feature emergence; Interaction.

Introduction

In this research, we examined the process of feature emergence, which is realized in comprehension of metaphors taking the form of “*TOPIC is VEHICLE*”, such as “Education is a gateway.” In previous papers, interpretations (features) of this kind of metaphor were classified into four types: common features, topic features, vehicle features and emergent features (Becker 1997; Gineste, Indurkha & Scart, 2000; Nueckles & Janetzko 1997). When an interpretation is thought of in relation to both the topic and the vehicle, it is regarded as a common feature. When an interpretation is thought of as a characteristic of the topic (or of the vehicle), it is referred to as a topic feature (or a vehicle feature). The common, topic and vehicle features are regarded as non-emergent features. Finally, emergent features are not typically thought of in relation to either the topic or the vehicle alone, but do come to mind when the topic and vehicle enter into a metaphoric comparison. For example, for the metaphor “Ideas are diamonds,” the feature “come in a flash” is a topic feature, “beautiful” is a vehicle feature, “precious” is a common feature because it is listed as a feature when people are given either “ideas” or “diamonds” by themselves, and “unique” is an emergent feature because it is not listed for either word by itself, but is listed when the words are paired.

Previous research (Gineste et al., 2000) made a list of features and reported that over 60% of metaphoric interpretations are emergent features. Emergent features are thus

prevalent and play an important role in metaphor comprehension. Furthermore, the authors conducted an experiment using priming effects. In their experiment, emergent, topic-term or vehicle-term features were presented and participants judged whether the feature was related to the primed metaphor (topic-/vehicle-term) or not. Emergent features required a longer response time to be regarded as a feature of the prime than topic or vehicle features, when the features were tested with topic-term or vehicle-term primes. When tested with the metaphor as the prime, the topic and vehicle features required longer response times than did the topic-term or vehicle-term as the prime. However, the emergent features did not change their response times from one prime condition to another. As a result of these results are consistent with the interaction theory of metaphor (Black 1979), which suggests that metaphor comprehension is a product of an interaction between the target and the vehicle concepts.

However, there is also evidence that links emergent interpretations asymmetrically with topics and vehicles. Becker listed interpretations of metaphors in an experiment. She reported that altering a metaphor’s vehicle (e.g. “A smile is a knife” vs. “A smile is a pearl”) produced greater changes in emergent content than did altering the topic (e.g. “A smile is a knife” vs. “Teeth are knives”). This suggests that emergent features are influenced primarily by one’s representation of the vehicle. Nueckles and Janetzko (1997) introduce the idea that metaphor comprehension proceeds in analysis-based and synthesis-based stages. According to their idea, there is first an analysis of the lexical meanings of the topic and vehicle during the analysis-based stage. If the topic and vehicle have sufficient similarity, the metaphor comprehension does not proceed to the synthesis-based stage. For cases in which the topic-vehicle similarity is not sufficiently high, a shift to synthesis-based processing occurs. In the later case, the metaphor comprehension is achieved through a construction of new components of meaning by synthesis of the topic and the vehicle. It is during this second phase that emergent features would be generated.

Previous computational models of metaphor comprehension have been constructed under the assumption that emergent features are emphasized more than non-emergent features through interactions among features in metaphor comprehension (Utsumi, 2000; Terai & Nakagawa 2007, 2008,

2010). All of these models function to increase activation of emergent features beyond that of non-emergent features by incorporating interactions among features. Terai and Goldstone (2011) reported that emergent features require more time to be recognized during a metaphoric interpretation than do non-emergent features. Conversely, when a relatively long time period was allowed for metaphor processing, then recognition of non-emergent features was diminished. This suggests that non-emergent features that are true of one metaphor term but not the other have reduced activation as metaphor processing continues. The results support the kind of positive and negative interaction among features assumed by the computational models above, and also supports Nueckles and Janetzko's (1997) two-process assumption. In particular, the meanings of the topic and the vehicle are emphasized as non-emergent features, and then with ongoing interactions among features, emergent features are discovered as valid interpretations. However, empirical evidence is still lacking to support the details of this mechanism.

Some previous research used a priming paradigm to investigate the roles played by the topic and the vehicle in metaphor comprehension and reported that metaphor comprehension was facilitated by presentation of either a vehicle or topic concept (Wolff & Gentner, 2000; McGlone & Manfredi, 2001). McGlone and Manfredi used a sentence ascribing a metaphor-irrelevant or metaphor-relevant property to a topic or a vehicle as a prime. They found that all of these presentations, including the presentation of the sentences ascribing metaphor-irrelevant properties to topics, facilitated metaphor comprehension with the exception of sentences ascribing metaphor-irrelevant properties to vehicles.

Thus, we conducted an experiment employing priming effects of non-emergent features (common, topic and vehicle features) in order to investigate the role played by these features in processing emergent features and test the two-process assumption of feature emergence. If the two-process assumption is correct, non-emergent features should activate emergent features. An unresolved issue concerns the kinds of non-emergent features that most influence activation of emergent features.

Experiment Method

In this experiment, we examined the priming effect of non-emergent features on processing of emergent features in metaphor comprehension.

Participants

134 undergraduates participated in this experiment. All participants were native English speakers.

Materials

We selected 39 metaphors of the form "*TOPIC is VEHICLE*" from Becker (1997) as "target metaphors." Becker (1997) asked participants to list features of individual words and interpretations of metaphors involving those words. She categorized the resulting features into four types: emergent, com-

mon, topic, and vehicle features. Based on her categorization and feature listings, for each of these 39 metaphors, 1 to 4 emergent features and 1 to 4 non-emergent features were selected. 114 emergent features, 26 common features, 29 topic features and 32 vehicle features were selected. The types of the non-emergent features (common, topic or vehicle feature) selected for a given metaphor differed from each other. Three native English speakers checked these selected features to ascertain whether a feature and the word is an appropriate interpretation of the metaphor or not. For the selected items, at least one judge recognized the feature as an apt interpretation of the metaphor.

In addition, another 39 metaphors of the form "*TOPIC is VEHICLE*" from previous research (Gentner & Clement 1988, McGlone & Manfredi 2001) were used as "irrelevant metaphors" in a baseline condition.

Procedures

The procedures are shown in Figure 1. In the prime condition, participants were first presented with a non-emergent feature as a prime on a screen for 2 seconds. In the no-prime condition, no prime was presented. In both conditions participants were then asked to interpret a metaphor that was presented on the screen for 3 seconds. After presentation of the metaphor, an emergent feature was presented as a target word. The participants were asked to respond "Yes" or "No" depending on whether the word was related to the metaphor or not. Participants responded by pressing the "p" key ("Yes") or "q" key ("No") within 6 seconds. They were asked to respond as fast as possible without sacrificing accuracy. If they could not respond within 6 seconds, the feature disappeared and the text "Your response is too slow" appeared on the screen. The fixation point was presented between trials. For each metaphor, the combination of the prime and emergent features was randomized. The target metaphor and baseline conditions were presented equally often, but the presentation frequencies of feature conditions were dependent on the number of features.

In order to distinguish between the relationship between just a prime (non-emergent features) and target words (emergent features) and the interaction between them in metaphor understanding, we used irrelevant metaphors as a baseline. For example, if presentation of the common feature "beautiful" as a prime for the metaphor "Stars are diamonds" facilitates recognition of the subsequent emergent feature "amazing," there are two possible cognitive mechanisms. One is that "beautiful" influences the metaphor understanding process and facilitates recognition of "amazing" as an interpretation of the metaphor. The other is that "amazing" directly relates to "beautiful" much in the same way that "doctor" is related to "nurse," and so presentation of "beautiful" facilitates "amazing" regardless of the metaphor understanding process. Thus, we also employed irrelevant metaphors as a baseline. If presentation of "beautiful" does not influence judgments of the interpretation of an irrelevant metaphor (e.g. "Crime is a disease") but does influence judgments of the related metaphor, then this will be taken as evidence that not only the

relationship between “beautiful” and “amazing” is relevant, but also the interaction between “beautiful” and “amazing” have a role in metaphor understanding. Therefore, in the target metaphor condition, prime and target words are listed as interpretations of an intervening target metaphor. In the baseline condition, an irrelevant metaphor is presented between prime and target words, which do not relate to it. Therefore, there were two conditions of metaphors (target metaphor and baseline conditions) and four conditions of primes (common, topic, and vehicle features, and no-prime). After all trials, participants were asked to evaluate aptness and conventionality of the metaphors on the scale of 1 (highly inappropriate or rare metaphor) to 5 (highly appropriate or common metaphor).

Results

The data of two participants were removed because they responded “Yes” to more than half of the items in the baseline condition. We analyzed the remaining data obtained from 132 participants. The average rate at which the participants responded within the time limit was 99.4%.

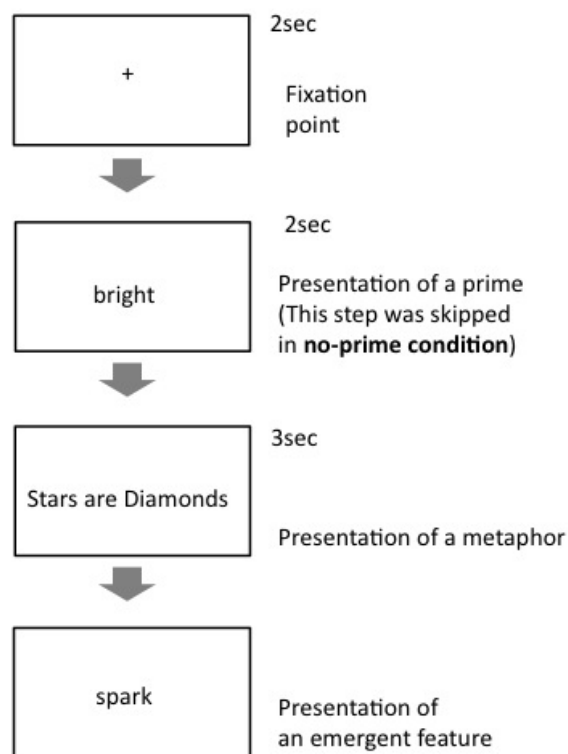


Figure 1: Time course of a trial in the experiment. In the target metaphor condition, prime and target words are interpretations of the metaphor which was presented between them. In the baseline condition, the primes and targets do not relate to the metaphor.

Analysis of all data

The averages of response times are shown in Table 1. In the target metaphor condition, the response time is longer than in the baseline condition ($F(1, 131) = 6.43, p < .05$). There is also a main effect of prime kind ($F(3, 393) = 7.38, p < .01$). Combining across difference of kinds of prime and metaphor conditions, primes made participants respond faster. The results show that the prime facilitated responding to target words (emergent feature) and made judgment to them faster in both conditions. The results indicate that there is a relationship between a prime (non-emergent features) and target words (emergent features).

We analyzed the difference between response times depending on the response. Average response times when the participants respond “Yes” or “No” are shown in Table 2. Thirty participants responded “Yes” (“No”) for all emergent features with any kind of prime in the target metaphor condition (in the baseline condition) and these data were removed for this analysis. There was an interaction between metaphor condition and responses ($F(1, 101) = 86.1, p < .01$). Participants responded “Yes” significantly faster than “No” in the target metaphor condition. Conversely, they responded “No” faster than “Yes” in the baseline condition. In the target metaphor condition, when participants responded “Yes,” the response is correct in the sense that the materials were designed so that the target would be an apt interpretation of the metaphor. Similarly, in the baseline condition, a “No” response would be correct. This suggests that people might be making errors not through fast guessing, but because of close competition between “Yes” and “No” responses. And, when participants made errors, there was a possibility that they could not interpret the metaphor. Thus, the response times confirmed an influence of the primes to “the correct responses.” So, we tested the “correct” responses.

Analysis of correct responses

The average response times when the participants responded with the “correct” response are shown in Figure 2. The results show that the primed non-emergent features (common, topic, vehicle features) facilitated processing of emergent features ($F(3, 393) = 8.12, p < .01$) in both conditions.

Therefore, we tested proportions of correct responses. The proportions of “Yes” responses in the target metaphor and “No” responses in the baseline condition are shown in Figure 3.

The proportions were analyzed using a two-way ANOVA¹. The proportion of correct responses in the baseline condition is higher than in the target metaphor condition ($F(1, 131) = 15.7, p < .01$). The response times and the accuracy rates indicate that it was more difficult to recognize an emergent feature as an interpretation of the metaphor than to find that

¹When an arcsine transformation was applied to the proportion data because of the restriction of these data to a 0-1 range and the proportions were analyzed using a two-way ANOVA after transformation, the results show the same tendency that are indicated when the non-transformed proportions are analyzed.

Table 1: Averages of the response times (milliseconds) for all data. Standard deviations are shown in parentheses.

		Metaphor (condition)	
		Target metaphor (Target metaphor condition)	Irrelevant metaphor (Baseline condition)
Kinds of prime	Common feature	1769.0 (957.0)	1724.2 (905.4)
	Topic feature	1759.8 (933.1)	1716.5 (927.2)
	Vehicle feature	1756.6 (877.8)	1718.2 (908.6)
	No prime	1848.7 (952.2)	1797.5 (934.8)

Table 2: Averages of the response times (milliseconds) depending on their responses. Standard deviations are shown in parentheses.

		Target metaphor condition	
		Response	
		“Yes”	“No”
Kinds of prime	Common feature	1704.3 (914.2)	1919.8 (1035.2)
	Topic feature	1726.6 (922.3)	1830.2 (952.3)
	Vehicle feature	1701.3 (891.6)	1861.6 (983.3)
	No prime	1816.3 (929.9)	1921.0 (997.1)
		Baseline condition	
		Response	
		“Yes”	“No”
Kinds of primes	Common feature	1839.3 (1080.4)	1687.9 (840.0)
	Topic feature	1821.8 (1010.5)	1684.1 (830.3)
	Vehicle feature	1851.9 (1042.3)	1679.6 (862.6)
	No prime	1848.9 (1056.8)	1781.8 (894.1)

the emergent feature was not an interpretation of the irrelevant metaphor. Furthermore, there is a two-way interaction ($F(3, 393) = 4.16, p < .01$). There are no significant differences among the proportions correct in the baseline condition, however, the accuracy with the vehicle primes is significantly lower than with the common primes or without a prime in the target metaphor condition at a $p < .05$ level. This means that presentation of a non-emergent feature as a prime affected the metaphor understanding process and that vehicle primes inhibited recognition of emergent features as interpretations of the metaphor. The difference of the results in the two conditions suggests an interaction between non-emergent and emergent features in metaphor comprehension.

Furthermore, there is no significant difference between proportions of correct responses with and without a com-

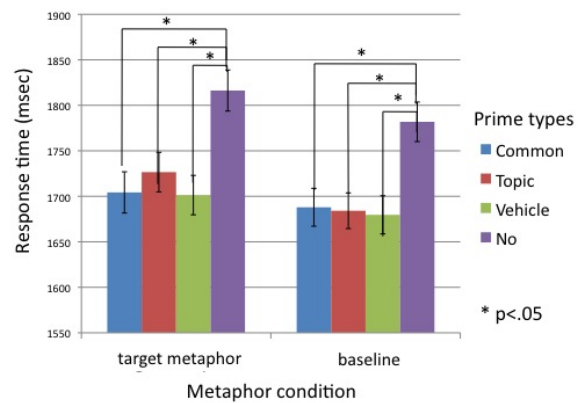


Figure 2: Average response times for correct responses. (The response time when they responded “Yes” in the target metaphor condition and when they responded “No” in the baseline condition.)

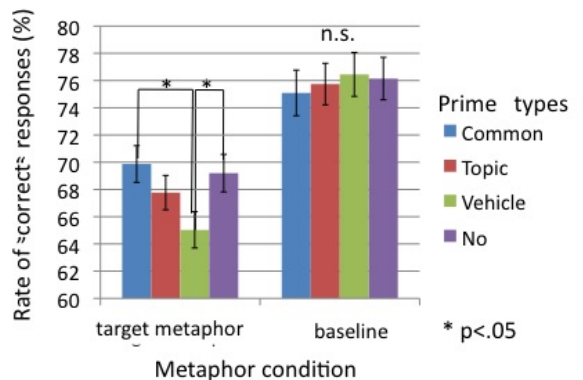


Figure 3: Average proportions of correct responses. (Average proportions of “Yes” responses in the target metaphor condition and that of “No” responses in the baseline condition.)

mon prime in the target metaphor condition. However, the proportion with common primes is slightly higher than without a prime. That is, the presentation of the common feature might make the emergent features recognized more easily as the metaphor interpretations.

Discussion

The response time results show that participants gave faster correct responses with a prime than without a prime. Even in the baseline condition, the response times with a prime are shorter. Therefore, there is a robust relationship between the primed feature (non-emergent feature) and the target word (emergent feature), regardless of the condition. The proportions of correct responses with a vehicle prime were significantly lower than that with a common prime or with no prime in the metaphor condition but there was no significant difference in the baseline condition. The results of the proportion correct suggest the existence of an interaction between non-emergent and emergent features in metaphor comprehension.

McGlone and Manfredi (2001) found that the primed metaphor-irrelevant properties of vehicles inhibited metaphor comprehension. They concluded that metaphor-irrelevant property primes led their participants to initially consider the inappropriate literal sense of the vehicle, rather than retrieve the metaphoric category that the vehicle exemplified, their results are consistent with the interactive property attribution model (Glucksberg, McGlone, & Manfredi 1997). This latter approach models metaphor comprehension as a process of interpreting the topic as a member of the metaphoric category of the vehicle. This model can account for the inhibition of the emergent interpretation of the metaphor by presenting the vehicle feature prime. For example, the vehicle "gateway" can be interpreted either as a literal arch or as a metaphorical opening. If the vehicle prime "swings" is presented, this may be expected to inhibit the emergent metaphoric feature of "way to reach desired destination." Our results provide evidence for active competition between literal and figurative interpretations of vehicles.

Particularly when a metaphor is not conventional, the metaphoric category of the vehicle may not simply be retrieved. For example, in the conventional metaphor "the lawyer is a shark," the metaphoric category of "shark" (*e.g.* vicious, dangerous) may be stable and reliably activated. However, for the metaphor "marriage is a joyride," because "joyride" is not only fun but also dangerous, the metaphoric category of "joyride" could be retrieved as a product of the features of either "fun" or "dangerous." That is, the category of "joyride" might be unstable and flexibly represented. In this case, the presentation of a vehicle feature "fun" might inhibit the recognition of "frightening" which is associated with "dangerous." In this experiment, the average rating of conventionality of the target metaphors is 2.74 (standard deviation is 1.73). Because this value is between 2 (slightly rare) and 3 (neutral), these metaphors should probably be considered non-conventional. As such, the priming of vehicle features could have inhibited recognition of the emergent features, many of which would not have been automatically triggered by the vehicle.

There was no significant difference between the proportions of correct responses with topic primes and without/with other primes in the metaphor condition. These results show

that features derived from the vehicle might affect feature emergence more than that from the topic, bearing in mind that the effect of vehicle features on the interpretation of emergent features is negative. This assumption is consistent with Becker's (1997) suggestion that altering a metaphor's vehicle produced greater changes in emergent content than did altering the topic.

The proportion of correct responses with the common feature primes is slightly higher than that without a prime, and the response times with primed common features are significantly shorter than without a prime. Priming with common features apparently made participants recognize emergent features quickly and easily. The common features are also, naturally, present in the vehicle. Thus, having a feature that is shared by both the topic and vehicle affects feature emergence in a very different manner than when the feature is only possessed by the vehicle. Given that the common features also come from the topic, variations in them are more limited than that of the vehicle features. In fact, Nueckles and Janetzko (1997) reported that different people agree on the same common features as interpretations of the metaphor. Furthermore, Becker (1997) showed that the common features are judged to be most important for metaphor interpretation. Therefore, priming with the common feature might give a well-constrained, general direction of the interpretation to the reader. As a result, it is likely that new features for a metaphor emerge through associations with common features. This is consistent with the findings that emergent features are relatively creative reactions to metaphors (Gineste et al., 2000), because the common features might be more active when the metaphor is primed than when the vehicle or topic term only is primed.

From these results, there are apparently interactions, both facilitative and inhibitory, among features in metaphor comprehension. Furthermore, because the feature derived from the vehicle had the greatest impact on emergent feature interpretation, it supports the interactive property attribution model. The property attribution model assumes that the literal level of abstraction is appropriate only for the topic term. The vehicle term is understood at a higher level of abstraction, specifically, a category. If the assumption is correct, then the primed features derived from the vehicle have a stronger affect on metaphor comprehension.

Previous research has shown that emergent features required more time to be recognized as interpretations of the metaphor than non-emergent features (Terai & Goldstone, 2011). Nueckles and Janetzko (1997) suggested the idea that metaphor comprehension proceeds in two stages. Based on these previous results and the findings in this experiment, we may speculate that metaphor comprehension proceeds in two processes. In the first process, a reader tries to interpret a metaphor based on the non-emergent features. If this does not produce a sufficiently high aptness evaluation, then the reader attempts to find emergent features, a longer and cognitively more taxing process. The first process could be ac-

completed according to the interactive property attribution model (Glucksberg et al., 1997). That is to say, at first, non-emergent features are discovered as interpretations through a process in which the vehicle is understood to be referring to a metaphoric category that includes the topic's literal referent as a member. Subsequently, new features become associated with non-emergent features.

This assumption has been incorporated into a simulation model but not validated by an experiment. The model (Terai & Nakagawa 2008, 2010) simulates feature emergence under the two-process assumption which consists of a categorization process followed by a dynamic interaction process. The categorization process is based on the interactive property attribution model and the dynamic interaction process represents interaction among features. The currently reported results support the two-process assumption. However the results did not provide unambiguous evidence for the two-process assumption. Therefore, more examination is required to verify it.

To elucidate the mechanism of feature emergence during metaphor interpretation, we used non-emergent features as primes. The experiment was conducted in order to explain feature emergence during the comprehension of metaphors taking the form of "TOPIC is VEHICLE." For this type of metaphor, the interaction could explain feature emergence. However, when "emergence" is explained in different types of metaphor comprehension (e.g. predicative metaphor comprehension), it might not be sufficient. Indurkha (2006) proposed an idea to explain how new representations emerge through a cognitive agent's interaction with the environment from the viewpoint of "interaction" and "Gestalt perception."

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