Running Head: Mixing Metaphors in the Hemispheres

Mixing Metaphors in the Cerebral Hemispheres: What Happens When Careers Collide?

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Abstract

Are processes of figurative comparison and figurative categorization different? An experiment combining alternative-sense and matched-sense metaphor priming with a divided visual field assessment technique sought to isolate processes of comparison and categorization in the two cerebral hemispheres. For target metaphors presented in the RVF/LH, only matched-sense primes were facilitative. Literal primes and alternative-sense primes had no effect on comprehension time compared to the unprimed baseline. The effects of matched-sense primes were additive with the rated conventionality of the targets. For target metaphors presented to the LVF/RH, matched-sense primes were again additively facilitative. However, alternative-sense primes, though facilitative overall, seemed to eliminate the pre-existing advantages of conventional target metaphor senses in the LVF/RH in favor of metaphoric senses similar to those of the primes. These findings are consistent with tightly controlled categorical coding in the LH and coarse, and flexible, context dependent coding in the RH.

Mixing Metaphors in the Hemispheres

Some metaphors are more familiar than others. These differences affect the intuitive difficulty with which a metaphor is comprehended. Compare for example the transparency of the very common, or conventional, metaphor (a) "That student is a star", with the relatively unusual (b) "An insult is a razor." Sentence (a) may fail to even register as metaphorical without conscious reflection, whereas (b) seems to require some effort for interpretation. Several prominent theories suggest that the degree of familiarity alters the cognitive processes underlying metaphoric language comprehension (Bowdle & Gentner 2005; Giora 1997). For instance, according to the Career of Metaphor model of Bowdle and Gentner (2005) conventional metaphorical terms are processed essentially as if they are established categories, whereas relatively novel metaphors are more likely to involve analogical comparison (e.g., structural alignment, Gentner & Wolff, 1997). Consider the following novel metaphoric sentence with "spider" as the *topic* and "fisherman" as the metaphor *vehicle*: "A spider is a fisherman." According to Bowdle and Gentner, its interpretation involves aligning salient properties of "fisherman," and relationships among those properties, and projecting them onto "spider."

For such novel metaphors, there are multiple potential structural relationships that can be projected onto the target. Does the speaker intend to evoke the lonely patience of the fisherman waiting for a tug on his line, or are we meant to notice that the spider's web is a net that is cast for protein-rich life forms that travel through air rather than water? Both kinds of structural similarities might be relevant. If the context preceding this metaphoric sentence had emphasized the idea of hunting, then we should probably construe the invocation of the fisherman as hunter. If the preceding context had invoked the

solitary nature of the spider's existence, however, then the metaphor vehicle might be intended to invoke the patient vigilance of a fisherman waiting for a tug on his line. Moreover, if the topic of the metaphoric sentence is changed altogether, as in "A salesman is a fisherman," some other concepts (like "bait" or "lure") might be more likely to be activated in understanding the intended metaphoric sense of fisherman than would be the case when the topic was "spider."

Because of this ambiguity of intended sense, novel metaphors pose different processing challenges for a listener than conventional metaphors, but can also offer communicative advantages to a speaker. On the one hand, whereas a conventional metaphor (e.g., "reeling [someone] in") has a salient, precise and restricted sense that, arguably, needs to be recognized rather than constructed, comprehension of a novel metaphor may sometimes require searching a fairly large semantic field in order to find the appropriate bases for structural alignment with the metaphor's topic. Thus, the granularity of the representational systems most useful for analyzing novel and conventional metaphors might be quite different. On the other hand, the representational power of using novel extensions of speech, including extended metaphors, requires a flexible representational system that can adapt itself to changing semantic alignments in different contexts. The flexibility that is required for novel and extended metaphors contrasts with pressure for established conventional uses to remain fixed. As a result, we might anticipate that the processes involved in interpreting novel metaphors would be more sensitive to the immediate context than would the processes involved in interpreting conventional metaphors.

From the standpoint of cognitive efficiency, repeated exposure to a particular novel metaphor ought to constrain its interpretation. Bowdle and Gentner (2005) report evidence supporting this view. Exposing participants to a few instances of sentences instantiating a similar sense of the novel metaphor vehicle was sufficient to partially conventionalize that metaphoric sense so that it was processed more like a common metaphor as assessed by a variety of behavioral measures. They describe the natural conventionalization of a metaphor in language as its "career." Thibodeau and Durgin (2009; in press) provide further support for this view by showing that rapid (experimental) "conventionalization" applies to a very specific metaphoric sense of a metaphor vehicle rather than being a property of the vehicle per se or of its metaphoricity. They showed that novel metaphoric sentences were comprehended more quickly and rated as more apt when there had been exposure during a preceding experimental task to metaphoric sentences using the same vehicle with a similar metaphoric sense rather than an alternative metaphoric sense. This result points to the importance of distinguishing between the conventionality of a metaphoric sentence (i.e., "A spider is a fisherman.") and the conventionality of the specific metaphoric senses (e.g., solitary vigilance, hunter by net) that the metaphor vehicle takes on in different contexts.

The Career of Metaphor hypothesis emphasizes the idea that novel metaphors may be processed quite differently than conventional ones (see also Giora, 1997, 1999), but it is important to note that several candidate processes may underlie the comprehension of novel metaphors. These could include structural alignment processes (Bowdle & Genter 2005; Gentner & Markman, 1997), dynamic category formation (Barsalou, 1987; Glucksberg & Keysar,

1990), or other forms of constraint satisfaction involved in relational reasoning (Hummel & Holyoak, 1997, 2003). We will refer to all of these kinds of processes as *comparison* processes. The use of this terminology is intended to contrast a general class of processes that might be used to develop or establish a particular metaphoric sense for a novel metaphor with *categorization* processes involved in accessing or invoking an already-established sense for a more conventional metaphor.

One way to try to isolate what is distinct about these two kinds of general processes (comparison and categorization) is to take advantage of recent evidence concerning lateralization of neural function. Whereas it had formerly been suggested that the right hemisphere may have a special role to play in the interpretation of figurative language generally, recent evidence has tended to contradict this view and to suggest instead that right hemisphere involvement may be better characterized along the axis of novelty, non-salience, remoteness, or unpredictability rather than metaphoricity per se (Coulson, 2008; Coulson & van Petten, 2007; Federmeier & Kutas, 1999; Giora & Stringaris, 2009; Kacinik & Chiarello, 2007; Mashal & Faust, 2009; Mashal, Faust, Hendler & Jung-Beeman, 2007; Rapp, Leube, Erb, Grodd & Kircher, 2007; Schmidt, DeBuse & Seger, 2007; Schmidt, Kranjec, Cardillo & Chatterjee, 2009). In particular, Jung-Beeman's (2005) coarse-coding hypothesis suggests that the right hemisphere provides greater overlap of activation between semantically remote concepts, and may thus provide the basis for processes of structural alignment necessary for analogical reasoning and the interpretation of novel or remote metaphoric comparisons. Indeed, several researchers have recently noted a correspondence

between theories of lateralization and the Career of Metaphor hypothesis (e.g., Mashal & Faust, 2009; Schmidt et al., 2009).

Mashal and Faust (2009) sought to demonstrate the correspondence between the lateralization theories and the cognitive processing theories by using a divided visual field paradigm (Burgess & Simpson 1988, see Banich 2003 for a review). They examined comprehension speed for figuratively related word pairs presented where the first word appeared centrally and the second appeared laterally (to the left or right). They found that novel metaphoric pairs were processed more slowly when presented to the right visual field / left cerebral hemisphere (RVF/LH) than when presented to the LVF/RH, but that this pattern was reversed when the metaphors were repeated in a second session. They argued that LH involvement increased because repetition conventionalized the metaphor so it was more likely to be processed by categorization. Although a skeptic may reasonably point out that mere familiarity (Schmidt, DeBuse & Seger, 2007) or predictability (Federmeier, 2007; Kandhadai & Federmeier, 2007) of the repeated figurative items is sufficient to explain speeded LH processing in the second session, this type of facilitation was not observed for non-metaphorically related pairs of words in Mashal and Faust's paradigm.

Mashal and Faust's (2009) study seems to confirm the idea that left hemisphere-specialized, categorical processing will occur for repeated figurative items. However, it does not address the role of the right hemisphere in the processing of novel metaphors. Indeed, because the same topics were employed with the same metaphors, it did not clarify whether it was a specific metaphoric sense rather than the metaphor-topic relationship that was gaining benefits

from familiarization. In the present study we sought to use the functional differentiation of the left and right hemispheric pathways to further investigate metaphor processing using a divided visual field paradigm. The effects of vehicle repetition were investigated in each hemisphere for both novel and conventional metaphor vehicles, but we also manipulated whether the vehicles used to prime the target sentence had the same metaphoric sense as the target or an alternative metaphoric sense.

To do this we used a variant of the "in vitro conventionalization" paradigm developed by Bowdle and Gentner (2005) for novel metaphors. In their paradigm, participants were shown pairs of novel figurative statements such as "a ballerina is (like) a butterfly" and "a gymnast is (like) a butterfly". Participants were then asked to generate a third example using the same vehicle (butterfly). When later asked to evaluate yet a fourth instance using this same vehicle, participants who had been exposed to the earlier instances, were more likely to accept a metaphorical form ("an acrobat is a butterfly") as preferable to a simile form ("an acrobat is like a butterfly") than were participants who had not been exposed to the prior instances (the effect was the same whether the prior instances had been in metaphor or simile form). A similar (though more extreme) pattern of metaphor-form preference was observed for highly conventional metaphors even without any experimental pre-exposure. Bowdle and Gentner consider that the shift in preference from simile form to metaphor form reflected the transition from comparison processes toward conventionalized categorization.

Because we were interested not only in the transition from comparison to categorization, but also in the granularity and flexibility of the categorization

and comparison processes themselves, we developed a similar paradigm based on the approach of Thibodeau and Durgin (2009, in press). They had participants simply rate a variety of metaphor primes for "metaphoricity" and then measured ratings of "aptness" as well as comprehension time for later instances that used the previously presented metaphor vehicles. Crucially, as an additional experimental condition they developed additional prime sentences that expressed alternative senses of the same metaphor vehicle. For example, the metaphoric sense of razor in "Betrayal is a razor" is quite different from the metaphoric sense of razor in "A genius' mind is a razor", and the metaphoric sense of the vehicle in the first sentence is rated as having a much more similar sense to the metaphorical sense of the vehicle in "An insult is a razor" than was the metaphoric sense of the vehicle in the second sentence[1]. Their study showed that prior exposure to a matched metaphoric sense was effective at increasing later ratings of aptness and in decreasing measures of comprehension time in comparison to literal primes. In contrast, exposure to prime sentences that instantiated an alternative metaphoric sense did not facilitate comprehension. Indeed, aptness ratings for target metaphor sentences were actually lowered when primes were alternative-sense uses of the same metaphor vehicle in the first part of the experiment. Thus, in the terminology of the Career of Metaphor hypothesis, it appeared that advancing the career of one metaphoric sense of a word might interfere with the career of another sense.

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[1] In ratings of the similarity of metaphoric sense of the vehicle "razor" in "Insult is a razor" and these other two sentences (on a 1-7 scale), metaphoric sense-similarity was reliably higher for "Betrayal is a razor " (6.35) than for "A genius's mind is a razor." (3.17), $t(30) = 6.05$, $p < .0001$.

By using a divided visual field paradigm and using competing metaphoric senses of a metaphor vehicle as primes in some cases and consistent metaphoric senses in others, we hoped to elucidate the granularity and context dependency of metaphor processing in the two hemispheres. If the right hemisphere's role in novel metaphor comprehension is primarily to aid with comparison processes by activating a coarse network of associated semantic features, it might turn out that prior activation of one metaphoric sense would still provide processing benefits for others. In contrast, for the LH, we should expect no benefit (and perhaps even a cost) from prior activation of an alternative metaphoric sense. This is because a category formed by conventionalizing one sense cannot be applied to an alternative sense. Thus conventionalization of an alternative sense should not facilitate LH processing for a targeted, but unprimed sense.

A second, subtler, prediction also follows from our lateralized interpretation of the Career of Metaphor hypothesis. Recall that RH comparison processes may need to flexibly accommodate novel metaphors so as to support extended metaphors, whereas LH categorization processes may rely on salient or conventional senses. If so, then the overall conventionality of a given metaphoric sense ought to have a stable role in LH metaphor processing, but things might be very different for RH metaphor processing. Primes that instantiate an alternative metaphoric sense of a target metaphor vehicle might induce a re-ordering of the salience of relevant structural alignments available in the RH. Such a realignment could impact the processing of the target sense dramatically. In particular, a re-ordering of salient alignments in the RH to accommodate a previously-presented alternative sense could reduce or

eliminate the normal processing advantages due to the long-term conventionality of the target sense. This differentiation between the possible effects of mixing metaphors (using a different metaphoric sense as prime than as target) on the two hemispheres may help explain why on-line comprehension time for target sentences was unaffected by alternative sense primes, even though aptness ratings were depressed (Thibodeau & Durgin, in press). Whereas comprehension time depends on arriving at *a* solution (categorization), making judgments of "aptness" may invite a more nuanced consideration of how satisfying that solution is (comparison).

Table 1. Example stimuli for target vehicle "razor"

Target Sentence	An insult is a razor
Matched-Sense Primes	A betrayal is a razor. Needless criticism is a razor.
Alternative-Sense Primes	A genius' mind is a razor. Her memory is a razor.
Literal Primes	A scalpel is a razor. Gillette shavers are razors.

We adapted our stimuli from prior studies (Thibodeau & Durgin, 2009, in press), involving three types of paired prime sentences: *matched-sense* primes, which used the target metaphor vehicle in the same sense as the target, *literal* primes, which used the target vehicle in a literal sense, and *alternative-sense* primes, which used the target vehicle in a different metaphoric sense than did the target sentence (see Table 1). Stimuli were constructed so that the conventionality of the vehicles used in targets varied substantially in order to

investigate how the familiarity of a metaphorical sense might interact with the different prime types. Whereas primes were presented centrally during an RSVP (rapid serial visual presentation) reading task, target metaphor vehicles were presented to either the right or left visual field to test for interactions between metaphor conventionality and prime-type across hemispheres.

Method

Participants

Sixty-four Swarthmore college undergraduates participated in the study for payment or course credit for participation. All were native speakers of English, self-reported as right-handed, and had normal or corrected-to-normal vision.

Task

Participants wore an eye-tracker while reading sentences presented one word at a time (for 200 ms) at fixation. At the conclusion of each sentence, participants indicated if the sentence made sense. The final word in some of the sentences (including all the target metaphor vehicles) was presented to the left or right of fixation, but participants were instructed to maintain fixation at the center of the screen throughout. These peripheral words were left up for 300 ms or until participants' gaze was not within a small distance (1.9°) of fixation.

Stimuli

The full set of experimental stimuli are shown in Appendix A along with ratings of *conventionality* and *similarity of sense*. The stimuli were adapted with several modifications from the studies by Thibodeau and Durgin (2009, in press). Each of the 32 nominal metaphor target sentences ended with a single-

word vehicle. The 192 associated prime sentences had the same structure, as did the 208 filler sentences (see Appendix B).

Conventionality ratings for target metaphor sentences were obtained by surveying 20 additional participants, who did not take part in the main study. Half these participants were asked to rate how "familiar" the metaphoric sense of the vehicle was and half were asked to rate how "unusual" it was. Both ratings were on a 7-point scale. *Conventionality* was then computed as the averaged difference between the two ratings and converted to z-scores. Normalized conventionality ratings are included in Appendix A. The same procedure was used with an additional 32 participants to assess the conventionality of the metaphoric sense for the alternative-sense and matched-sense prime sentences (presented as a pair; condition was varied within subjects, but between subjects by item). These ratings are also included in Appendix A.

Similarity of Sense ratings were used to test whether vehicles in the target metaphor sentences were judged more similar in sense to those in the matched-sense metaphors than to those in the alternative-sense metaphors. After the completion of the main experiment, 32 additional participants were presented with pairs of either alternative-sense or matched-sense prime sentences (condition was varied within subjects, but between subjects by item) along with the relevant target sentence and asked to rate either how "similar" or how "different" the metaphoric sense of the metaphor vehicle was in the target sentence compared with the other two (on a 7-point scale). "Different" ratings were reverse-coded and combined with "similar" ratings by item; means are reported in Appendix A. The mean overall difference between matched-sense and alternative-sense primes was 1.92 points on this scale, $t(31) = 8.46$, $p <$

.0001. There were two items that trended in the wrong direction (“donkey” and “fossil”), though not reliably so. Elimination of these two items in later analyses did not affect any statistical conclusions, so they were included in the reported analyses.

Design

Targets were presented laterally in either visual field (RVF, LVF), and were preceded (not immediately) by four prime conditions (match, literal, mix, none), for a total of eight conditions for each target. Two priming sentences were used for each target item in each primed condition. Each participant was assigned to one of 8 target lists, each of which contained all 32 targets, and each target was assigned to a condition once across all 8 lists, so that a list contained 4 targets in each condition. Target order was shuffled, but all 8 conditions were cycled through before any condition was repeated, and appropriate primes were added immediately before their targets to form a critical sentence list with 80 entries. These were then combined with 208 filler sentences to form the actual sequence of 288 trials. (A practice block of 36 additional items preceded the main experiment.)

The trials were subdivided into 8 sub blocks of 36 sentences, each containing 26 filler sentences and 10 critical sentences (4 targets, one in each prime condition, and 6 associated primes). Sub block order was randomized between subjects. Within each sub block, critical sentences were always separated by 2 or 3 filler sentences. To ensure that subjects did not use vehicle repetition or metaphoricity as a response cue, multiple filler sentences used repeated final words, distributed across metaphoric, literal, and nonsensical

senses; in addition, one third of fillers used peripheral presentation of the final word of the sentence.

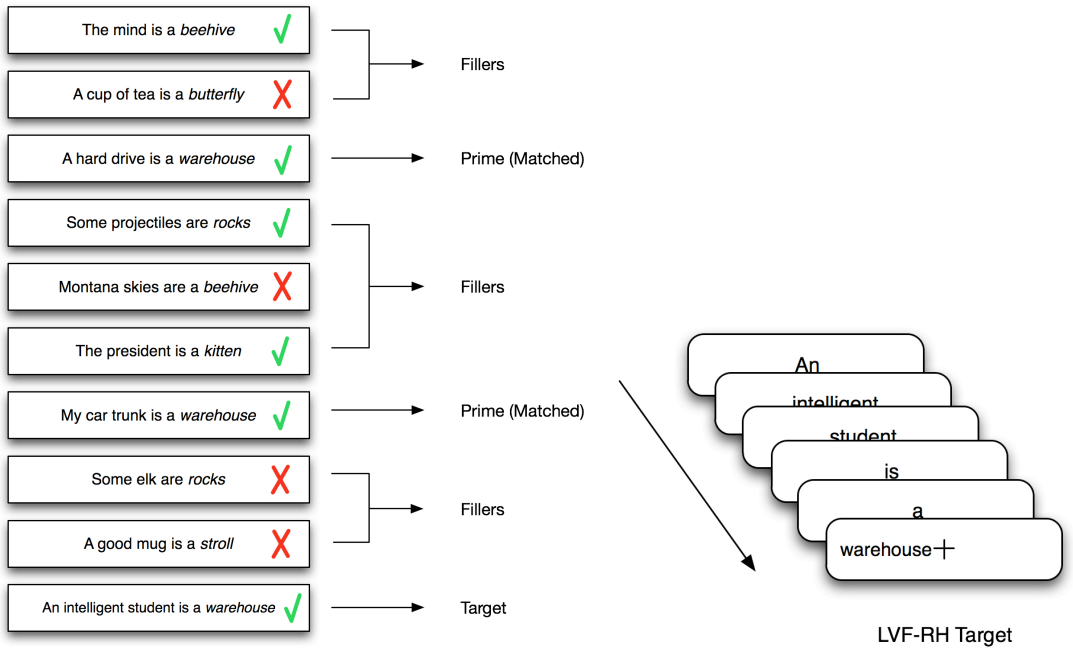

Figure 1. Schematic illustration of interleaving of prime sentences with fillers (left) and of an RSVP trial (right) with lateralized presentation of the metaphor vehicle. One third of filler sentences were lateralized. A light blue fixation crosshair was visible throughout each trial.

The specific composition of fillers in each sub block included 11 different vehicles: Two vehicles were used four times (twice metaphorically and twice nonsensically or twice literally and twice nonsensically). Three vehicles were used three times (one was once each of literal, metaphorical and nonsensical; the second was used twice nonsensically and once metaphorically; the third was used twice nonsensically and once literally). Three vehicles were used twice (one nonsensical and literal; one literal and metaphoric; one metaphoric and nonsensical). Finally, three filler vehicles in each sub block were used only one time, one as nonsense, one literal, and one metaphoric. In all, 12 filler sentences in each sub block were nonsensical (33% of trials). Prime vehicles

were always presented centrally, but filler sentence-final words were assigned randomly with equal weight to left, central, or right visual field presentation, with the result that, overall, 30% of sentence-final words were presented to the left, 40% at the center, and 30% to the right. The full stimulus list (not including the practice block) was thus 288 sentences, a third of which were intended to be nonsense, and which were designed to prevent recognition of critical sentences by either metaphoricity, laterality, or vehicle repetition.

Procedure

We measured participants' response latency for 'sense' judgments using a go/no-go design. Participants were instructed to judge a sentence as making 'sense' if a sentence had a clear metaphoric or literal meaning, even if the use of certain words were unfamiliar. Participants were instructed not to consider whether they agreed with the statement in making 'sense judgments'. The following example was used to illustrate 'sense' for participants: 'My brother is a pain' has a familiar sense; 'my brother is an itch' is not a familiar usage of 'itch', but there's a fairly straightforward interpretation; 'my brother is a table' has no familiar meaning, and to construct an interpretation would require extensive elaboration and interpretation. Recognizing that 'sense' is not black and white, participants were instructed to note the contrast between 'my brother is an itch' and 'my brother is a table' in evaluating the sense of sentences they read.

Each trial consisted of an RSVP sentence, followed by a 'sense' judgment period of 2 seconds. If a positive 'sense' judgment was not made within this period, the judgment was recorded as negative. Participants made positive 'sense' judgments by pressing the 'A' button on a gamepad controller resting

on a surface between them and the monitor, using their right index finger. Words were presented one-by-one, for 200ms each, except for sentence final words which were always presented for 300ms, to facilitate comprehension when presented laterally.

To familiarize participants with task structure, speed, and sense judgments, participants began the experiment with a practice block of 36 sentences, mirroring the composition of filler and critical sentences in the experimental sub blocks. On practice sentences only, immediate feedback on sense judgments was given, by presenting 'Correct' in green or 'Wrong' in red text in an effort to calibrate the participant's threshold.

Apparatus and display parameters

The experiment was run using Psychtoolbox-3 (Kleiner, Brainard, & Pelli, 2007; http://psychtoolbox.org) running on Matlab 7.6.0 (Mathworks, Nantucket, Massachusetts). Participants sat with their head in a chin-rest, positioned 49 cm from a 17 inch-diagonal flatscreen CRT monitor with a resolution of 1024 x 768 at 100 Hz. An Eyelink II eye-tracker was used to monitor fixation at 250 Hz. Each trial began with a small blue cross hair, presented in the center of the screen against a black background. Words were then presented in white Helvetica font, size 42, either centered on the cross hair, or to the left or right of the cross, with the inner edge of the word 100 pixels (3.8˚) from fixation. These dimensions were selected to accommodate the demands of monitoring fixation with reasonable precision. The font size was large enough to be legible at this eccentricity.

Many divided visual field studies present lateralized words for no longer than 200 ms, approximately the time it takes to plan and perform a saccade

(e.g., Chiarello, Liu, Shears, Quan & Kacinik, 2003; Matin, Shao & Boff, 1993). To present sentence-final words for a longer duration (300 ms) while ensuring that laterally presented words were not fixated, we replaced the lateral word with a string of '#' symbols whenever fixation was not within 50 pixels (1.9°) of the center of the display.

Results

Analyses reported here were conducted with linear mixed effects regression (see Baayen, Davidson & Bates, 2008) using the lme4 package (Bates & Maechler, 2009) for the statistical language R (R Core Development Team, 2009). Linear mixed-effects models were used to analyze the response latency (RT) data for trials where a positive sense response was given. Mean positive sense response rate (accuracy) for experimental trials over all subjects was 76% (74% in the LVF/RH and 78% in the RVF/LH). Mean positive sense response rate was 80% for primes (always central) and 83% for fillers (each of these categories include literal sentences). The overall false-alarm rate for nonsense fillers (an interpretation can be found for almost any sentence with sufficient effort) was only 21%. Unfortunately, lateralization information about the false alarms for the fillers was not retained due to a programming oversight. A total of 1555 observations were included in our analyses, 758 in the LVF/RH.

Interaction between Visual Field, Prime Type and Conventionality

In an initial analysis, testing for a predicted three-way interaction, Visual Field (VF: RVF/LH, LVF/RH) and Prime (None, Matched-Sense, Literal, or Alternative-Sense) were included as categorical factors, and target vehicle Conventionality was included as a continuous predictor. Subject and Item were included as random effects. To ensure that the analyses were not

anticonservative (Levy, forthcoming), and to account for differences in fixed effects among individual subjects and items, the model specification included random slopes for the main effects as well as random intercepts. Additionally, log word frequency (based on $SUBTLEX_{US}$; Brysbaert & New, 2009) was included as a covariate. Because a histogram of sense judgment RTs appeared right-skewed, we used the log transform of RT as the dependent variable in this initial analysis. We used the no-prime condition as the baseline. We expected primes to have different effects on targets in the RVF/LH and LVF/RH as a function of Conventionality. Indeed, a model including all two and three-way interactions between Conventionality, Prime, and VF explained more variance than when only the two-way interactions were included, $\chi^2(3)= 10.42$, $p = .0153$. Specifically, the interaction between Conventionality and the effect of Alternative-Sense Primes relative to the None condition, differed as a function of VF (i.e., hemisphere), $t = 2.71$, $p = .0065$. We therefore split the data by VF for further analysis.

Right Visual Field/Left Hemisphere

Because models using log-transformed and untransformed RTs revealed the same effects, and because effects in the separate VF analyses were generally strong, we will report analyses of untransformed RT values hereafter for easier interpretation of the magnitude of effects. For RVF/LH target vehicle presentation, a model including two-way interactions between Conventionality and Prime and modeling Random Effect slopes as well as intercepts explained no more variance than a simpler model including no interactions, $\chi^2(15) = 10.4$, $p > .20$. The inclusion of Random Effects slopes did not improve the model. There was a main effect of Conventionality (-180 ms/SD, $p < .0001$), as expected. More importantly, the model showed that Matched-Sense Primes

reliably facilitated target processing (M = -137ms, p = .0001), but Literal (M = -29ms) and Alternative-Sense Primes (M = -26ms) did not (p > .20). Our data thus supports the inference that, in the RVF/LH, target sentence processing was only facilitated by priming of the narrow metaphoric sense intended, but was essentially unaffected by the activation of other senses including literal ones. A representation of the modeled data for the RVF/LH is shown in the left panel of Figure 2. These data are consistent with the findings of Thibodeau and Durgin (2009, in press), who observed, using a rather different paradigm, that matched-sense primes elevated aptness ratings and speeded comprehension time, but that alternative-sense primes did not.

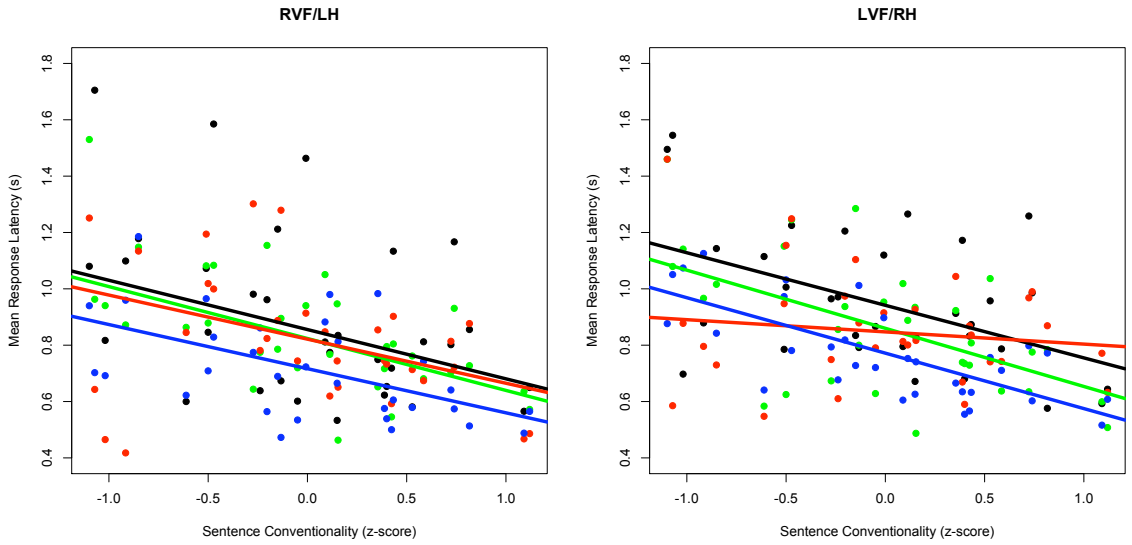

Figure 2. Mean RTs by item as a function of Prime Type and Conventionality for each hemisphere (RVF/LH on left; LVF/RH on right). Lines are best fits to the full data. Black: unprimed condition; blue: Matched-sense metaphor condition; red: Alternative-sense metaphor condition; green: Literal prime condition.

Left Visual Field/Right Hemisphere

For LVF/RH target vehicle presentation, a model including two-way interactions between Conventionality and Prime explained more variance than a simpler model including no interactions, $\chi^2(3) = 15.5$, $p = .0014$. The inclusion of Random Effects slopes did not improve the fit of the model. There was a reliable interaction between Conventionality and the effect of Alternative-Sense Primes relative to the baseline ($t = 3.15$, $p = ,0017$), where increasing conventionality was correlated with decreased Alternative-Sense Prime facilitation. As shown by the modeled data in the right panel of Figure 2, one way of describing the effect of Alternative-Sense Primes is that they essentially eliminated any effect of target Conventionality. Overall, all Prime types decreased target RT relative to the baseline condition (Literal: M = -87 ms, $p = .0120$; Alternative-Sense: M = -109 ms, $p = .0016$; Matched-Sense: M = -183 ms, $p < .0001$).

Recall that in the RVF/LH, there was no reliable priming except for Matched-Sense Primes. Because word reading is generally more difficult in the LVF/RH, it is possible that some effects of the Prime conditions (e.g., of the literal Primes) were merely due to word repetition, rather than semantic effects. To control for lexical priming, we can use the Literal Prime condition as a baseline. When the two metaphoric prime conditions were compared to the Literal condition (eliminating the non-primed condition from the analysis), there was no reliable effect of the Alternative-Sense Primes (M = -26 ms, $t < 1$, $p > .20$), but Matched-Sense Primes still showed reliable facilitation (M = -99 ms, $t = 3.28$, $p = .0011$). However, the interaction between Alternative-Sense Prime effects (relative to the Literal condition) and Conventionality was still highly reliable ($t = 3.54$, $p = .0004$).

The lack of difference between the Literal and Alternative-Sense prime conditions overall might be construed as indicating that facilitation in both, relative to the baseline condition, were due to effects of lexical repetition. However, it must be borne in mind that no such lexical repetition effects were found in the RVF/LH, and that the overall difference in response time between targets presented to the two VFs was only about 100 ms in the present experiment. It is therefore equally possible that partial semantic activation in the right hemisphere was responsible for facilitation from both Literal and Alternative-Sense Prime types.

Figure 2 (right panel) suggests that, relative to Literal Primes, Alternative-Sense Primes produced robust facilitation for targets of low conventionality (equivalent to the facilitation produced by Matched-Sense Primes), but costs for targets of high conventionality. Such costs are consistent with inhibition of the intended sense of the metaphor vehicle by the alternative sense of the primes (Gernsbacher, Keysar, Robertson & Werner, 2001). However, another way of construing the data is to note that Alternative-Sense primes facilitate nearly all target metaphors relative to the unprimed baseline, but the facilitation they provide is orthogonal to the conventionality of the target metaphor. Thus, rather than being additive with effects of target sentence conventionality (like Matched-Sense or Literal prime conditions) the effect of experimental exposure to the alternative metaphoric sense of the target metaphor vehicle is to cancel out any advantage accrued by the existing conventionality of that vehicle. In essence, the repetition of the mismatched metaphor primes may (temporarily) eliminate the influence of the

conventionality of the target by reorienting the flexible RH to favor an alternative alignment.

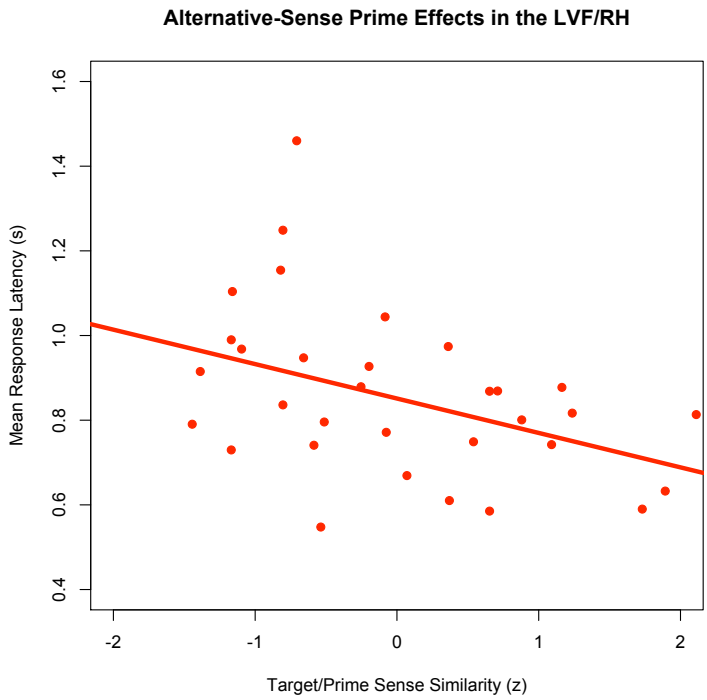

Figure 3. When Alternative-Sense primes had been presented, response latencies for metaphor vehicles presented to the LVF/RH were best predicted by the rated similarity between the metaphoric senses of the primes and the target sentence.

We can test this latter hypothesis by using the item-wise Sense-Similarity rating data (between target sentences and their alternative-sense prime sentences) to try to predict response latencies in the Alternative-Sense prime condition of the LVF/RH. We started with a full predictive mixed-effects linear model including z-scores of Prime-Target Sense Similarity, Target Sense Conventionality, Prime Sense Conventionality, and log Word Frequency ($SUBTLEX_{US}$), and all 2-way interactions between them. In the full model, response latency was reliably predicted by Prime-Target Sense Similarity alone (-179 ms/SD, t = 2.95, p = .0036). When all other factors were eliminated serially

with successive model comparisons, it was finally concluded that a model that included only Prime-Target Sense Similarity was no worse than the full model ($X^2(9) = 11.7$, p = .2322). This univariate model, shown in Figure 3, indicated a reliable effect of Sense Similarity in the RH (-76 ms/SD, t = 2.85, p = .0012). Thus, after priming with alternative sense of the vehicle metaphor, the rated conventionality of the target sense was no longer robustly predictive of comprehension time. Instead, the local context, defined by the similarity between the target metaphor sense and the prime metaphor sense predicted the speed of comprehension. This provides additional evidence that RH facilitation in this condition is not due to word repetition but to the repetition of a specific structural alignment. Moreover the elimination of a target conventionality effect indicates that alignments in the RH can be flexibly modified in a manner appropriate to the use of extended metaphor.

In contrast, when a corresponding analysis was carried out for the Alternative-Sense prime condition in the RVF/LH, it collapsed to a univariate model with target conventionality as the sole reliable factor, (-150 ms/SD, t = 2.60, p = .0101). Although there was also a marginal trend for prime/target sense similarity to predict response time when added to the model for the RVF/LH data, (-60 ms/SD, t = 1.79, p = .0749), this is consistent with other evidence that matched-sense primes provided an additive benefit to (categorical) LH processing.

Discussion

In the present experiment we used an experimental conventionalization procedure to familiarize participants with a specific sense of a metaphor vehicle.

Using lateral presentation of metaphor vehicles, we showed evidence of facilitation in both hemispheres as a consequence of such conventionalization when the tested metaphor had the same metaphorical sense as the metaphor primes. This facilitation was additive with effects of the baseline conventionality of the target metaphor sentence and seems to correspond to strengthening of the categorical representation of the metaphoric sense, as proposed by Bowdle and Gentner (2005). However, the effects of literal and alternative-sense metaphor primes were quite different in the two hemispheres and reinforce the idea that there are differences in coding granularity and coding flexibility in the two.

As expected based on categorization (access) processes, metaphor vehicles presented to the RVF/LH were not benefited by primes that used the vehicle literally or in an alternative metaphorical sense. However, for metaphor vehicles presented in the LVF/RH, both kinds of alternative primes showed evidence of facilitating metaphor processing. Facilitation by literal primes presented to the LVF/RH was additive with sentence conventionality effects, suggesting a non-competitive activation of related conceptual material useful for processes of structural alignment. Facilitation by LVF/RH primes that activated an alternative metaphoric sense, however, eliminated the effect of sentence conventionality. Instead, comprehension times, following alternative sense primes, were predicted by the rated similarity of the metaphoric senses of the prime sentences and the target sentence. This suggests that the alternative sense established a new comparison context, consistent with a flexible processor model.

An alternative view might appeal to inhibitory processes. For example, for metaphoric senses that were rated to be unfamiliar or unusual, prior activation of alternative senses facilitated metaphor comprehension as much as did priming of the same sense. In contrast, for metaphorical vehicles that were rated as highly familiar, priming of an alternative metaphorical sense provided less facilitation for metaphor processing compared to primes where the vehicle was used literally, for example. However, it is not clear that literal priming is the right baseline. Gernsbacher et al., (2001) argued that processing nominal metaphors caused irrelevant features of the vehicle to be actively suppressed. Thus, for example, following the presentation of "My lawyer is a shark," decisions about the truth of a literal sentence that referred to an irrelevant feature of the metaphor vehicle (like "A shark is a good swimmer.") were delayed compared to the case where the prior sentence was a literal categorization statement (like "A hammerhead is a shark"). Decisions about relevant features ("Sharks are tenacious.") were facilitated. However, these results are also consistent with differential facilitation rather than inhibition, and it seems relevant in this context to emphasize that in our LVF/RH data, literal primes had facilitative effects that were additive with effects of metaphor conventionality rather than competitive. Moreover, in direct tests, Thibodeau and Durgin (2008; 2009, in press) have not found evidence of inhibitory costs on metaphor comprehension time in alternative-sense metaphor contexts compared to literal contexts.

If we are correct to interpret the effects of the alternative-sense primes in the RH as re-aligning RH activity in a way that eliminated the RH benefits of target sense conventionality, then the appropriate conclusion is that the

comparison process is highly flexible: Advantages that would otherwise accrue to the target metaphor as a result of its present career status were effectively nullified by the recent processing of its alternative-sense competitor. This representational flexibility seems desirable for the comprehension of extended novel metaphors.

In the LH the main finding was that there was essentially no interference produced by alternative-sense primes, whereas there was facilitation from matched-sense primes. This is consistent with the idea that LH processing has finer semantic fields (Jung-Beeman, 2005), but also with ideas concerned with better prefrontal control of semantic activation in the LH (Thompson-Schill, D'Esposito & Kan, 1999). Whatever the mechanism, the LH seems to maintain a remarkably precise target metaphor sense.

Finally, with respect to the comparison process itself, the coarse coding model seems to be generally supported by the present results: In the RH, we saw facilitation of metaphorical processing from literal primes as well as from competing metaphorical primes. However, coarse coding does not appear to supply, on its own, an explanation of analogical comparison processes necessary for novel metaphor comprehension. The present data merely suggest that the coding in the right hemisphere is flexible, such that different sorts of structural alignments may be more or less readily available under various interpretive contexts. A more developed theory may need to appeal to a process of constraint satisfaction (e.g., Holyoak & Thagard, 1989; Hummel & Holyoak, 1997, 2003; McClelland, Rumelhart & Hinton, 1986). Specifically, given overlap across coarse-grained semantic fields, structural alignment might arise by

subjecting the activation patterns that emerge to principles of satisfaction of multiple constraints.

Our study has been framed in the terms of the Career of Metaphor hypothesis (Bowdle & Gentner, 2005), but our findings might be understood as indicating that there are two levels at which careers unfold. In the longer time-scale, there are the careers of metaphors in the language of a speaker or set of speakers. With frequent use, metaphors become conventionalized categories, as represented by the overwhelming relationship between target conventionality and target comprehension speed in our data. (See Thibodeau and Durgin, in press, for a fuller discussion of the measurement of conventionality.) But in the short term, sensitivity to the use of repeated or extended metaphor also clearly plays an important role in facilitating comprehension, and it is this flexibility and context dependence, even in the face of highly conventionalized metaphors that lends productive power to metaphoric speech.

The principal goal of the present study has not been to precisely localize metaphor-processing function, but to examine lateralized processes of comparison and categorization. We have shown that conventional metaphors seemed to lose their advantage in the RH when the “career” of a competing alternative metaphoric meaning of the same word had been recently “advanced” by priming. We take this as an indication of the flexibility of metaphor processing in the RH.

Whereas prior results concerning the lateralization of metaphor processing have been mixed (see Coulson, 2008), our results are consistent with the idea that something like novelty or salience (Giora, 1997; Giora & Stringaris, 2009; Mashal & Faust, 2009) rather than metaphoricity per se

(Schmidt et al., 2009) determines the type (and possibly the neural location) of processing that is engaged. Studies that use conventional metaphors with salient metaphoric senses are unlikely to observe the same patterns of processing as studies that choose metaphor senses with lower salience. But even studies using novel metaphor sentences have sometimes reported greater activation in the LH (e.g., Mashal, Faust, Hendler & Jung-Beeman, 2009; Rapp et al., 2007). We expect that some of the discrepancies that appear in the literature on lateralization may be traced back to methodological issues. The processing requirements of the specific behavioral task chosen may be as important as the selection of the metaphor stimuli themselves.

One of the hallmarks of metaphoric speech is its productivity. Extended metaphors are an efficient and compelling rhetorical device for persuasion via the communication of a particular framing of a topic of discussion (Thibodeau, McClelland & Boroditsky, 2009). Thibodeau and Durgin (2008) showed that when even highly conventionalized metaphors are used consistently, the comprehension of novel extensions of their literal imagery is facilitated. Of course, it is not unusual for people to mix common metaphors inadvertently because they are so transparent in their meaning. Our results suggest that the subtle effects of mixed metaphors on comprehension may be most evident when the LVF/RH is probed.

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Appendix A: Target and Prime Sentences.

Note that these are ordered here according to the rated conventionality of the metaphoric sense of the vehicle in the target sentence.

Sentence Type	Stimulus	Conventionality[a]	Similarity[b]
Target	That bedroom is a dump.	1.119	
Matched-Sense	This kitchen is a dump.		
	My office is a dump.	2.166	6.56
Alternative-Sense	That toilet is a dump.		
	A cesspool is a dump.	0.196	5.21
Literal Primes	A landfill is a dump.		
	The trash heap is a dump.		
Target	Some fashion models are twigs.	1.091	
Matched-Sense	Some math nerds are twigs.		
	A greyhound is a twig.	0.325	4.83
Alternative-Sense	My old bones are twigs.		
	Egg shells are twigs.	-0.512	3.29
Literal Primes	A piece of kindling is a twig.		
	Small branches are twigs.		
Target	Some teachers are encyclopedias.	0.816	
Matched-Sense	Some game show contestants are encyclopedias.		
	A history buff is an encyclopedia.	0.759	6.79
Alternative-Sense	A phone book is an encyclopedia.		
	An epic poem is an encyclopedia.	0.095	4.06
Literal Primes	Wikipedia is an encyclopedia.		
	Some book sets are encyclopedias.		
Target	Alcohol is a crutch.	0.740	

Matched-Sense	A mortgage is a crutch.		
	Drug use is a crutch.	1.261	5.67
Alternative-Sense	The Parthenon's columns are crutches.		
	A wide bookshelf is a crutch.	-1.492	2.21
Literal Primes	A cane is a crutch.		
	A wooden brace is a crutch.		
Target	Faith is an anchor.	0.723	
Matched-Sense	A friend is an anchor.		
	My goal is an anchor.	1.029	6.44
Alternative-Sense	A broken leg is an anchor.		
	My debt is an anchor.	-0.726	2.28
Literal Primes	A ship's brake is an anchor.		
	Some iron weights are anchors.		
Target	A senator is a fossil.	0.585	
Matched-Sense	The bottle of wine is a fossil.		
	A classic movie is a fossil.	0.457	4.11
Alternative-Sense	Those crackers are fossils.		
	The beef jerky is a fossil.	-0.562	4.42
Literal Primes	Dinosaur bones are fossils.		
	Petrified wood is a fossil.		
Target	Ideas can be diamonds.	0.528	
Matched-Sense	Paintings can be diamonds.		
	Some jokes are diamonds.	0.607	5.72
Alternative-Sense	Steel beams are diamonds.		
	My cast is a diamond.	-0.980	2.79
Literal Primes	Some necklaces are diamond.		
	An expensive jewel is a diamond.		

Target	His marriage was a leash.	0.433	
Matched-Sense	Her daily chores were a leash.		
	A nine-to-five weekday job is a leash.	0.665	6.11
Alternative-Sense	A pony-tail is a leash.		
	That kid's headphone wire is a leash.	-0.999	2.57
Literal Primes	A dog guide is a leash.		
	Some ropes are leashes.		
Target	Jalepeno Peppers are fire.	0.424	
Matched-Sense	Taco sauce is fire.		
	Raw onions are fire.	0.386	6.79
Alternative-Sense	Fresh pizza is fire.		
	The sun today is fire.	0.531	4.00
Literal Primes	The flickering light is fire.		
	A cooking element is fire.		
Target	His college class is a zoo	0.399	
Matched-Sense	Sometimes Times Square is a zoo.		
	My child's day care center is a zoo.	0.145	6.64
Alternative-Sense	The used car lot was a zoo.		
	The professor's bookshelf was a zoo.	1.571	5.06
Literal Primes	His animal collection is a zoo.		
	Some lions live in a zoo.		
Target	Some marriages are storms.	0.388	
Matched-Sense	The presidential debate was a storm.		
	Some business partnerships are storms.	0.431	5.39
Alternative-Sense	Some runningbacks are storms.		
	Her mind is a storm.	0.028	3.43

Literal Primes	A tornado is a storm.		
	A downpour is a storm.		
Target	Her ex-husband is a gem.	0.355	
Matched-Sense	A great job is a gem.		
	His little daughter is a gem.	0.374	4.36
Alternative-Sense	The lake's surface is a gem.		
	The office building's facade is a gem.	0.431	3.28
Literal Primes	A ruby is a gem.		
	An emerald is a gem.		
Target	My Grandfather's legs are steel	0.154	
Matched-Sense	A bouncer's arms are steel.		
	That football player's neck is steel.	1.376	4.89
Alternative-Sense	The meditating monk was steel.		
	His face was steel.	-0.049	4.57
Literal Primes	Some tableware is steel.		
	An industrial material is steel.		
Target	An insult is a razor.	0.150	
Matched-Sense	A betrayal is a razor.		
	Needless criticism is a razor.	-0.057	6.35
Alternative-Sense	A genius' mind is a razor.		
	Her memory is a razor.	0.990	3.17
Literal Primes	A scalpel is a razor.		
	Gillette shavers are razors .		
Target	A lie is a dagger.	0.113	
Matched-Sense	Losing a loved one is a dagger.		
	Some breakups are daggers.	0.024	5.78

Alternative-Sense	The silent shot was a dagger.		
	The quick jab was a dagger.	0.969	4.22
Literal Primes	A short knife is a dagger.		
	Some weapons are daggers.		
Target	My rat's fur is silk.	0.089	
Matched-Sense	A pig's fur is silk.		
	The snake's skin is silk.	0.023	5.83
Alternative-Sense	A baby's bottom is silk.		
	My father's bald head is silk.	-0.084	5.43
Literal Primes	A chinese fabric is silk.		
	A product of worms is silk.		
Target	Education is a lantern.	-0.008	
Matched-Sense	A how-to book is a lantern.		
	My mentor is a lantern.	-0.986	5.86
Alternative-Sense	An excited dog's tail is a lantern.		
	A swing is a lantern.	-1.062	2.00
Literal Primes	That light is a lantern.		
	Some oil-lamps are lanterns.		
Target	My boyfriend is a peach.	-0.050	
Matched-Sense	Some grandmothers are peaches.		
	The baby is a peach.	-0.731	6.07
Alternative-Sense	Some dog fur is a peach.		
	My blanket is a peach.	-0.598	1.94
Literal Primes	A sweet fruit is a peach.		
	A candy flavor is peach.		
Target	Her personality is a mirror.	-0.133	

Matched-Sense	Some artists are mirrors.		
	Introspection is a mirror.	-0.188	4.29
Alternative-Sense	Some twins are mirrors.		
	The 2008 and 2009 models are mirrors.	0.469	3.11
Literal Primes	A dark window is a mirror.		
	Some beauty tools are mirrors.		
Target	A beaver is a lumberjack.	-0.150	
Matched-Sense	A chainsaw is a lumberjack.		
	Those termites are lumberjacks.	-0.855	6.29
Alternative-Sense	A gladiator is a lumberjack.		
	Some wrestlers are lumberjacks.	-0.321	2.22
Literal Primes	Paul Bunyan was a lumberjack.		
	A logger is a lumberjack.		
Target	Some snores are sirens.	-0.204	
Matched-Sense	Some whistles are sirens.		
	This applause is a siren.	0.250	4.67
Alternative-Sense	The news release was a siren.		
	An advertisement is a siren.	-0.967	3.71
Literal Primes	That horn is a siren.		
	Some alarms are sirens.		
Target	A zoo is a museum.	-0.238	
Matched-Sense	A library is a museum.		
	His photograph collection is a museum.	0.598	5.36
Alternative-Sense	My grandmother’s jewel box is a museum.		
	A nursing home is a museum.	0.586	3.72
Literal Primes	The Smithsonian is a museum.		
	A sculpture garden is a museum		

Target	That advertisement was a sermon.	-0.273	
Matched-Sense	Conversation with my father is a sermon.		
	Public health announcements are sermons.	0.027	5.79
Alternative-Sense	Textbook reading is a sermon.		
	Attendance roll calls are sermons.	-0.495	3.89
Literal Primes	A preacher's speech is a sermon.		
	Some moralizing discussions are sermons.		
Target	An intelligent student is a warehouse.	-0.472	
Matched-Sense	A hard drive is a warehouse.		
	My car trunk is a warehouse.	0.378	4.11
Alternative-Sense	The library's exterior was a warehouse.		
	The apartment complex was a warehouse.	-0.430	2.57
Literal Primes	A storage facility is a warehouse.		
	Home Depot is a warehouse		
Target	Hostility is a veil.	-0.500	
Matched-Sense	A curtain is a veil.		
	The clouds are a veil.	0.426	4.07
Alternative-Sense	A tissue is a veil.		
	Thin socks are a veil.	-0.341	2.56
Literal Primes	That white cloth is a veil.		
	Some masks are veils.		
Target	The moon is a pie.	-0.510	
Matched-Sense	Some faces are pies.		
	My cat's belly is a pie.	-0.961	3.67
Alternative-Sense	Some temperaments are pies.		
	A smile is a pie.	-1.673	2.71

Literal Primes	All tarts are pies.		
	Some desserts are pies.		
Target	A cocaine habit is a bomb.	-0.611	
Matched-Sense	Highway speeding is a bomb.		
	Running with scissors is a bomb.	-1.198	5.36
Alternative-Sense	The spiteful political ad was a bomb.		
	The critique of my paper was a bomb.	0.782	3.72
Literal Primes	A grenade is a bomb.		
	Land mines are bombs.		
Target	Sadness is a volcano.	-0.851	
Matched-Sense	Anger is a volcano.		
	Political unrest is a volcano.	1.437	3.89
Alternative-Sense	A chimney is a volcano.		
	Steam engines are volcanoes.	-0.687	2.21
Literal Primes	A hole in the earth's crust is a volcano.		
	Mt. Vesuvius is a volcano		
Target	My family is a raft	-0.916	
Matched-Sense	Sometimes work is a raft.		
	An enduring tradition is raft.	-0.661	4.44
Alternative-Sense	That old house is a raft.		
	Some future plans are rafts.	-1.252	2.86
Literal Primes	That boat is a raft.		
	A canoe is a raft.		
Target	Grandparents can be donkeys.	-1.019	
Matched-Sense	That bureaucrat is a donkey.		
	Some politicians are donkeys.	0.713	3.72

Alternative-Sense	Some taxi drivers are donkeys.		
	The D student was a donkey.	-0.778	4.50
Literal Primes	Eeyore is a donkey.		
	A farm animal is a donkey		
Target	The good news was an earthquake.	-1.072	
Matched-Sense	The opposition's election was an earthquake.		
	The underdog victory is an earthquake.	-1.195	4.57
Alternative-Sense	The stock market crash was an earthquake.		
	My brother's death was an earthquake.	0.845	4.00
Literal Primes	Those vibrations are an earthquake.		
	A natural disaster is an earthquake.		
Target	Some hairlines are clocks.	-1.099	
Matched-Sense	The general's scars are a clock.		
	A tree's rings are a clock.	-1.048	4.50
Alternative-Sense	Your episodes are a clock.		
	The ocean's waves are a clock.	-0.464	2.67
Literal Primes	Some pendants are clocks.		
	A wristwatch is a clock.		

a Z-score of "not unusual" and "familiar" metaphoric sense ratings

b Mean rating of similarity with the target vehicle's metaphoric sense (1-7 scale)

Appendix B. Filler sentences, practice sentences, and their intended responses

Filler sentence	Intended response
A salesman is a worm	Y
A lake is a worm	N
The skirt is a squirrel	N
The animal is a squirrel	Y
A television is a radio	N
A pair of jeans is clothing	Y
Searching for happiness is a cardgame	Y
Elementary school is a garden	Y
A museum is a garden	Y
Electricity is a garden	N
The ant hill is a garden	N
A shark is a wart	N
That rug is a wart	N
That bump is a wart	Y
Some tumors are warts	Y
Some sons are tigers	Y
The beast is a tiger	Y
A couch is a tiger	N
Knowledge is a fortress	Y
Masonry is a fortress	N
Fresh drinking water is a fortress	N
Euclidean geometry is a tart	N
The philosopher's stone is a tart	N
The rhubarb pastry is a tart	Y
The congressman is a rat	Y
A critter is a rat	Y
Gas is a computer	N

Mixing Metaphors in the Hemispheres

Some machines are computers	Y
The supermarket clerk was a slug	Y
Some pears are slugs	N
All my days are clouds	Y
Birth is a kraken	N
The shack on the corner is a home	Y
My linguistics midterm was a stroll	Y
Life's vicissitudes are a stroll	Y
Bottled water is a stroll	N
A good mug is a stroll	N
A simple education is a cart	N
True love is a cart	N
Some child's toys are carts	Y
My favorite vehicle is a cart	Y
Some merchants are wolves	Y
A stone is a wolf	N
Some canines are wolves	Y
Her ideas are gold	Y
The puffy billow is gold	N
Dulled vision is gold	N
A Portobello is a mushroom	Y
Some minidiscs are mushrooms	N
A printout is a mushroom	N
That amateur dancer is a cow	Y
That spotted beast is a cow	Y
That mango is a leech	N
My in-laws are leeches	Y
Risk is a game	Y
A Pepper is a game	N
A younger sibling is a stain	Y

Murder is a spice	N
A Maglite is a flashlight	Y
The job market is a forest	Y
The American legal system is a forest	Y
Tyrannosaurus Rex is a forest	N
The gentleman's chivalry is a forest	N
My coffee is a zombie	N
Stereo speakers are zombies	N
Some braineaters are zombies	Y
The undead lowlife are zombies	Y
His grin is plastic	Y
Some pools are plastic	Y
Java beans are plastic	N
Their words were firearms	Y
Alzheimer's disease is a firearm	N
Most janitors are firearms	N
The science fair is a grill	N
Hard work is a grill	N
An open burner is a grill	Y
That politician is a skunk	Y
That odor is a skunk	Y
A promise is a web	Y
Courage is a web	N
This biscuit is a doctor	N
A pediatrician is a doctor	Y
My drug dealer is a shark	Y
Some sculptures are paintings	N
A trashcan is a container	Y

Mixing Metaphors in the Hemispheres

Practice sentence	Intended response
My Latin teacher is a corpse	Y
That old dog is a corpse	Y
Strong dictators are corpses	N
A desktop is a corpse	N
Transparency is a laptop	N
Warm soup is a laptop	N
A common student possession is a laptop	Y
Portable computers are laptops	Y
Some ideologies are prisons	Y
An ostrich is a prison	N
Some edifices are prisons	Y
All my friends are vampires	Y
A California wine is a vampire	N
Beethoven's 3rd symphony is a vampire	N
National security is a turtle	N
Some happiness is a turtle	N
A cute pet is a turtle	Y
My office is a playground	Y
A space for children is a playground	Y
A baby is a sponge	Y
A lightswitch is a sponge	N
Driving home is a drug	N
Heroin is a drug	Y
The invaders' arrival was a flood	Y
A zipper is a button	N
Patience is a virtue	Y
Some bladders are barrels	Y
Some stomachs are barrels	Y
My pickup truck is a barrel	Y

Mixing Metaphors in the Hemispheres

Some dogs are princesses	Y
A king's daughter is a princess	Y
Some fairy tale heroines are princesses	Y
A basket weaver is a spider	Y
A hunter is a spider	Y
A poacher is a spider	Y
Life is an open_book	Y