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Metaphor comprehension as attributive categorization ☆

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Abstract

The class-inclusion model claims that metaphors (e.g., *That exam is a filter*) are comprehended by inclusion of the topic (or subject) as a member of an attributive category named after and exemplified by the vehicle (or predicate). In three experiments, participants rated the extent to which a topic concept (e.g., EXAM) was a member of a vehicle category (e.g., FILTERS). To test the scope of the class-inclusion model, both conventional and novel metaphors were included in Experiments 1 and 2, and both high and low apt metaphors were included in Experiment 3. Class inclusion was higher following metaphorical primes than following either literal primes (Experiment 1) or no primes (Experiments 2 and 3). Moreover, this metaphor-induced categorization occurred equally for conventional and novel metaphors, but occurred to a greater extent for the high apt than for the low apt metaphors. Thus, aptness rather than conventionality mediated categorization in metaphor comprehension.

Keywords: Metaphor comprehension; Attributive categorization; Class-inclusion model; Career of metaphor hypothesis; Structure mapping; Aptness

Few people would comprehend the sentence *My beagle is a princess* as meaning that the beagle attends royal functions and wears a tiara. Rather, people recognize this sentence as a metaphor and process it accordingly. But exactly how *are* metaphors processed? The class-inclusion model claims that metaphors (e.g., *That desk is a junkyard*) are to be taken literally as categorical assertions, wherein the topic (e.g., DESK) is included in the class of entities named after and exemplified by the vehicle (e.g., JUNKYARD; Glucksberg & Keysar, 1990, 1993; Glucksberg, McGlone, & Manfredi, 1997). While several studies have provided indirect support for the class-inclusion model (Blasko & Connine, 1993; Gernsbacher, Keysar, Robertson, & Werner, 2001; Glucksberg, Newsome, & Goldvarg, 2001; McGlone & Manfredi, 2001), the categorical processing of metaphors has yet to be demonstrated. Therefore, the primary purpose of this study was to provide a direct test of the class-inclusion model by assessing participants' likelihood of including the metaphor topic within the vehicle-named category (e.g., To what extent is a DESK a member of the category JUNKYARD?). In Experiment 1, participants made these category judgments immediately following either a metaphorical prime (e.g., *That desk is a junkyard*) or a

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matched literal prime (e.g., *That desk is from a junkyard*). In Experiments 2 and 3, one group of participants was primed with sensible metaphors, scrambled metaphors (e.g., *Hard work is a teddy bear*), and literal categorical assertions (e.g., *A jet ski is a boat*) prior to the categorization task, and another group of participants received no primes at all. If metaphors are comprehended as categorical assertions, then the probability and extent of class inclusion should be higher following a metaphor prime than following a literal prime (Experiment 1) or no prime (Experiments 2 and 3). Furthermore, this metaphor-induced categorization should be elicited by sensible metaphors but not by scrambled metaphors or literal assertions.

A second and related purpose of this study was to test the generality of the class-inclusion model. Do all metaphors entail attributive categorization, or is class-inclusion limited to only certain types of metaphors? A *career of metaphor* hypothesis posits that conventional metaphors, but *not* novel metaphors, may be comprehended as categorical assertions. Gentner, Bowdle, Wolff, and Boronat (2001) claim "the proposal that metaphors [are] a species of categorization … [is] fundamentally wrong for novel metaphors, but that it may apply well to some conventional metaphors" (p. 233). Glucksberg (2003) contrarily maintains that the same comprehension process (i.e., attributive categorization) applies to both novel and conventional metaphors. Alternatively, however, he suggests that aptness rather than conventionality should mediate attributive categorization (Glucksberg, 2003; see also Chiappe & Kennedy, 1999; Chiappe, Kennedy, & Smykowski, 2003). Specifically, highly apt metaphors should be comprehended via attributive categorization, whereas less apt metaphors may not. Thus, we investigated both conventionality and aptness as potential mediators of class inclusion.

The class-inclusion model and dual reference

An important aspect of the class-inclusion model is its supposition that the vehicle has *dual reference*. That is, metaphor vehicles have both literal and figurative meanings. The dual reference of metaphors is related to polysemy (see Klein & Murphy, 2001, 2002): Virtually every concrete noun has at least two related meanings (Murphy, 1997), one referring to an exemplar (e.g., *The* DOG *barked at her boss*), and one referring to a class (e.g., *A beagle is a* DOG). Similarly, according to the class-inclusion model, "shark" refers to an exemplar when in a literal sentence (e.g., *That* SHARK *is ravenous*) and to a class of objects when in a metaphor (e.g., *That lawyer is a* SHARK). In this latter example, "shark" refers metaphorically to the class of AGGRESSIVE ANIMALS.

During metaphor comprehension, the figurative reference of the vehicle is activated while the literal reference may be inhibited (McGlone & Manfredi, 2001). Blasko and Connine (1993) demonstrated the dual activation of a vehicle's figurative and literal references in a lexical decision task (LDT). In their study, participants were given a metaphor prime (e.g., *Hard work is a ladder*) followed by one of three target words: a target related to the vehicle's literal meaning (e.g., rungs), a target related to the vehicle's metaphorical meaning (e.g., advance), or an unrelated control word (e.g., pastry). The metaphorical prime facilitated the lexical retrieval of both the literal targets and the metaphorical targets, relative to the unrelated control word.

Although the metaphor vehicle's literal meaning was activated in a LDT (Blasko & Connine, 1993), it was inhibited in a property verification task (Gernsbacher et al., 2001). Gernsbacher and colleagues (Experiment 1) had participants read a metaphorical prime (e.g., *That defense lawyer is a shark*) or a literal prime (e.g., *That large hammerhead is a shark*) before verifying either a metaphorical target property (e.g., *Sharks are tenacious*) or a literal target property (e.g., *Sharks are good swimmers*). The metaphor primes facilitated verification of the metaphorical properties, while impeding verification of the literal properties.

In a related study, Glucksberg et al. (2001) also found inhibition of irrelevant literal information during metaphor comprehension. Participants read metaphor primes (e.g., *My lawyer was a shark*) or literal primes (e.g., *The hammerhead is a shark*) prior to judging the sensibility of targets. The sensible targets were related to the prime vehicle's metaphorical meaning (e.g., *Geese are vicious*) or to the prime vehicle's literal meaning (e.g., *Geese can swim*). They found longer sensibility judgment latencies for literal targets following metaphorical primes than following literal primes. Thus, the metaphorical prime activated the figurative reference (e.g., vicious) of SHARK and inhibited the literal reference (e.g., can swim).

According to the class-inclusion model, the vehicle provides candidate properties for attribution to the topic, whereas the topic provides dimensions for attribution, thereby constraining the set of candidate vehicle properties (Glucksberg et al., 1997; McGlone & Manfredi, 2001). McGlone and Manfredi found that priming a metaphor (e.g., *Sarcasm is a veil*) with a literal property of the vehicle (e.g., *A veil can be fashionable*) impeded the comprehension of that metaphor. The topic's literal property (e.g., *Sarcasm can be witty*), on the other hand, facilitated metaphor comprehension. This finding supports the hypothesis that the topic and vehicle concepts play different roles: Because the vehicle provides metaphorical properties for attribution, activation of the vehicle's irrelevant literal properties impedes metaphor comprehension. But because the topic does not require metaphorical dual reference, activation of the topic's literal reference facilitates metaphor comprehension.

Potential mediators of class inclusion

The above studies support the class-inclusion model by providing evidence for the metaphor vehicle's dual reference. However, those studies do not provide evidence that metaphor comprehension entails categorization. Furthermore, if evidence of metaphor-induced categorization were obtained, it would also be necessary to examine its generality, as different models posit different mediators of the categorization process. Namely, the structure-mapping model claims that conventionality predicts categorization, whereas the class-inclusion model claims that aptness may determine the extent to which a metaphor is comprehended via attributive categorization. These two potential mediators of class inclusion are discussed in turn below.

Vehicle conventionality

According to the structure-mapping model (Gentner et al., 2001), metaphors establish mappings between the topic and the vehicle, each representing two different domains of knowledge (Gentner & Bowdle, 2001). To illustrate, the metaphor *Men are wolves* is understood via an alignment of the shared relation "prey on." Next, the nonidentical arguments of this relation are aligned. The concept MEN is aligned with WOLVES, and the concept ANIMALS is aligned with WOMEN. Finally, the unique vehicle characteristics connected to the shared relation (e.g., the instinctive cause of the shared relation "prey on") are applied to the topic. Thus, the metaphor is comprehended as an analogy: Men prey on women just as wolves prey on other animals.

The structure-mapping model explains the creation of metaphoric categories (i.e., the figurative reference of the metaphor vehicle) as a "byproduct of the comparison process" which "may be stored separately from the original [topic] and [vehicle] concepts" (Gentner & Bowdle, 2001, p. 228). If a concept is used as a metaphor vehicle only rarely, its metaphoric abstraction will decay. However, if a concept is used repeatedly as a metaphor vehicle, then the metaphorical abstraction will become conventional and associated with the vehicle term itself. It is at this point that the vehicle term gains dual reference (i.e., acquires a figurative meaning in addition to its literal meaning). For example, at one time ROADBLOCK simply referred to a barricade in the road. However, with repeated metaphoric usage over time, the concept ROADBLOCK has acquired the figurative denotation of "anything obstructing progress." This acquisition of dual reference yields a *career of metaphor hypothesis*, which asserts that as metaphor vehicles become increasingly conventional, the mode of processing shifts from alignment to categorization (Bowdle & Gentner, 1999). Metaphors with novel vehicles can be interpreted only via a comparison process in which the topic is structurally aligned with the vehicle. Because these novel vehicles lack a figurative dual reference, categorical processing is not possible. Metaphors with conventional vehicles, however, may be interpreted using either a comparison or a categorization process, because these vehicles have obtained dual reference as a result of repeated usage.

One way to determine whether a comparison or categorization process was used during comprehension is to assess preference for a figurative statement as either a simile or a metaphor. Bowdle and Gentner (1999) claimed that a preference for the simile form (e.g., *An academic career is like a poker game*) would indicate a comparison process, whereas a preference for the metaphor form (e.g., *An academic career is a poker game*) would indicate a categorization process. They employed this metaphor-simile distinction in examining the career of metaphor hypothesis. To experimentally simulate a metaphoric vehicle becoming conventionalized, Bowdle and Gentner repeated the use of the vehicle term two times with different topics in simile statements. They then asked participants to provide a topic for a third simile. For example, the simile *An acrobat is like a butterfly* was followed by *A figure skater is like a butterfly*. Then participants saw _____ *is like a butterfly*, and they provided a topic that would make the simile analogous in meaning to the first two statements. After this first phase, participants had to indicate whether their preference was stronger for the metaphor form (e.g., *A ballerina is a butterfly*) or for the simile form (e.g., *A ballerina is like a butterfly*). As predicted by the career of metaphor hypothesis, the preference for the metaphor was greater when the vehicle term had been conventionalized than when there had been no prior exposure to the vehicle.

Although Bowdle and Gentner's (1999) finding provides evidence for a shift towards more categorical processing as the metaphor vehicle becomes more conventional, it does not necessarily indicate that novel metaphors can be processed only by alignment. Indeed, Glucksberg (2003) maintains that both conventional and novel metaphors are processed as categorical assertions. Thus, the acquisition of the metaphor vehicle's dual reference is a point of contention between these models. According to the class-inclusion model, metaphor vehicles have dual reference a priori, and the processing of a metaphor activates the vehicle's figurative meaning. In contrast, the career of metaphor hypothesis asserts that a metaphor vehicle must acquire dual reference through repeated use, which in turn causes a shift from comparison to categorization in metaphor comprehension.

Metaphor aptness

The aptness of a metaphor is "the extent to which the statement captures important features of the topic" (Chiappe et al., 2003, p. 97), or "how well … the metaphor expresses its specific nonliteral meaning" (Blasko & Connine, 1993, p. 297). Aptness thus differs from conven-

tionality in that it takes both the vehicle and the topic into account, whereas conventionality pertains to the vehicle only. For instance, recall that Bowdle and Gentner (1999) attempted to conventionalize the vehicles (e.g., BUTTERFLY) by presenting them three times each, whereas the topic was varied each time. Gentner and Wolff (1997) similarly assessed conventionality solely with regard to a given vehicle. Aptness, on the other hand, refers to the fit between the vehicle and its given topic: A metaphor is apt if a salient property of the vehicle is attributed to a relevant dimension of the topic.

Although this distinction between conventionality and aptness may seem subtle, it is nevertheless an important one. As previously described, the class-inclusion model posits that the selection of the attributed property is guided and constrained by the metaphor topic (Glucksberg et al., 1997). Therefore, vehicle conventionality does not adequately account for this interaction between topic and vehicle. In contrast, because metaphor aptness refers to the vehicle and topic together, it thereby serves as a more likely mediator of metaphor-induced class inclusion. For instance, in the metaphor *Her marriage was a filing cabinet*, the vehicle FILING CABINET has no readily available property that could be attributed to the topic MARRIAGE. Consequently, these less apt metaphors may require comprehension by structural alignment rather than attributive categorization (Glucksberg, 2003).

To be clear, both apt and unapt metaphors may be comprehensible. For instance, Gerrig and Healy (1983) found that apt metaphors (e.g., *The night sky was filled with drops of molten silver*) were read only a nonsignificant 250 ms faster than less apt metaphors (e.g., *The night sky was filled with drops of molten resin*). The current paper, however, investigates the effect of aptness on the categorical processing of metaphors, rather than on the speed of metaphor comprehension. That is, "aside from the relative speed of comprehension, the comprehension process is the same in both [apt and unapt] cases" (Glucksberg, 2003, p. 94).

Previous findings suggest that aptness may indeed affect class inclusion. To begin with, Blasko and Connine (1993) found that metaphor aptness facilitated lexical decisions to metaphorical properties, at least for unfamiliar metaphors. Presumably, then, aptness would facilitate metaphorical class-inclusion as well. Recall that Bowdle and Gentner (1999) claimed that a preference for the metaphor form of a figurative statement indicated a categorization process whereas a preference for the simile form indicated a comparison process. Chiappe and Kennedy (1999) found that aptness reliably predicted the preference between metaphors and similes, with the metaphor preferred for more apt figurative statements and the simile preferred for less apt statements. In a similar study, Chiappe et al. (2003) further showed that the preference for the metaphor form was correlated with aptness ($r = +.63$, $p < .001$) but not with conventionality ($r = +.01$). Thus, as predicted by the class-inclusion model, aptness rather than conventionality mediated attributive categorization in metaphor comprehension.

In summary, the class-inclusion model asserts that metaphors are comprehended via categorization, but vehicle conventionality and metaphor aptness have both been proposed as mediators of this categorization process. The experiments reported below test these claims.

Experiment 1

The studies reviewed above have tested the class-inclusion model in various indirect ways (e.g., LDT, property verification, metaphor/simile preference, etc.). However, no study to date has directly demonstrated that metaphors are comprehended via the categorization of the topic as a member of the attributive category defined by the vehicle. If metaphor comprehension does entail such attributive categorization, then a metaphorical prime (e.g., *That exam is a filter*) should increase the probability that the topic concept (i.e., EXAM) will be categorized as a member of the vehicle category (i.e., FILTERS). Experiment 1 tested this prediction. The experiment also tested vehicle conventionality as a mediator of class inclusion by including both conventional and novel metaphors.

Participants first were exposed to either a literal or figurative prime, each having the same subject and predicate. For example, participants read either the metaphor prime *That librarian is a mouse* or the literal prime *That librarian saw a mouse*. Immediately following the prime, participants judged the extent to which the topic (e.g., LIBRARIAN) was a member of the vehicle category (e.g., MOUSE). We used a 3-alternative forced-choice (3-AFC) methodology for assessing class inclusion, in which "partial member" was included in addition to the "nonmember" and "full member" response options (Estes, 2003). Participants were informed that a partial member response meant that the item belonged in the category, but not to the same extent as some other items. This 3-AFC procedure allows a relatively more sensitive measure of category membership, since a binary (member/nonmember) judgment would be insufficient to capture graded categorization (see Rosch, 1975). Class-inclusion, defined as the summed probability of "partial" and "full" member responses, served as the primary dependent measure.

According to Glucksberg and colleagues' class-inclusion model, the figurative reference of the vehicle is activated during the comprehension of the metaphor, and the topic is included in that attributive category. This categorization should lead to greater class inclusion following a metaphorical prime than following a literal prime. Moreover, the class-inclusion model claims that conventional and novel metaphors are both processed via attributive categorization (Glucksberg, 2003). Therefore, the class-inclusion model predicts a main effect of

Prime. More specifically, the metaphor-primed items should have greater class inclusion than the literal-primed items for both the conventional and the novel item types. Under the career of metaphor view, conventional metaphors can be comprehended by attributive categorization, but novel metaphors cannot. Therefore, the career of metaphor hypothesis predicts an interaction such that conventional metaphors should increase class inclusion, but novel metaphors should not.

Method

Participants

Fifty-one University of Georgia undergraduates participated for partial course credit.

Materials and design

Stimuli consisted of 32 metaphors and 32 matched literal control sentences. Wolff and Gentner (2000) suggested that alignment processing is most dominant for metaphors high in relational similarity (i.e., the extent to which the topic and vehicle "participate in the same relationships"; p. 534). Therefore, to provide the strongest possible test of the class-inclusion model, we used the 32 "high similarity" metaphors from Gentner and Wolff (1997, Experiment 4). Gentner and Wolff further divided these 32 metaphors into 16 high conventional and 16 low conventional (i.e., novel) metaphors on the basis of conventionality ratings. Their participants read sentences such as "When we say something is a *rocket*, how conventional is the interpretation that this is *something that moves very fast*?" (p. 341). They then provided a conventionality rating. The conventional metaphors were indeed rated significantly more conventional than the novel metaphors (see Gentner & Wolff, 1997 for detail). In the current experiment, a literal sentence was created for each of these 32 metaphors, using the same topic and vehicle concepts. For example, the literal counterpart for the metaphor *That librarian is a mouse* was *That librarian saw a mouse*. A complete list of the stimuli used in Experiment 1 is provided in Appendix A.

Two lists were constructed such that each participant saw either the metaphor prime (e.g., *That casino is a drug*) or the corresponding literal prime (e.g., *That casino sold a drug*) prior to each question item (i.e., To what extent is a CASINO a member of the category DRUG?). Each participant read 32 prime sentences: eight conventional metaphors, eight conventional literals, eight novel metaphors, and eight novel literals. Thus, the experiment used a 2 (Prime: literal, metaphorical; within-participants) × 2(Conventionality: conventional, novel; within-participants) factorial design.

Procedure

Each prime sentence was displayed for 4 s in bold red 22-point font on a black background. Following each prime sentence, participants answered a categorization question regarding the extent of the membership of the topic in the category defined by the vehicle. Participants indicated their response by pressing 1 for "nonmember," 2 for "partial member" or 3 for "full member." The "partial member" response was defined as an exemplar that belonged to the category but not to the same extent as other members. The order of trials was randomized across participants.

To ensure that participants attended to the prime sentences, they were informed that their memory for those primes would be tested immediately after the categorization task. Thus, in a recognition test, participants were presented with 16 previously seen "old" items (half of the original stimuli—four items from each of the four prime types) and 16 "new" items. These new items contained the topic and vehicle concepts from the 16 untested original items, but with the concepts rearranged into new unseen sentences. Participants indicated whether the sentence was an old item by pressing the "Y" key for "yes" or the "N" key for "no." The presentation of items was randomized across participants.

Results and discussion

To summarize, the topic concept (e.g., LIE) was reliably more likely to be judged a member of the vehicle category (e.g., BOOMERANG) following a metaphorical prime (e.g., *That lie is a boomerang*) than following a literal prime (e.g., *That lie was about a boomerang*). This metaphor-induced categorization occurred for novel and conventional metaphors alike, and was manifest as an increase in full (rather than partial) membership judgments.

Recognition

Recognition accuracies were corrected for potential response bias by subtracting the proportion of false alarms (i.e., calling a new item old) from the proportion of hits (i.e., calling an old item old) for each participant's metaphorical and literal items separately. Accuracy was nearly identical for the metaphorical ($M = .82$, $SE = .03$) and literal primes ($M = .82$, $SE = .03$), $t(50) < 1$, $p = .94$. That is, participants attended to the metaphorical and literal primes equally, and therefore any obtained difference in categorization cannot be attributed to a difference in attention to the metaphorical and literal primes.

Class inclusion

Analyses used repeated measures ANOVA with both participants (F_p) and items (F_i) as the random variable. Prime-type was within-participants and within-items, and Conventionality was within-participants but between-items. Results are illustrated in Fig. 1.

The class-inclusion model predicts a main effect of Prime, such that conventional and novel metaphors

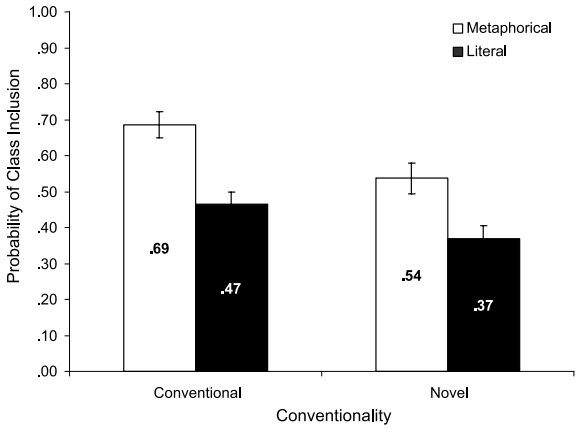

Fig. 1. Probability of class inclusion, Experiment 1. *Note.* The probability of class inclusion is the summed proportion of "partial" and "full" membership responses. Error bars represent one standard error of the mean.

should both increase the probability of class inclusion. The career of metaphor hypothesis predicts an interaction, such that conventional metaphors should increase class inclusion, but novel metaphors should not. Critically, the interaction of Prime and Conventionality was nonsignificant, $F_p(1,50) = 1.71$, $p > .15$ and $F_i(1,30) = 1.31$, $p > .25$. The results therefore failed to support the career of metaphor hypothesis; attributive categorization was not mediated by vehicle conventionality. As apparent in Fig. 1, both the conventional and the novel metaphor primes increased the probability of class inclusion. That is, the metaphor primes produced greater class inclusion ($M = .61$, $SE = .03$) than the literal primes ($M = .42$, $SE = .03$), $F_p(1,50) = 22.26$, $p < .001$ and $F_i(1,30) = 80.49$, $p < .001$. This main effect of Prime supports the class-inclusion model, in that metaphor comprehension facilitated the categorization of the topic as a member of the vehicle-named category.

Finally, the main effect of Conventionality was also reliable, with the conventional items ($M = .58$, $SE = .03$) eliciting greater class inclusion than the novel items ($M = .45$, $SE = .03$), $F_p(1,50) = 27.10$, $p < .001$ and $F_i(1,30) = 4.73$, $p < .05$. This effect may be attributable to the aptness of the metaphorical items: If aptness mediates categorization (Chiappe & Kennedy, 1999; Chiappe et al., 2003; Glucksberg, 2003), and if the conventional items were more apt than the novel items, then aptness may explain the main effect of Conventionality on categorization. We investigate this speculation further in the discussion on aptness following Experiment 2.

Partial and full membership

In addition to the summed measure of class inclusion reported above, we also analyzed the proportions of "partial" and "full" membership judgments separately.

Table 1
Experiment 1, proportions of partial and full membership responses

Prime	Item-type	Partial	Full
Metaphorical	Conventional	.39 (.04)	.29 (.05)
	Novel	.30 (.03)	.24 (.05)
Literal	Conventional	.38 (.03)	.09 (.02)
	Novel	.33 (.03)	.03 (.01)

Note: Standard errors are in parentheses.

Proportions are presented in Table 1. This analysis affords closer investigation of the metaphor-induced categorization effect. A 2 (Prime) × 2 (Conventionality) ANOVA on the proportions of partial membership judgments revealed no reliable effect of Prime. That is, there was no difference between the metaphorical ($M = .35$, $SE = .02$) and literal ($M = .35$, $SE = .02$) prime conditions, $F_p(1,50) < 1$ and $F_i(1,30) < 1$. The main effect of Conventionality approached reliability, $F_p(1,50) = 8.82$, $p < .01$ and $F_i(1,30) = 2.87$, $p = .10$, but the interaction was nonsignificant, $F_p(1,50) = 1.98$, $p = .17$ and $F_i(1,30) = 3.11$, $p = .09$.

A 2 (Prime) × 2 (Conventionality) ANOVA on the proportions of full membership judgments, however, did reveal a reliable effect of Prime. The metaphorical primes ($M = .27$, $SE = .03$) elicited a higher proportion of full membership judgments than did the literal primes ($M = .06$, $SE = .01$), $F_p(1,50) = 18.38$, $p < .001$ and $F_i(1,30) = 97.03$, $p < .001$. The main effect of Conventionality was also significant, $F_p(1,50) = 14.38$, $p < .001$ and $F_i(1,30) = 4.08$, $p = .05$. The interaction failed to approach significance, both $F < 1$. Thus, the difference in class inclusion between the metaphorical and literal primes was due to a difference in the proportion of full membership judgments. A likely explanation of this finding is that the metaphorical primes induced a general upward shift in the ratings: Items that would ordinarily have been judged nonmembers became partial members, and items that would have been partial members became full members. This upward shift in category membership judgments is consonant with the class-inclusion model.

Experiment 2

Experiment 1 provided evidence for the categorical processing of conventional and novel metaphors by demonstrating a higher degree of class inclusion for the topic as a member of the vehicle following a metaphorical prime than following a literal prime. In that experiment, given the use of literal prime sentences as the relative control condition, it is unclear whether the metaphor primes increased class inclusion, or whether instead the literal primes interfered with class inclusion. Because it is critical for the class-inclusion model that metaphor increases the probability of class inclusion, in Experi-

ment 2, an unprimed control group of participants received no prime sentence prior to categorization. This allowed us to more clearly demonstrate an increase in class inclusion following a metaphorical prime.

Another alternative explanation of Experiment 1 is that the nominal structure (i.e., *That X is a Y*) of the metaphorical primes may have induced a task demand, such that participants were more likely to judge that an X is a Y after reading the prime *That X is a Y*. If this task demand explanation were correct, then *any* nominal sentence should facilitate the categorization of the topic or subject as a member of the vehicle or predicate. To address this potential demand characteristic, Experiment 2 additionally included two types of controls—borderline literal category assertions (e.g., *Poker is a sport*) and scrambled metaphors (e.g., *Hard work is a teddy bear*). If the metaphor-induced categorization effect were due simply to the nominal structure of the primes, then the borderline literal primes should also increase class inclusion, since they exhibit the same nominal structure as the metaphorical primes. We used borderline exemplars (e.g., POKER as a SPORT) rather than definite category members (e.g., FOOTBALL as a SPORT) to avoid a possible ceiling effect. That is, in order for the primed condition to exhibit an increase in class inclusion, the unprimed condition must be below ceiling to allow the presumed increase. The scrambled metaphor condition served as a more stringent test of the class-inclusion model's requirement that the vehicle must have a property that can be attributed to the topic. The scrambled metaphor items were metaphorical in nature but lacked this crucial requirement. If all metaphor-like assertions increase categorization, regardless of whether the vehicle has a property that is attributable to the topic, then the scrambled metaphor primes should increase class inclusion. Thus, an important aim of Experiment 2 was to determine whether the metaphor-induced categorization effect was truly due to metaphor comprehension (i.e., attributive categorization), or whether it extends to any prime with nominal structure (i.e., borderline literal) or to any nonsensical metaphorical prime (i.e., scrambled metaphor).

In Experiment 2, participants were randomly assigned to either a primed or an unprimed condition. In the primed condition, they read sentences containing the exemplar and category as the subject and predicate, respectively, before making the category judgment. All participants saw 16 of each Item-type: scrambled metaphor, borderline literal, conventional metaphor, and novel metaphor. For the control stimuli, the initial quantifier or article terms and verb phrase were varied to produce more natural-sounding items (e.g., *An avocado is a fruit* as opposed to *That avocado is a fruit*). For purposes of consistency between the control and experimental items, the metaphor stimuli were also varied accordingly (e.g., *Horoscopes are maps; A casino is a drug*). If the results of Experiment 1 were attributable to the nominal structure, then the primed condition should exhibit greater class inclusion than the unprimed condition for *all four* of these item types. However, if attributive categorization is responsible for the greater class inclusion, then only the metaphorical items having a topic-attributable vehicle property (i.e., the conventional and novel metaphor items) should exhibit this difference between the primed and unprimed conditions.

Method

Participants

Sixty University of Georgia undergraduates participated for partial course credit. Participants were randomly and evenly assigned to the primed and unprimed conditions.

Materials and design

The same 32 metaphors were used as in Experiment 1. In addition to these 16 conventional metaphors and 16 novel metaphors, 16 borderline literal items, and 16 scrambled metaphor items were included. The exemplars of the borderline items were selected to be familiar to the undergraduate population and were thought by the authors to be borderline members of their categories. (Indeed, as described below, the mean category ratings confirmed this intuition.) Scrambled metaphors (e.g., *Respect is a vampire*) consisted of a topic from one of the high apt metaphors in Experiment 3 (e.g., *Respect is a precious gem*) paired with the vehicle from another high apt metaphor (e.g., *A mosquito is a vampire*). A complete list of these controls is provided in Appendix B. The Prime factor consisted of an unprimed condition, in which participants made category membership judgments in the absence of a sentence, and a primed condition in which the sentence (e.g., *Rice is a vegetable*) was provided prior to each categorization question. In summary, the experiment used a 2 (Prime: primed, unprimed; between-participants) × 4 (Item-type: conventional, novel, borderline, scrambled; within-participants) mixed design.

Procedure

For the participants in the primed condition, the procedure was the same as in Experiment 1, except that we used a 7-point scale of category membership (1 = "not at all a member" to 7 = "completely a member") in the present experiment. The participants in the unprimed condition made the same category judgments (e.g., To what extent are FINGERNAILS a member of the category WEAPON?) in the absence of the prime sentences. Because the unprimed group was not exposed to the prime sentences, the recognition test was not included in Experiment 2.

Results and discussion

As illustrated in Fig. 2, the results of Experiment 2 closely replicated those of Experiment 1. That is, the

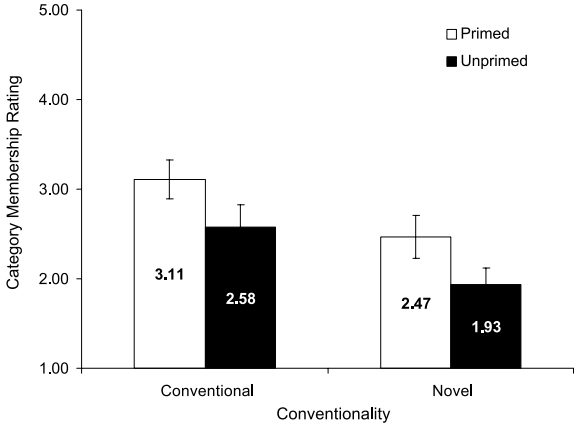

Fig. 2. Category membership ratings, Experiment 2. *Note.* Scale = 1 (not at all a member) to 7 (completely a member). Error bars represent one standard error of the mean.

topic concepts were reliably more likely to be included in the vehicle categories when preceded by a metaphorical prime than when unprimed. This metaphor-induced categorization held for both conventional and novel metaphors, and critically demonstrated that metaphor increases categorization. Moreover, the effect of the metaphor primes was not attributable to a task demand: The metaphorical (e.g., *That librarian is a mouse*) and the control (e.g., *A music box is a toy*) primes shared the same nominal structure (i.e., *That X is a Y*), yet, only the conventional and novel metaphorical primes increased class inclusion. The failure of the scrambled metaphor (e.g., *Crime is an ambassador*) primes to increase class inclusion provided further evidence for an attributive categorization process. Thus, metaphor comprehension apparently induces a process of attributive categorization that does not occur during the comprehension of literal sentences or during the attempted comprehension of scrambled metaphors. Results therefore supported the class-inclusion model, and again failed to support the career of metaphor hypothesis.

Participant (F_p) and item (F_i) analyses were conducted via repeated measures ANOVA. Prime-type was between-participants but within-items, whereas Item-type was within-participants but between-items. An initial 2 (Prime: primed, unprimed) × 4 (Item-type: conventional, novel, borderline literal, scrambled) ANOVA on the probability of class inclusion revealed the expected interaction between Prime and Item-type, $F_p(3,174) = 3.18$, $p < .05$ and $F_i(3,60) = 3.17$, $p < .05$. To examine whether this interaction reflected differences in class inclusion between or within the control and experimental items, the control items and the experimental items were analyzed separately via 2 (Prime) × 2 (Item-type) mixed ANOVAs.

Control items

Unsurprisingly, there was a main effect of Item-type, with the borderline literal items ($M = 4.19$, $SE = .09$) having a higher category membership rating than the scrambled metaphor items ($M = 1.52$, $SE = .07$), $F_p(1,58) = 773$, $p < .001$ and $F_i(1,30) = 376$, $p < .001$. Critically, neither the main effect of Prime, $F_p(1,58) < 1$, $p = .71$ and $F_i(1,30) = 2.90$, $p = .10$, nor the Prime × Item-type interaction (both $ps > .65$) was reliable. Planned comparisons further revealed a lack of Prime effect within each control condition. The primed borderlines ($M = 4.28$, $SE = .15$) did not differ from the unprimed borderline literal items ($M = 4.09$, $SE = .12$), $t_p(58) < 1$, $p = .33$ and $t_i(15) = 1.18$, $p = .26$. The close proximity of the unprimed borderline literal items (4.09) to the scalar midpoint (4.00) confirms that they were indeed borderline items. Importantly, then, the lack of a prime effect cannot be attributed to ceiling ratings in the unprimed condition. Likewise, the primed scrambled metaphor items ($M = 1.58$, $SE = .11$) did not differ in membership ratings from the unprimed scrambled metaphor items ($M = 1.46$, $SE = .09$), $t_p(58) < 1$, $p = .42$ and $t_i(15) = 1.46$, $p = .17$. Thus, any increase in class inclusion following a metaphor prime (cf. Experiment 1) is not attributable to their nominal structure.

Experimental items

The means for each of the four metaphorical conditions are shown in Fig. 2. As predicted by the class-inclusion model, the primed metaphorical items ($M = 2.79$, $SE = .12$) induced greater category membership than did the unprimed items ($M = 2.25$, $SE = .11$), $F_p(1,58) = 7.02$, $p = .01$ and $F_i(1,30) = 36.22$, $p < .001$. This main effect of Prime provides further evidence for attributive categorization during metaphor comprehension. Moreover, contrary to the career of metaphor hypothesis, the interaction between Prime and Item-type (i.e., Conventionality) again failed to approach significance, both $ps > .98$. Indeed, the difference in category membership ratings between the primed and unprimed conditions was .54 for both the conventional and novel items. These results directly replicate the findings of Experiment 1—both experiments found that the facilitation of class inclusion by the metaphor primes was equivalent across the conventional and novel metaphors. That is, vehicle conventionality did not mediate attributive categorization. Finally, there was also a main effect of Item-type (i.e., Conventionality), such that the conventional items ($M = 2.84$, $SE = .12$) again exhibited greater category membership than the novel items ($M = 2.20$, $SE = .10$), $F_p(1,58) = 78.93$, $p < .001$ and $F_i(3,60) = 28.74$, $p < .001$. We previously speculated that if attributive categorization were mediated by aptness (Chiappe & Kennedy, 1999; Chiappe et al., 2003; Glucksberg, 2003), and if the conventional metaphors were more apt than the novel metaphors, then aptness might explain the greater class

inclusion of the conventional items than of the novel items in Experiments 1 and 2. The following section investigates this explanation.

Conventionality or aptness?

Metaphorical interpretations are automatically elicited (Glucksberg, Gildea, & Bookin, 1982; Keysar, 1989), particularly when the topic and vehicle concepts constitute an apt metaphor (Blasko & Connine, 1993). Thus, even when unprimed, highly apt items (e.g., To what extent is an EXAM a member of the category FILTER?) are somewhat likely to be interpreted metaphorically, whereas less apt items (e.g., To what extent is a SAILBOAT a member of the category CAT?) are less likely to be interpreted metaphorically. In this way, aptness might explain the main effect of Conventionality observed in Experiments 1 and 2. To investigate the plausibility of this explanation, we had 16 participants rate the aptness, on a scale from 1 (not at all apt) to 7 (highly apt), of the 16 novel and 16 conventional metaphors used in Experiments 1 and 2. Aptness was defined and exemplified for the participants with the following instructions: "Aptness refers to the extent to which the statement captures important features of the topic. For instance, for the metaphor DOGS ARE ROYALTY you would determine how well this metaphor expresses an important feature of dogs" (cf. Chiappe et al., 2003). We initially conducted a Pearson correlation between each metaphor's mean aptness rating and its mean category membership rating (pooling over Prime-type, since Prime and Conventionality failed to interact). As predicted, aptness was strongly correlated with category membership, $r = .75$, $p < .001$. Furthermore, the conventional metaphors ($M = 4.31$, $SE = .15$) were indeed more apt than the novel metaphors ($M = 3.52$, $SE = .16$), $t_p(15) = 3.99$, $p = .001$ and $t_i(30) = 2.39$, $p < .05$. Thus, aptness appears to provide a tenable explanation of the main effect of Conventionality.

To more closely investigate this explanation, we subsequently conducted a 2 (Prime; within-items) × 2 (Conventionality; between-items) ANCOVA on the conventional and novel metaphor ratings of Experiment 2, with aptness as the covariate. In contrast to the prior ANOVA analysis, the main effect of Conventionality was no longer reliable. That is, when aptness was statistically controlled, the adjusted category membership ratings did not differ between the conventional metaphors ($M_{adj} = 2.59$, $SE_{adj} = .22$) and the novel metaphors ($M_{adj} = 2.46$, $SE_{adj} = .21$), $F_i(1,29) < 1$, $p = .60$. The main effect of Prime still resulted, $F_i(1,30) = 36.22$, $p < .001$, indicating that the prior comprehension of the metaphor primes did increase class inclusion. Finally, a lack of interaction between Prime and Conventionality, $F_i(1,30) < 1$, $p = .99$, corroborated the conclusion that conventionality did *not* mediate class inclusion.

In summary, prior research has shown that the preference for a figurative statement as either a metaphor or a simile is predicted by aptness rather than conventionality (Chiappe et al., 2003). The current analysis revealed that when aptness was statistically controlled, the main effect of Conventionality disappeared. Thus, conventionality does not appear to mediate attributive categorization, but aptness may. We investigate this possibility more directly in Experiment 3.

Experiment 3

Whereas the preceding experiments manipulated vehicle conventionality, Experiment 3 investigated the influence of metaphor aptness on class inclusion. Glucksberg (2003) claims that it is aptness, and not conventionality (Gentner & Wolff, 1997), that mediates metaphor-induced categorization. Chiappe and Kennedy (1999; Chiappe et al., 2003) have provided indirect support for this claim, by showing that aptness rather than conventionality predicts whether a categorical (i.e., metaphor) or a comparative (i.e., simile) statement is preferred. Thus, to provide direct evidence that aptness mediates class inclusion, the present experiment used high apt and low apt metaphors. As in Experiment 2, participants were randomly assigned to either a primed group or an unprimed group, and borderline literal and scrambled metaphor controls were included. If aptness mediates the process of categorization for metaphors, then only the high and low apt metaphorical items should exhibit a priming effect on category membership. Critically, if aptness predicts categorization (Chiappe & Kennedy, 1999; Chiappe et al., 2003; Glucksberg, 2003), then an interaction between Prime and Item-type should obtain. Specifically, the priming effect should be greater for the high apt metaphors than for the low apt metaphors. This interaction would suggest that aptness mediates the extent to which a metaphor is comprehended by attributive categorization.

Method

Participants

Sixty University of Georgia undergraduates participated in the experiment proper and an additional 40 participated in an aptness rating pre-test. All received partial course credit for participation. Participants were randomly and evenly assigned to the primed and unprimed conditions.

Materials and design

The 64 experimental stimuli (i.e., 32 high apt and 32 low apt metaphors) were selected from a larger group of 120 metaphors, which were sampled from Allbritton, McKoon, and Gerrig (1995), Gernsbacher et al. (2001), Katz, Paivio, Marschark, and Clark (1988), and McGlone (1996). A separate group of 40 participants rated

the aptness of these 120 metaphors on a 7-point aptness scale (as described above). These ratings were used to select 32 high apt and 32 low apt metaphors. The high apt metaphors ($M = 5.19$, $SE = .12$) were significantly more apt than the low apt metaphors ($M = 2.83$, $SE = .08$), $t(62) = 17.09$, $p < .001$. Moreover, the mean of the high apt metaphors was significantly greater than the scale midpoint of 4.00, $t(31) = 10.32$, $p < .001$, and likewise, the mean of the low apt metaphors was significantly lower than this midpoint, $t(31) = 15.37$, $p < .001$. Furthermore, the difference from the midpoint was nearly identical for both the high apt (1.19) and the low apt (1.17) metaphors. These 64 metaphors are shown in Appendix C along with their aptness ratings.

The 32 borderline literal items consisted of exemplars different from those used in Experiment 2, though some of the same categories were used. The 32 scrambled metaphors (e.g., *That stagecoach is a dart*) were constructed from the Gentner and Wolff (1997) metaphors used in Experiments 1 and 2 by pairing the topic of one metaphor (*That stagecoach is a dinosaur*) with the vehicle of another metaphor (*That mosquito is a dart*). The items for both the borderline literal and scrambled metaphor control conditions can be found in Appendix D. In summary, the experiment used a 2 (Prime: primed, unprimed; between-participants) × 4 (Item-type: high apt, low apt, borderline literal, scrambled metaphor; within-participants) mixed design. As in Experiment 2, participants in the primed condition made categorization judgments following a prime statement, and participants in the unprimed condition made these judgments in the absence of the prime statement.

Procedure

The procedure was the same as in Experiment 2.

Results and discussion

As in Experiment 2, analyses consisted of repeated measures ANOVAs and planned comparisons for the control conditions. Consistent with the previous finding of Experiment 2, the topic concepts were reliably more likely to be included in the vehicle categories when preceded by a metaphorical prime than when unprimed. This metaphor-induced categorization held for both the high apt and the low apt metaphors, and critically demonstrated that metaphor increases categorization for even the less apt metaphors (e.g., *A forest is a harp*). However, aptness mediated the categorical processing of metaphors (Chiappe & Kennedy, 1999; Chiappe et al., 2003; Glucksberg, 2003), as this effect was reliably greater for the highly apt metaphors than for the less apt metaphors. The borderline literal primes (e.g., *A jet ski is a boat*) again failed to increase category membership, once more demonstrating that the categorical structure of the prime sentences was insufficient by itself to induce categorization. The failure of the scrambled metaphor (e.g., *An exam is a mouse*) primes to increase class inclusion provides further evidence that the attributive categorization process is specific to sensible metaphors. That is, although the scrambled metaphors had conventional vehicles, their conventionalized properties could not be attributed to the topics with which they were paired. In fact, these scrambled metaphor primes included the exact same conventional vehicles as in the preceding experiments, but they failed to elicit categorization in this experiment because they were paired with a different topic. Clearly then, vehicle conventionality is also insufficient to induce categorization. Rather, the process of attributive categorization was again shown to be limited to metaphors having a topic-attributable vehicle property, as predicted by the class-inclusion model.

An initial 2 (Prime) × 4 (Item-type) ANOVA revealed the expected interaction between Prime and Item-type, $F_p(3,174) = 3.18$, $p < .05$ and $F_i(3,60) = 3.17$, $p < .05$, reflecting a greater difference between the primed and unprimed items in the experimental conditions (high apt and low apt) than in the control conditions (i.e., borderline literal and scrambled metaphor). To test the effects of aptness on class inclusion, the experimental conditions were examined separately in a 2 (Prime) × 2 (Item-type: high apt, low apt) mixed ANOVA. The control conditions were also separately examined in a 2 (Prime) × 2 (Item-type: borderline literal, scrambled metaphor) mixed ANOVA. Additionally, planned comparisons were done between the primed and unprimed conditions within the scrambled metaphor items and within the literal borderline items, to more closely detect any potential category membership differences within these control items.

Control items

As in Experiment 2, there was a main effect of Item-type, with the borderline literal items ($M = 4.90$, $SE = .10$) having higher category membership ratings than the scrambled metaphor items ($M = 1.52$, $SE = .07$), $F_p(1,58) = 1001$, $p < .001$ and $F_i(1,62) = 240$, $p < .001$. Critically, neither the main effect of Prime, $F_p(1,58) < 1$, $p = .33$ and $F_i(1,30) = 2.31$, $p = .13$, nor the Prime × Item-type interaction (both $ps > .63$) was reliable. Planned comparisons again also revealed a lack of Prime effect within each control condition. The scrambled metaphor items did not differ in membership ratings between the primed ($M = 1.57$, $SE = .10$) and unprimed conditions ($M = 1.48$, $SE = .08$), $t_p(58) < 1$, $p = .49$ and $t_i(31) < 1$, $p = .42$. Nor did the borderline literal items differ between the primed ($M = 4.98$, $SE = .14$) and the unprimed conditions ($M = 4.81$, $SE = .15$), $t_p(58) < 1$, $p = .40$ and $t_i(31) = 1.30$, $p = .20$. Thus, the lack of difference between the Prime conditions found in Experiment 2 was replicated in the current experiment using a different and larger set of borderline literal and scrambled

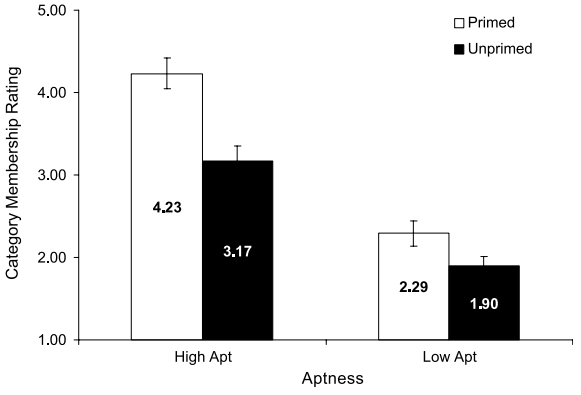

Fig. 3. Category membership ratings, Experiment 3. *Note.* Scale = 1 (not at all a member) to 7 (completely a member). Error bars represent one standard error of the mean.

metaphor items. This further demonstrates that attributive categorization does not occur for literal items or for metaphors lacking a topic-attributable vehicle property.

Experimental items

The means for each of the four experimental conditions (i.e., Prime × Aptness) are shown in Fig. 3. As predicted by the class-inclusion model, the primed items ($M = 3.26$, $SE = .17$) produced higher category membership ratings than did the unprimed items ($M = 2.54$, $SE = .13$), $F_p(1,58) = 11.58$, $p < .001$ and $F_i(1,62) = 90.89$, $p < .001$. This finding further supported Glucksberg and colleagues' class-inclusion model by demonstrating an attributive categorization process for an even broader range of metaphors (i.e., high apt and low apt metaphors).

There was also a main effect of Aptness with the high apt metaphors ($M = 3.70$, $SE = .15$) having a higher category membership rating than the low apt metaphors ($M = 2.10$, $SE = .10$), $F_p(1,58) = 373.68$, $p < .001$ and $F_i(1,62) = 113.65$, $p < .001$. That is, it appears that apt metaphors may be automatically processed metaphorically (cf. Blasko & Connine, 1993; Glucksberg et al., 1982; Keysar, 1989), and hence they may elicit higher category membership ratings even in the absence of the metaphor prime. This effect of aptness is consistent with the ANCOVA results of Experiment 2. Recall that there initially appeared to be an effect of conventionality on categorization, but when aptness was removed as a covariate, the effect of conventionality disappeared. That original effect was therefore attributable to aptness rather than conventionality. The results of the present experiment corroborate this conclusion.

The potential interaction between Prime and Aptness was of particular interest in this experiment, because it would indicate that aptness mediates attributive categorization (Chiappe & Kennedy, 1999; Chiappe et al., 2003; Glucksberg, 2003). This expected Prime × Aptness interaction did in fact obtain. The difference in category membership ratings between the primed and unprimed items within the high apt metaphors (1.06) was reliably greater than the difference within the low apt metaphors (.39), $F_p(1,58) = 373.68$, $p < .001$ and $F_i(1,62) = 113.65$, $p < .001$. Thus, this interaction demonstrates the importance of aptness in determining whether a metaphor can be processed via attributive categorization. Although both the high and low apt metaphor primes increased category membership ratings, the comprehension of the high apt metaphors provided much more of an increase in category membership than did the comprehension of the low apt metaphors. This, in turn, suggests that attributive categorization is more likely to occur in the comprehension of a high apt metaphor than in the comprehension of a low apt metaphor.

General discussion

In Experiment 1, metaphorical primes (e.g., *That desk is a junkyard*) produced greater class inclusion for the topic (i.e., DESK) as a member of the vehicle (i.e., JUNKYARD) than did literal primes having the exact same topic and vehicle concepts (e.g., *That desk is from a junkyard*). Experiments 2 and 3 corroborated this result by demonstrating reliably greater class inclusion for the primed than for the unprimed metaphorical items. The greater class inclusion following the metaphorical primes in all three experiments suggests that the vehicle was understood as an attributive category of the topic. For example, in comprehending *That desk is a junkyard*, participants first created the attributive category "things that are cluttered" from the vehicle JUNKYARD, then they included the topic DESK in that attributive category. The greater class inclusion following the metaphors, therefore, provides the first *direct* evidence for the categorical processing of metaphors, as posited by the class-inclusion model (Glucksberg & Keysar, 1990, 1993; Glucksberg et al., 1997). Although prior studies had demonstrated that metaphor vehicles have dual reference (Blasko & Connine, 1993; Gernsbacher et al., 2001; Glucksberg et al., 2001; McGlone & Manfredi, 2001), structure-mapping theory could account for those results via the career of metaphor hypothesis (Bowdle & Gentner, 1999; Gentner & Bowdle, 2001; Gentner & Wolff, 1997). Thus, by directly demonstrating attributive categorization in metaphor comprehension, the present study provides stronger support for the class-inclusion model.

The metaphor-induced categorization was not due to a task demand produced by the nominal (i.e., *That X is a Y*) structure of the metaphorical primes, because all of the primed items in Experiments 2 and 3 had this structure, but only the sensible metaphor primes increased

class inclusion. For example, the borderline literal primes (e.g., POKER IS A SPORT) did *not* increase class inclusion. Furthermore, although both the sensible metaphors (the conventional, novel, low apt, and high apt metaphors) and the nonsensical metaphors (the scrambled metaphors) of Experiments 2 and 3 had vehicles with plausible figurative references, only the sensible metaphor primes facilitated class inclusion. Indeed, the exact same metaphor vehicles that induced categorization in Experiment 2 (i.e., conventional and novel metaphors) subsequently failed to increase category membership ratings when used in the scrambled metaphors of Experiment 3. Thus, in order for categorical processing to occur, there must be some property of the vehicle that can be sensibly attributed to the topic. This finding clearly supports a model of metaphor comprehension in which the topic and vehicle concepts interact by performing different functional roles: The vehicle provides candidate properties for attribution, whereas the topic constrains which properties are relevant for attribution (Glucksberg & Keysar, 1990, 1993; Glucksberg et al., 1997).

There was a consistent and reliable effect of Item-type such that in Experiments 1 and 2 the conventional items induced greater class inclusion than the novel items, and in Experiment 3 the highly apt items elicited greater categorization ratings than the less apt items. Interestingly, this effect occurred even when those items were not preceded by a metaphorical prime. Although this main effect may initially appear to support the claim that conventional metaphors are more likely to induce categorization, notice that the career-of-metaphor hypothesis does not predict such an effect in the control conditions. We suggest the following explanation: Metaphorical references are activated automatically, even in the absence of a metaphorical context, and especially when the concepts would constitute an apt metaphor. Prior research supports this explanation. To illustrate the automaticity of metaphorical interpretation, Glucksberg et al. (1982) had participants judge the literal truth or falsity of sentences. Of most interest were the literally false sentences, some of which were comprehensible metaphors (e.g., *Some jobs are jails*, *Some flutes are birds*) and some of which were scrambled metaphors (e.g., *Some jobs are birds*, *Some flutes are jails*). They found that comprehensible metaphors took reliably longer than scrambled metaphors to reject as literally false, suggesting that the metaphorical meaning was comprehended nonvolitionally. Similarly, Keysar (1989) found that comprehension of a literally false sentence (e.g., *My son is a baby*) was significantly slower after a context story that rendered the target sentence metaphorically true (i.e., the son exhibits immature behavior) than after a context that rendered it metaphorically false (i.e., the son exhibits mature behavior). Thus, the metaphorical reference was apprehended regardless of the literal context. Finally, in a cross-modal priming experiment, Blasko and Connine (1993) found that lexical decisions for metaphorical target words were facilitated by highly apt metaphor primes, but not by less apt metaphor primes. These three studies collectively indicate that metaphorical references are apprehended automatically (Glucksberg et al., 1982), regardless of literal context (Keysar, 1989), and particularly for highly apt metaphors (Blasko & Connine, 1993).

In terms of the present experiments, then, in the literally primed condition of Experiment 1 and in the unprimed conditions of Experiments 2 and 3, participants were somewhat likely to detect a metaphorical reference in the target question. Moreover, this metaphorical reference was more accessible for highly apt items (e.g., To what extent is a TREE a member of the category UMBRELLA?) than for less apt items (e.g., To what extent is a STORM a member of the category COFFEEPOT?). This explanation indirectly accounts for the effect of Item-type (i.e., conventionality) in Experiments 1 and 2. Specifically, we found that the original effect of conventionality was no longer reliable once aptness was statistically controlled via ANCOVA. This finding suggests the conclusion that aptness, rather than conventionality, was responsible for the effect. Indeed, this conclusion was more directly supported by the result of Experiment 3, where the highly apt items induced higher category membership ratings than the less apt items.

Now, given that the conventional metaphors were more apt than the novel metaphors, why was there no interaction between Prime and Item-type in Experiments 1 and 2, like there was in Experiment 3? A likely explanation for this lack of interaction is the small difference in aptness between the conventional and novel metaphors (i.e., 4.31–3.52 = .79 on a 7-point scale; see Experiment 2). The difference in aptness between the high apt and low apt metaphors of Experiment 3, on the other hand, was more substantial (i.e., 5.19–2.83 = 2.36). Furthermore, although the conventional and novel metaphors differed significantly in aptness, both means approached the midpoint of the aptness scale, and hence both could be considered moderately apt rather than high or low apt metaphors. Thus, aptness appears to be a tenable explanation of the robust categorization effect in the absence of a metaphorical prime, though clearly further research is needed to strengthen this conclusion.

According to the career of metaphor hypothesis, conventional metaphors may be comprehended via categorization, but novel metaphors cannot (Bowdle & Gentner, 1999; Gentner & Bowdle, 2001; Gentner et al., 2001; Gentner & Wolff, 1997; Wolff & Gentner, 2000). This hypothesis therefore predicts an interaction between Prime-type and Conventionality. Critically, however, neither Experiment 1 nor Experiment 2 exhibited this

predicted interaction. That is, the novel metaphor primes facilitated attributive categorization just as much as the conventional metaphor primes did. Because metaphor comprehension facilitated class inclusion for both the conventional and the novel metaphors to an equal extent, the career of metaphor hypothesis was not supported. Note that we do not dispute the claim that metaphors having a conventional or lexicalized vehicle (e.g., ROCKET) may have a stronger metaphorical reference than more novel vehicles. However, our evidence suggests that the strength of the metaphorical reference does not determine the mode of processing. Of course, it remains possible that some other manipulation or measure would support the career of metaphor hypothesis (e.g., Bowdle & Gentner, 1999; Wolff & Gentner, 2000). But the present experiments, which provide a clear and direct test of the hypothesis, indicate that vehicle conventionality does not mediate attributive categorization. On the contrary, Experiment 3 demonstrated that aptness mediates metaphor-induced categorization (Chiappe & Kennedy, 1999; Chiappe et al., 2003; Glucksberg, 2003), as evidenced by the greater facilitation from the high apt primes than from the low apt primes. Essentially, the less apt a metaphor is, the less likely it is to be interpreted metaphorically, and hence the less likely it is to induce categorization. In fact, this conclusion is also evident from the scrambled metaphors—because they were virtually incomprehensible, they did not exhibit the metaphor-induced categorization effect, despite their metaphorical sentence structure.

Gentner and Wolff (1997) found that priming a metaphor with its vehicle facilitated interpretation time only for metaphors that were high in conventionality and low in relational similarity. For example, priming with the vehicle concept (i.e., DRUG) facilitated comprehension of *That resort is a drug*, but did not facilitate comprehension of *That casino is a drug*, which is higher in relational similarity. They concluded from this that the class-inclusion model may be limited to metaphors low in similarity. Wolff and Gentner (2000) reiterated that structure mapping was fostered by topic-vehicle similarity, "alignment processing dominates for high-similarity metaphors" (p. 538). However, the results of Experiments 1 and 2 demonstrate that Gentner and Wolff's (1997) high similarity metaphors were processed via categorization, despite the claimed dominance of alignment for these metaphors. Thus, the scope of the class-inclusion model appears not to be as limited as previously suggested. Rather, metaphor comprehension involves a process of attributive categorization, whether conventional or novel, highly apt or less apt, and regardless of the relational similarity between topic and vehicle. Indeed, attributive categorization seemingly applies to any metaphor having a vehicle property that can be attributed to the metaphor's topic.

Appendix A. Experiment 1 stimuli

Conventional

Conventional metaphor	Conventional literal
That argument is a war.	That argument started a war.
That lawyer is a sponge.	That lawyer used a sponge.
That lie is a boomerang.	That lie was about a boomerang.
That hippopotamus is a blimp.	That hippopotamus was under a blimp.
That horoscope is a map.	That horoscope was next to a map.
That sauna is an oven.	That sauna is located behind an oven.
That ferry is a bridge.	That ferry went under the bridge.
That dragster is a rocket.	That dragster is on the way to a rocket.
That exam is a filter.	That exam was about a filter.
That suburb is a parasite.	That suburb had a parasite.
That giraffe is a skyscraper.	That giraffe looked at a skyscraper.
That audition is a door.	That audition took place behind a door.
That baby is an angel.	That baby wanted an angel.
That librarian is a mouse.	That librarian saw a mouse.
That stagecoach is a dinosaur.	That stagecoach was next to a dinosaur.
That salesman is a bulldozer.	That salesman sold a bulldozer.

Novel

Novel metaphor	Novel literal
That philanthropist is a fountain.	That philanthropist walked by a fountain.
That desk is a junkyard.	That desk is from a junkyard.
That casino is a drug.	That casino sold a drug.
That submarine is a fish.	That submarine was next to a fish.
That ballerina is a top.	That ballerina played with a top.
That island is a cork.	That island contains a cork.
That detective is a ferret.	That detective bought a ferret.
That sailboat is a cat.	That sailboat transported a cat.
That groupie is a satellite.	That groupie went to see a satellite.
That genius is an eagle.	That genius studied an eagle.
That mosquito is a dart.	That mosquito landed on a dart.
That fisherman is a spider.	That fisherman caught a spider.
That moat is a fence.	That moat is in front of a fence.
That slum is a tumor.	That slum contained a tumor.
That canary is a violin.	That canary flew over a violin.
That camel is a cactus.	That camel walked by a cactus.

Appendix B. Experiment 2 control stimuli

Control items

Borderline literal	Scrambled metaphor
A tire is a boat.	Hard work is a teddy bear.
Rice is a vegetable.	Respect is a vampire.
A cucumber is a fruit.	A tree is a whirlpool.

Appendix B (*continued*)

Borderline literal	Scrambled metaphor
A donkey is a horse.	Beavers are umbrellas.
Brooms are kitchen utensils.	A judge is a museum.
A handkerchief is clothing.	A zoo is a crutch.
Vacuuming is exercise.	Indecision is a diamond.
Poker is a sport.	A college degree is a virus.
A seahorse is a fish.	Lies are precious gems.
Those fingernails are weapons.	Alcohol is a warehouse.
A scorpion is an insect.	Crime is an ambassador.
Those roller skates are vehicles.	A best friend is thunder.
That piano is furniture.	A temper is a lantern.
A music box is a toy.	A rumor is an anchor.
Perjury is a crime.	A smile is a volcano.
That ruler is a tool.	An idea is gasoline.

Appendix C. Experiment 3 metaphors with aptness ratings

Low apt metaphors

Metaphors	Aptness
A fireman is a boxer.	2.13
Sleep is a snowstorm.	2.13
A machine is an animate being.	2.20
A wish is a rainbow.	2.28
Artists are gods.	2.40
A storm is a coffeepot.	2.43
Silence is an apron.	2.43
Billboards are warts.	2.48
Creativity is a toaster.	2.48
Money is blood.	2.48
A job is a jail.	2.55
Offices are icebergs.	2.55
A desert is a sea.	2.73
A sailboat is a leaf.	2.73
Security is a trap.	2.75
Power is penicillin.	2.78
That bird is an airplane.	2.85
Truth is a firefly.	2.85
A lawyer is a lighthouse.	2.88
A forest is a harp.	2.95
History is an alarm clock.	3.03
My apartment is a refrigerator.	3.03
Time is a physician.	3.03
A dog is a walking stick.	3.05
Beaches are grills.	3.05
Discipline is fertilizer.	3.38
Extravagance is poison ivy.	3.38
Danger is a spice.	3.43
A theory is a building.	3.48
Responsibility is a shackle.	3.50
The past is a bottomless pit.	3.53
Ideas are plants.	3.53

High apt metaphors

Metaphors	Aptness
A temper is gasoline.	4.03
A goal is a place.	4.08

Appendix C (*continued*)

Metaphors	Aptness
A business is a living organism.	4.13
The subconscious is an arena.	4.33
A zoo is a museum.	4.40
Emotions are temperatures.	4.48
A smile is an ambassador.	4.58
Alcohol is a crutch.	4.63
Crime is a disease.	4.68
A judge is a balance.	4.78
The mosquito is a vampire.	4.80
A tree is an umbrella.	4.98
The cheering crowd was thunder.	5.00
Beavers are lumberjacks.	5.10
A lover is a teddy bear.	5.13
Indecision is a whirlpool.	5.15
Research is mountain climbing.	5.33
Happiness is gold.	5.35
Hard work is a ladder.	5.43
Education is a lantern.	5.45
Time is money.	5.45
A lie is a dagger.	5.55
Anger is a volcano.	5.55
Loneliness is a desert.	5.70
Adventure is a roller coaster.	5.78
A rumor is a virus.	5.78
Books are treasure chests.	5.85
Respect is a precious gem.	5.88
That desk is a junkyard.	6.10
A best friend is an anchor.	6.15
Love is a journey.	6.18
A college degree is a doorway.	6.25

Appendix D. Experiment 3 control stimuli

Control items

Borderline literal	Scrambled metaphor
Clocks are furniture.	Suburbs are eagles.
Bowling is a sport.	Her lie was an angel.
Horses are vehicles.	My lawyer is a door.
A funnel is a tool.	Their baby is a map.
A caterpillar is an insect.	That librarian is a cork.
Forks are weapons.	His desk is an oven.
Bats are birds.	An exam is a mouse.
An avocado is a fruit.	That hippopotamus is a junkyard.
Whistles are musical instruments.	That sauna is a fish.
A barrette is jewelry.	That giraffe is a fountain.
Kleenex is medicine.	That ferry is a spider.
Pumpkins are vegetables.	My canary is a skyscraper.
A lobster is a fish.	Horoscopes are bulldozers.
A cactus is a tree.	Auditions are blimps.
A dustpan is a kitchen utensil.	Mosquitoes are dinosaurs.
A jet ski is a boat.	A ballerina is a war.

(*continued on next page*)

Appendix D (*continued*)

Borderline literal	Scrambled metaphor
Coyotes are dogs.	The camel is a ferret.
Dandelions are flowers.	Their argument is a sponge.
A tree house is a dwelling.	That slum is a rocket.
Pollution is a crime.	Fishermen are filters.
A chess set is a toy.	That stagecoach is a dart.
Slippers are shoes.	That salesman is a drug.
Whales are mammals.	The genius is a top.
A DVD player is an appliance.	Islands are boomerangs.
A belt is clothing.	A groupie is a cactus.
Dancing is a profession.	A sailboat is a tumor.
Cooking is exercise.	The casino is a cat.
Hammocks are beds.	The philanthropist is a parasite.
Mercury is a metal.	The moat is a bridge.
Cubic zirconia is a gem.	The detective is a satellite.
Columbus Day is a holiday.	A dragster is a fence.
A vase is a dish.	The submarine is a violin.

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