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Productive figurative communication: Conventional metaphors facilitate the comprehension of related novel metaphors

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Abstract

Three experiments explored whether conceptual mappings in conventional metaphors are productive, by testing whether the comprehension of novel metaphors was facilitated by first reading conceptually related conventional metaphors. The first experiment, a replication and extension of Keysar et al. [Keysar, B., Shen, Y., Glucksberg, S., Horton, W. (2000). Conventional language: How metaphorical is it? *Journal of Memory and Language* 43, 576–593] (Experiment 2), found no such facilitation; however, in the second experiment, upon re-designing and improving the stimulus materials, facilitation was demonstrated. In a final experiment, this facilitation was shown to be specific to the conceptual mappings involved. The authors argue that metaphor productivity provides a communicative advantage and that this may be sufficient to explain the clustering of metaphors into families noted by Lakoff and Johnson [Lakoff & Johnson, M. (1980a). The metaphorical structure of the human conceptual system. *Cognitive Science* 4, 195–208].

Keywords: Metaphor; Comprehension; Idioms; Structure-mapping; Conventional metaphors

Lakoff and Johnson (1980a, 1980b; Lakoff, 1987) suggest that metaphors underlie our conceptual life to a degree that is underappreciated by most people. They argue that abstract concepts such as *love* and *argument* are incomprehensible unless related to a directly perceivable referent (e.g., *love is madness* and *argument is war*). Accordingly, the properties of the referent map onto the properties of the original abstract concept and significantly influence how people think about the concept: describing someone as "steaming" has metaphorical entailments that substantial heat induction (frustration or irritation) has been applied and that there is risk of an explosion (emotional outburst). On this view, the *base* of the metaphor (heat/pressure in this case) is an active part of our understanding of anger when we are using metaphoric language. Lakoff and Johnson cite the abundance of "families" of metaphoric ideas in the English language as evidence of their conceptual utility. For example, Lakoff and Kovecses (1987; Lakoff, 1987; Kovecses, 1986), list over 30 conventional instantiations of the ANGER IS A HEATED FLUID IN A CONTAINER metaphor in American English. Similar metaphor clusters have been documented in other languages, including Chinese (Yu, 2004) and Italian (Deignan & Potter, 2004).

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In contrast, critics of Lakoff and Johnson see no need for such complex mapping. When someone is said to be *steamed*, is it really necessary to activate irrelevant information about water vapor? (Gernsbacher, Keysar, Robertson, & Werner, 2001). Instead, would it not be simpler to have a lexicalized entry for *steamed* as *angry*, since the term is used so frequently? In that case, there would be no need to invoke the source content. In fact, a recent empirical paper supports this view—by demonstrating that conventional metaphors do not activate their original conceptual content, whereas novel metaphors do (Keysar, Shen, Glucksberg, & Horton, 2000). As we explain below, however, the question remains open for debate. We will describe a set of experiments that allow us to reinterpret the results presented in Keysar et al.

In this paper, we demonstrate that even conventional metaphors can facilitate processing of novel metaphoric content as long as both the conventional and novel metaphors refer to the same conceptual vehicle (see also, Allbritton, McKoon, & Gerrig, 1995). Although we do not intend to argue in favor of Lakoff and Johnson's strong claims about the role of metaphor in conceptual comprehension (see also Gibbs, 1996), which are deservedly in dispute (Murphy, 1996, 1997), our data do go a long way toward demonstrating that the original conceptual content of conventional metaphors is not dead and that there may be a psychological reality to the idea of metaphor families.

As an alternative to Lakoff and Johnson's explanation for the emergence of metaphor families, we propose that they develop not as a result of conceptual need, but because they confer a communicative advantage. That is, one's conceptual understanding of anger does not depend on a prior understanding of heat and pressure; instead, describing anger through heat and pressure allows the speaker to rely on a preexisting reference scheme or conceptual mapping familiar to both the speaker and listener. As a result, the speaker can convey a large amount of information with minimal effort (see Relevance Theory, Wilson & Sperber, 2004). The formation of metaphor clusters could be evidence of the continued utility of activating established schemes and extending them. Support for this view would be found if conventional metaphor mappings could be shown to be productive—to facilitate the processing of related novel metaphors.

Experiments conducted by Nayak and Gibbs (1990) can be evaluated as predecessors to the current productivity question. They found that people were quite sensitive to whether a series of conventional metaphors within a passage were related conceptually. That is, given a lead-up scenario containing a few related metaphors and then a target sentence, people preferred that the target sentence use consistent metaphoric imagery rather than inconsistent imagery, even if the intended meaning of the target sentence did not change. If a passage began by talking about anger in terms of heat and pressure, a conclusion about anger in terms of a wild animal seemed relatively inappropriate.

However, subsequent experiments by Glucksberg, Brown, and McGlone (1993) found no differences in processing time for stimuli like those studied by Nayak and Gibbs (1990). Glucksberg et al. (1993) measured reading times for the target sentences (e.g., *blew her top*) and found that conventional metaphor phrases were read equally fast when preceded by metaphor phrases from the same family (e.g., ANGER IS HEAT) as they were when preceded by metaphor phrases from a different family (e.g., ANGER IS A WILD BEAST). They concluded that the processing of conventional metaphors failed to activate their source domain—implying that conventional metaphor mappings were not productive. However, it appears likely that the reading time data from their experiment was subject to floor effects and therefore insensitive to any conceptual facilitation; others have shown that conventional metaphors are read with speed equivalent to literal speech (e.g., Blank, 1988).

Keysar et al. (2000) realized that a stronger test of whether conventional metaphors activate metaphoric conceptual content would utilize novel metaphors in the target sentence. Evidence that conventional metaphors facilitate the processing of related novel metaphors would provide support for the productivity hypothesis. As noted above, Keysar et al.'s findings suggested instead that conventional expressions identified by Lakoff and Johnson are not, in fact, productive in this sense. Specifically, Keysar et al. found that when a novel metaphor was read in the context of related conventional metaphors it was processed no more quickly than when read in the context of non-metaphoric language. Conversely, reading times for the novel target read in the context of related novel metaphors, were reduced. Keysar et al. argued that conventional metaphors are dead and that only novel metaphors activate broader conceptual content.

However, two properties of the stimuli used in the Keysar et al. (2000) experiments (provided to us by Drs. Keysar and Horton) lead to important questions regarding the results. First the conventional metaphor stimuli often were not conceptually parallel with the novel metaphor stimuli to which they were experimentally compared, sometimes leading to the impression of non sequitur in the conventional case. Second, many of the conventional metaphor phrases were inconsistent with the Lakoff and Johnson sources from which they were derived and were not truly conventional metaphors. We describe in further detail these particular concerns in Appendix A.

To eliminate the effect of these issues and address the theoretical question asked by Keysar et al., 2000, we

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developed a new stimulus set, following their techniques, but also meeting a set of additional criteria, which we list here. These criteria are not intended as a recipe for generating a stimulus set, but rather a set of tests we used to ensure our stimulus set was effective for answering the theoretical question. First, we used conventional metaphors from Lakoff and Johnson. Though often edited to suit the context, all of the conventional metaphor phrases could be accurately attributed to their text. Although other methods could have been chosen to operationalize "conventional metaphor" (e.g., see Bowdle & Gentner, 2005; see also Jones & Estes, 2006), we chose for this experiment to implement the operationalization used by Keysar et al. (2000).

Second, we ensured that the conventional metaphors were conceptually consistent and were truly stock phrases. Given that the list of conventional phrases was 25 years old, we often used internet search engines, such as Google, to check the frequency of Lakoff and Johnson's identified metaphor phrases. Using Google enabled us to easily, albeit informally, check the relative frequency of particular phrasings. For example, when we searched for the phrases ("argument was shaky", "argument is shaky", or "shaky argument") we found 784 results. When searching for the same phrases with "wobbly" in place of "shaky" we found only 131 hits. To more formally evaluate the conventionality of the metaphors in the population being used in our experiment, we also asked people to rate the conventionality of the various scenarios, as we report below.

Third, we sought to create conventional-metaphor and novel-metaphor scenarios that were conceptually parallel and for which the target sentences did not appear to be non sequitur following the scenarios. To ensure that the stimuli actually were conceptually parallel, after creating the stimuli, we surveyed participants: some were asked to rate the fit of the target sentence with individual scenarios; others were asked to compare two scenarios and rate the conceptual parallelism of their meaning. Note that for the purposes of this paper, we used "fit" not as a theoretical construct concerning metaphors, but a methodological construct concerning sentence-reading studies. We wished to ensure that differences in reading time reflected metaphor comprehension time rather than violations of discourse norms. In addition to these criteria, we decided that only one set of context scenarios would be developed for any given target concept or conceptual metaphor domain. For example, because we included the metaphor family, A RELATIONSHIP IS A JOURNEY, in our stimulus set, we retained AN ARGUMENT IS A WAR rather than AN ARGUMENT IS A JOURNEY. We did include LOVE IS MADNESS in addition to A RELATIONSHIP IS A JOURNEY (Lakoff, 1986), because they seemed sufficiently distinct. We also retained A THEORY (or ARGUMENT) IS A BUILDING, because a theoretical argument, built by one person, is easy to distinguish from a verbal conflict between two. We also eliminated the initial explicit statement of the metaphor used by Keysar et al. in their novel scenarios. Thus, we sought in all ways to make our stimuli conceptually parallel and thus suited for comparing the effects of novel and conventional metaphors with non-metaphoric text.

Finally, we tried to avoid promoting reading strategies that would cause people to skim over metaphors. The questions following our filler scenarios predominantly asked about facts (6 out of 10), but four of the questions asked about metaphors (2 novel and 2 conventional). These questions ensured that participants were not simply memorizing facts from the scenarios. For example, in a filler scenario that described Jessica as a lifesaver for picking up a friend who had a flat tire, the follow-up question read, "Was Jessica compared to a lifeguard?" In another that compared dealing with a bureaucratic institution to quicksand, we asked if there was sand in the building. As a manipulation check, after completing the experiment participants were asked if they had read for comprehension or had focused on facts. Survey responses confirmed that when we asked about both metaphors and facts (Experiment 2), participants were more careful readers than when asked about facts only (Experiment 1, replicating Keysar et al.).

We will first present our replication of the crucial experiment from Keysar et al. (2000, Experiment 2). We will then present our own version of the experiment, which suggests that conventional metaphors can indeed facilitate the comprehension of related novel metaphors. After providing evidence that conventional metaphors do aid in the comprehension of novel metaphors, we will present a third experiment that considers the conclusions of Glucksberg et al. (1993). Using triads of scenarios representing two different metaphor families as well as a non-metaphoric control scenario, we will show in Experiment 3 that facilitation in the processing of novel metaphors depends on reading conceptually-related conventional metaphors.

Experiment 1: Replication using the materials of Keysar et al. (2000)

In order to ensure that we understood the methods used in the experiments cited in Keysar et al. (2000), we first set out to replicate Keysar et al.'s Experiment 2 as originally conducted. The only change we made to the experiment was that, following the main experiment, participants were asked to rate a selection of scenarios from the experiment both for "conventionality" and for "fit" with the target sentences (see Appendix B). This was done to quantify our impression that the target sentences often did not fit with the conventional metaphor

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scenarios nearly as well as they fit with the novel metaphors. As noted above, we regard "fit" not as a theoretical construct concerning metaphors, but a methodological construct concerning sentence-reading studies—essentially "how well does the target sentence follow from the lead-up scenario?".

We also added a questionnaire to collect participants' overall reaction to the experiment. We expected to replicate the results from Keysar et al. (2000) and to find that when using the stimuli set provided by Drs. Keysar and Horton, conventional metaphors would not facilitate the comprehension of related novel metaphors. However, we did expect to measure large differences in "fit" between the novel and conventional metaphor scenarios.

Methods

Participants

Thirty-six Swarthmore College undergraduates who were native speakers of American English contributed data for this experiment either for pay or academic credit as a component of their Introductory Psychology class.

Replication materials

All of our experimental materials, except the questionnaires, were provided to us by Drs. Keysar and Horton. We implemented the experiment using DirectRT software, and using a DirectIN keyboard to maintain accurate response timing. Each participant read a total of sixteen conceptual mapping scenarios in one of four conditions as well as fifteen filler scenarios.

Just as in the Keysar et al. (2000) study, participants read each scenario on a computer screen (ours was a 16″ flat-screen cathode ray tube monitor). The scenarios were broken into units that fit onto a single line in the middle of the screen. Whenever possible, each unit contained a full sentence; otherwise, the sentence was broken in a logical place and split into two lines. The participants were instructed to press the "0" button on the number-pad of the keyboard as soon as they finished a line. The following line then replaced the current one and the software stored the reading times. The target sentence was not singled out in any way and represented the final line of each scenario. Before each scenario began, a "Prepare for next scenario" message was shown on the screen for 5000 ms; after each scenario ended, an "end of scenario" message was shown on the screen. Five of the filler items appeared at the beginning of the experiment as practice items, two of which included questions.

Design

The design of the experiment we replicated was within-subjects, with four conditions. For three of the conditions, the target sentence involved a novel metaphor and the scenario used (1) *novel* metaphors, (2) *conventional* metaphors, or (3) *non-metaphorical* language. In the fourth condition, a (non-metaphoric) scenario had been constructed that prepared for a (4) *literal* reading of the target sentence (see Table 1 for examples). Each participant read four of the experimental scenarios from each of the four conditions. To this end, four different groups of the scenario-condition pairings were created, with a quarter of the participants assigned to each group. The order of presentation was randomized for each participant.

Procedure

Written and verbal instructions were presented that emphasized both speed of reading and accuracy of answering questions. The written instructions for the experiment were: "You will be reading a series of brief stories. They will be presented on the screen, line by line. Press the '0' key as soon as you comprehend each line. After some of the stories there will be a yes/no question asked about it. Answer 'Y' for yes and 'N' for no. Work quickly for all trials, but make sure to be accurate for the yes/no questions. Thanks. Press any key to begin." The experimenter remained with the participant for the first two practice trials and then left the room. When the participant had completed the main experiment, paper surveys and questionnaires were administered.

Before rating the conventionality and fit of scenarios, participants were given a chance to identify scenarios that were particularly memorable and to make other comments about the experiment. This survey included a manipulation check to assess the effect of the questions: We asked "Did you focus on remembering facts for the questions or did you just read and try to comprehend the stories?"[1] Afterwards participants were asked to make "conventionality" and then "fit" judgments on eighteen scenarios (which included two practice) in three conditions—novel, conventional, and non-metaphorical. For the conventionality judgments, the target sentence was not shown. Instructions and practice materials for the questionnaires are shown in Appendix B.

Results and discussion

In the analysis of the main experiment, extreme reading times were trimmed so that response times below 50 ms (button-press errors) were removed, as were response times above 6000 (roughly 4 *SD*s longer than the mean reading time). This caused 11 response times to be taken out, which represented 1.9% of the data.

[1] The manipulation-check question, though somewhat leading, was based on volunteered remarks from pilot subjects. The same question was used for both Experiment 1 and Experiment 2.

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Table 1
Example stimuli from Keysar et al. (2000)

Stimulus type	Text
A. Metaphor family: LIFE IS A GAMBLING GAME	
Target sentence	This place is a casino
Novel metaphors	Life is a gambling game. Though the doctors told her that the house always won, Joan decided to save up her aces and have the operation. As she walked into the hospital she thought: [target sentence]
Conventional metaphors	Life is risky. Though the doctors told her that her chances were slim, Joan decided to stand pat and have the operation. As she walked into the hospital she thought: [target sentence]
Non-metaphorical	Life is risky. Though the doctors told her that she probably wouldn't survive, Joan decided to go ahead and have the operation. As she walked into the hospital she thought: [target sentence]
Literal scenario	Life is a gambling game. That's why people like to take risks. When the local laws were changed to permit gambling, the local hotel installed slot machines, poker tables, and roulette. When we walked into the hotel lobby, we thought: [target sentence]
B. Metaphor family: IDEAS ARE PEOPLE	
Target sentence	Tina is currently weaning her latest child
Novel metaphors	As a scientist, Tina thinks of her theories as her children. She is a fertile researcher, giving birth to an enormous number of new findings each year. [target sentence]
Conventional metaphors	As a scientist, Tina thinks of her theories as her contribution. She is a prolific researcher, conceiving an enormous number of new findings each year. [target sentence]
Non-metaphorical	As a scientist, Tina thinks of her theories as her contribution. She is a dedicated researcher, initiating an enormous number of new findings each year. [target sentence]
Literal scenario	As a scientist, Tina thinks of her theories as children. She makes certain that she nurtures them all. But she does not neglect her real children. She monitors their development carefully. [target sentence]

Mean reading times were computed by scenario type for each participant.

Our reading time results revealed essentially the same pattern as those of Keysar et al. (2000), as shown in Fig. 1. There was a significant main effect of scenario type, $F(3,105) = 9.14$, $p < .01$.[2] Planned comparisons ($\alpha = 0.05$) indicated that reading times for the target sentence following non-metaphoric and conventional-metaphor scenarios were each reliably longer than reading times following novel-metaphor scenarios and scenarios that allowed for a literal reading of the target sentence. Reading times were no longer following novel metaphor scenarios than following those that prepared the reader for a literal interpretation of the target sentence. That is, novel metaphors were as facilitative as literal reading. Additionally, although Fig. 1 appears to suggest otherwise, reading times were not reliably faster in the presence of conventional metaphors than they were when no metaphors were used until the target sentence, $t(35) = 1.43$, $p > .10$. This replicates the findings of Keysar et al. insofar as there was no evidence of a comprehension delay for the metaphorical target sentence when it was preceded by novel metaphors, but there was evidence of delayed comprehension when the target was preceded by conventional metaphors.

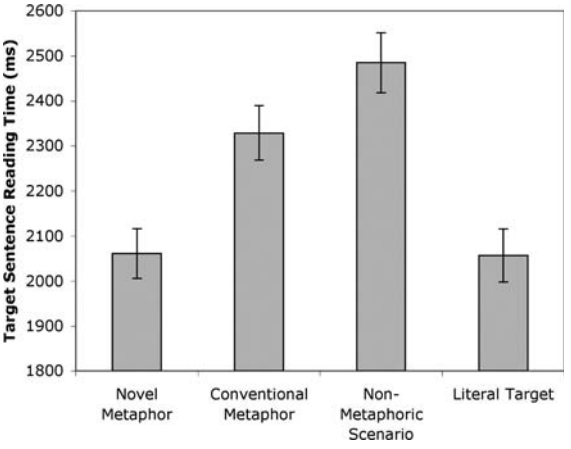

Fig. 1. Average reading times for target sentences by scenario condition in Experiment 1. "Literal" refers to the targets following a scenario that led to a literal reading of the target sentence and is used as a baseline. Standard errors, computed with respect to within-subject differences, are shown.

In Keysar et al. (2000), this pattern of results was explained as novel metaphors activating conceptual structures that facilitated understanding of the novel metaphor in the target sentence and conventional metaphors

[2] Note that F2 is not reported because items were not sampled randomly from some population that we wish to generalize to (Raaijmakers, Schrijnemakers, & Gremmen, 1999).

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failing to activate those structures. Further, using questionnaire data, it was demonstrated that neither "specificity" nor "explicitness" was confounded with the conventionality of their metaphors. However, there was no measure of "fit" in the Keysar et al. (2000) experiments.

Average judgments of "non-conventionality" and of "fit" for the stimulus materials used in the Keysar et al. (2000) experiments are shown in Fig. 2. Evident from these data, the novel metaphor scenarios are not only judged as more unconventional (4.64 vs. 2.70 and 2.18), as is appropriate, they are also judged to fit much better with the target sentences (5.04 vs. 3.40 and 2.86). Planned pair-wise comparisons showed that all three conditions significantly differed from one another ($\alpha = .01$), both for "fit" and for "conventionality". More importantly, in both cases the novel metaphor scenarios differed from the conventional metaphor scenarios by a reliably greater amount than the conventional metaphor scenarios differed from the non-metaphoric scenarios. Thus, degree of conventionality is confounded with the "fit" between the scenarios and their targets.

To test for effects of scenario condition independent of "fit", we used the mean fit scores for each item in each condition (expressed as deviations from the average fit score) as a covariate in a mixed models analysis of target sentence reading times by item and subject, computing confidence intervals using a Markov Chain Monte Carlo procedure. With fit thus accounted for, reading times following novel-metaphor scenarios no longer differed reliably from conventional metaphor scenarios ($p > .40$).

Is it possible that "fit" is just another way of assessing the inefficacy of conventional metaphors? That is, will it turn out that any manipulation of conventionality will in fact affect judgments of fit to this extent because novel metaphors simply activate the right conceptual structures, while conventional ones do not? We do not think this is the case. Although our questionnaire concerning fit did not distinguish between conceptual fit and stylistic fit, we think the very large difference in rated fit is an indication of differences in the stimuli that are not due to stylistic differences alone (e.g., to metaphoricity or to novelty), but probably to conceptual fit and non sequitur. As we have suggested in the introduction, there are many examples of "conventional" metaphors from the stimulus set developed by Keysar et al. (2000) that were not conceptually parallel to the novel metaphors used, or that made the target sentences seem like non sequiturs. Indeed, we believe that conventional metaphors did not facilitate the comprehension of the target sentences because the specific metaphor phrases in the conventional condition did not lead into the target sentences as well as the novel metaphors did. Clearly, if differences in conceptual fit can be reduced by maintaining conceptual parallelism among variants of the scenarios, it should be possible to determine whether it was actually the conventionality of the metaphors that produced the longer reading time of the target following conventional-metaphor scenarios. It is with this goal in mind that we developed the materials for Experiment 2.

Experiment 2: New materials

As described in the introduction, we sought to develop a set of stimuli that satisfied a number of specific criteria. Principally, our goal was to develop stimuli that used conventional or novel metaphors that were consistent conceptually. We expected that this would reduce the differences in "fit" between novel metaphor

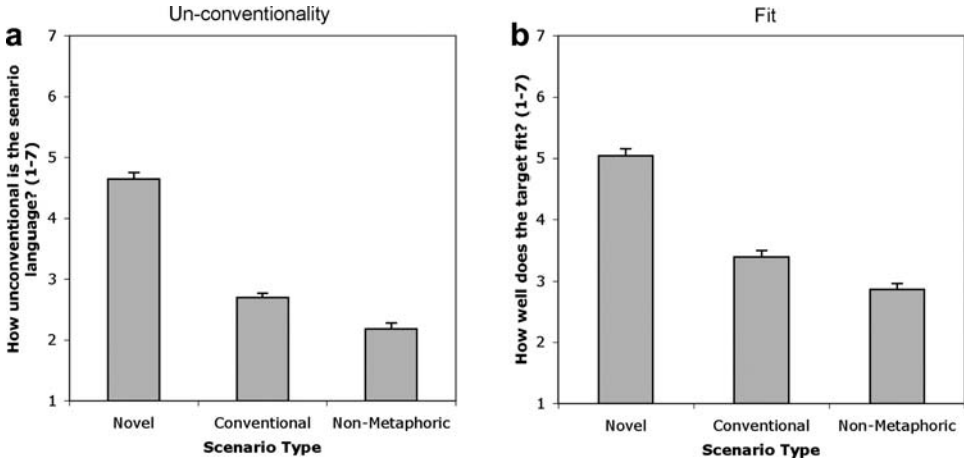

Fig. 2. Average ratings in Experiment 1 (on a 7-point Likert scale) for "non-conventionality" (a) and for "fit" (b) are shown for the three scenario types that preceded metaphorical readings of the target sentence. Standard errors, computed with respect to within-subject differences, are shown.

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scenarios and the others, reducing the likelihood of confounding "conventionality" and "fit".

By reducing this confound, we believed that we could find evidence that conventional metaphors activate an underlying conceptual structure and facilitate the comprehension of related novel metaphors. Such evidence, would counter the strong conclusion argued in Keysar et al. (2000): that conventional metaphors are dead insofar as they do not activate their metaphoric conceptual structure. The methods adopted for our experiment were very similar to those of Experiment 1, except that the stimulus materials were modified to conform to the criteria laid out in the introduction. The complete stimulus set is presented in Appendix C.

Methods

Participants

Sixty-seven Swarthmore College undergraduate students who were native speakers of American English participated in the study for money or credit in their introductory psychology class. None of the sixty-seven participants was a participant in the first experiment. Three participants answered incorrectly to three or more questions, so their data was not included in the analysis. One additional participant read all materials too slowly to be included (more than 4 standard deviations from the mean).

Materials

We created new stimuli according to the conditions listed above for twelve conceptual mappings. We also re-developed many of the fifteen filler items, of which ten included a follow-up question. Five of the fillers contained novel metaphors; five of the fillers contained conventional metaphors; and five of the fillers were non-metaphoric. All of these materials are shown in Appendix C.

Procedure and design

The procedure and design were identical to our Experiment 1, except that the number of stimuli was reduced because we only had 12 experimental scenarios rather than 16 (as a result of eliminating duplicate conceptual targets and domains). Participants therefore were exposed to three scenarios of each type, which, with the fillers, constituted 27 scenarios in all. As in Experiment 1, there were four different groups of scenarios used—with each scenario assigned to a different condition for each of the four groups. The order of presentation was randomized for each person (except that five fillers served as initial practice trials). The format and instructions were the same as in Experiment 1.

The questionnaires were also developed in a similar manner. Literal-target scenarios were not included; so only three groups of questionnaires were developed. These three were divided fairly evenly across participants in each of the four different groups of the main experiment.

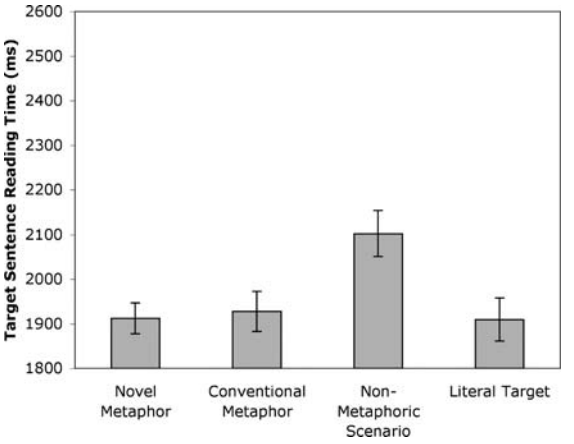

Fig. 3. Average reading times for target sentences by scenario condition in Experiment 2. "Literal" refers to the times following a scenario that leads to a literal reading of the target sentence and is used as a baseline. Standard errors, computed with respect to within-subject differences, are shown.

Results and discussion

The results were analyzed as in Experiment 1. The mean reading times for the target sentences are shown in Fig. 3. There was a reliable effect of condition, $F(3,186) = 3.16$, $p < .05$. As is evident from the figure, there were no reliable differences in this experiment between scenarios constructed from novel metaphors (1912 ms) and those constructed from conventional ones (1928 ms). Nor did either of these reading times differ from the reading time for the same target sentences when the lead-up scenario induced a literal reading (1910 ms). In contrast, planned comparisons ($\alpha = .05$)[3] showed that the metaphoric reading of the target sentences was reliably longer than each of the other conditions when the scenarios were parallel in meaning with the metaphoric scenarios, but lacked metaphorical conceptual content (2102 ms).

The present results provide evidence that conventional metaphors do, in fact, aid the understanding of target novel metaphors by activating metaphorical content: Reading times for target sentences containing novel metaphors were faster following the reading of conceptually-related conventional metaphors than they were

[3] Although we did not correct for multiple tests, there is actually only one test that is important to our thesis: Target sentences were processed faster following conventional metaphor scenarios than following non-metaphoric scenarios, $t(62) = 2.12$, $p < .05$.

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following non-metaphoric language with a parallel interpretation. Thus, it would appear that conventional metaphors did activate metaphoric concepts as well as the novel metaphors did.

As expected, the conventionality data yielded a main effect for condition, $F(2,124) = 78.5$, $p < .01$. Planned comparisons confirmed that novel metaphor scenarios (4.50) were judged to be more unconventional than were conventional metaphor scenarios (2.39), which were in turn judged more unconventional than non-metaphoric scenarios (1.49). The average difference in conventionality between scenarios constructed from novel and from conventional metaphors (2.11), was not reliably different from that in Experiment 1 (1.94), $t(97) = 0.81$, $p > .10$. As in Experiment 1, however, the difference in unconventionality between novel and conventional metaphor scenarios was much greater than that between conventional metaphor and non-metaphor scenarios (0.90), $t(62) = 6.64$, $p < .01$, confirming that the scenarios differed in conventionality as intended.

The fit data also yielded a main effect for condition, $F(2,124) = 17.6$, $p < .01$. Although planned comparisons confirmed that novel metaphor scenarios (4.48) were still judged as fitting better with the target sentence than were conventional metaphor scenarios (4.07), post-hoc comparisons showed that the average difference in *fit* between scenarios constructed from novel and from conventional metaphors (0.42), was reliably less than in Experiment 1 (1.64), $t(97) = 4.77$, $p < .01$. Conventional metaphor scenarios were also still judged to fit slightly better than the non-metaphorical scenarios (3.40), however, the difference in fit between the conventional metaphor scenarios and the non-metaphorical scenarios (0.77) was not reliably different from that of Experiment 1 (0.53), $t(97) = 1.01$, $p > .10$. Residual differences in judgments of fit may be unavoidable because the target sentences include novel metaphors (and are therefore, stylistically, most consistent with novel metaphor scenarios and least consistent, stylistically, with non-metaphoric language).

To test for effects of scenario condition independent of "fit", we again used the mean fit scores for each item in each condition (expressed as deviations from the average fit score) as a covariate in a mixed models analysis of target sentence reading times by item and subject, computing confidence intervals using a Markov Chain Monte Carlo procedure. Even with fit accounted for, conventional metaphor scenarios still demonstrated reliable facilitation relative to non-metaphoric scenarios ($p < .05$).

While improving "fit" certainly altered the results significantly between Experiments 1 and 2, we would argue that "fit" is too broad a measure. To differentiate conceptual from stylistic or other differences, we therefore asked 16 new participants from the same pool to rate the level of *conceptual parallelism* (similarity of intended literal meaning on a 9-point scale) between pairs of scenarios taken from both Experiment 1 and from Experiment 2. Each subject saw one of three possible pairings for each scenario in each experiment. They were told to ignore sentences in the scenarios that were identical, and to consider only those sentences that were clearly variants of one another.

Although pairwise judgments of parallelism make it difficult to identify the specific type of item that has been advantaged or disadvantaged by departures from, in this case, conceptual parallelism, we were able to confirm that scenario pairs from Experiment 2 were judged more conceptually parallel (6.77) than were those of Experiment 1 (5.60), $F(1,15) = 27.9$, $p < .01$. Interestingly, across both sets of materials, greater conceptual parallelism was attributed whenever a novel scenario was compared to either of the other types, than when non-metaphoric scenarios were compared to conventional metaphors $F(2,30) = 3.78$, $p < .05$. We suspect that this result reflects that interpretations of novel metaphoric scenario were more malleable (assimilative to their context) than were those of conventional-metaphor and non-metaphoric scenarios (Fig. 4).

One final concern that we had about both of these experiments was that overall reading times for the lead-up scenarios might have differed by condition. If metaphoric scenarios took longer to read than non-metaphoric scenarios in our experiment, it might be that the shorter reading times on the final sentences reflected the fact that our readers were spending more time processing the metaphoric content in advance. This seemed especially likely because we had chosen to include questions about metaphors and this might have caused people to spend more time reading conventional metaphoric scenarios in Experiment 2 than in Experiment 1. In fact, the patterns of reading time for the three scenario types did differ somewhat, as is illustrated in Fig. 5. It is well-established that people are generally slower to read novel metaphors than conventional ones (Blank, 1988), and in Experiment 2, scenarios containing novel metaphors did take marginally longer to read (7.60 s) than those containing conventional metaphors (7.03 s), $t(62) = 1.78$, $p < .08$, and reliably longer than those containing no metaphors (6.53 s), $t(62) = 3.90$, $p < .01$. The difference between conventional metaphor scenarios and their non-metaphoric counterparts was not reliable, $t(62) = 1.48$, $p > .10$. This is similar to the pattern of results that occurred in Experiment 1, where the scenarios were slightly longer and reading times for novel metaphor scenarios (11.35 s) were again longer than those for conventional metaphor scenarios (10.43 s), $t(35) = 2.93$, $p < .01$, and longer than those for non-metaphoric scenarios (10.19 s), $t(35) = 3.44$, $p < .01$, but conventional metaphor scenarios did not differ from non-metaphoric ones.

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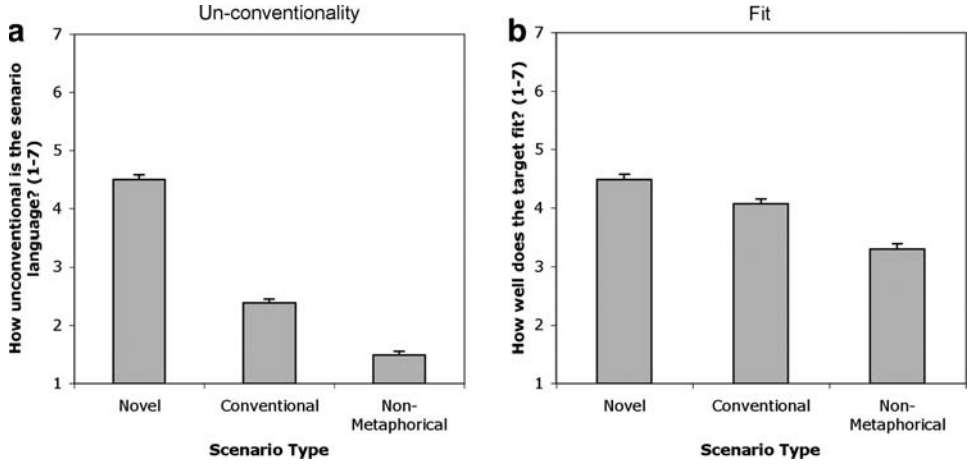

Fig. 4. Average ratings in Experiment 2 (on a 7-point Likert scale) for "non-conventionality" (a) and for "fit" (b) are shown for the three scenario types that preceded metaphorical readings of the target sentence. Standard errors, computed with respect to within-subject differences, are shown.

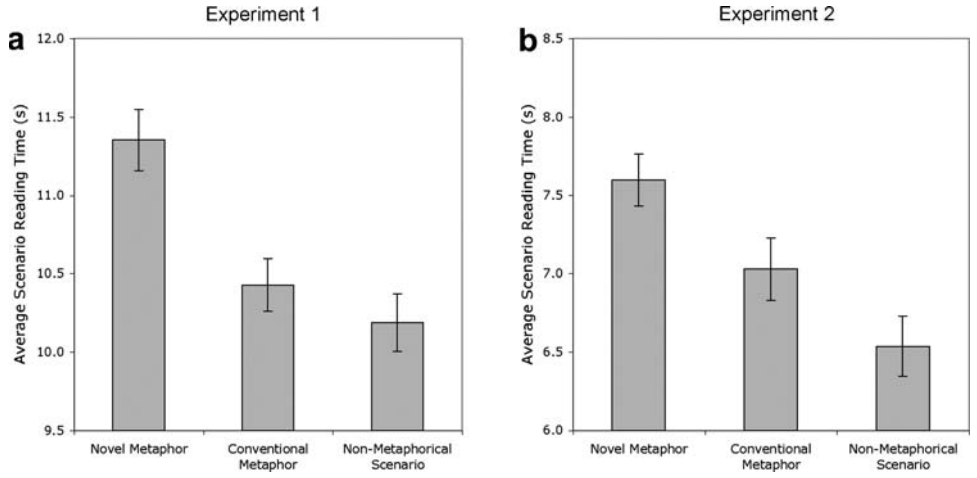

Fig. 5. Average scenario readings times for Experiment 1 (a) and Experiment 2 (b) are shown for the three conditions leading up to metaphorical target sentences. Standard errors, computed with respect to within-subject differences, are shown.

Although we had not attempted to equate the numbers and lengths of syllables or the word frequencies employed in our various conditions, the current analysis is at least reassuring that the patterns of scenario reading times for the second experiment did not differ dramatically from those of the first as a result of the inclusion of questions about metaphors, though we can not rule out the likelihood that there may have been relatively more time spent on conventional metaphors in Experiment 2. Such an outcome is consistent with the manipulation check, which suggested that subjects in Experiment 2 were less likely to report that they tended to focus on facts (rather than reading for comprehension) than those in Experiment 1 (29% vs. 53%), $X^2 = 5.71$, $p < .05$.

Experiment 3: Metaphor content matters

Experiment 2 demonstrated that conventional metaphors facilitated comprehension of a related novel metaphor. But our method did not establish whether the activation was specific to the content of the metaphors used, as would occur if the facilitation required an activation of conceptual mappings. That is, our theory predicts that hearing "I had to take a moment to let off some steam" should facilitate the processing of a novel metaphor relating anger to heat (e.g., "Otherwise my boiler would burst") but not a metaphor relating anger to a dangerous animal (e.g., "Otherwise my claws would come out").

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Experiment 3 therefore addresses an alternative interpretation of the findings of Experiment 2: that participants read the target metaphor equally fast between the novel and conventional conditions not because the related conceptual mapping was activated, but because subjects were just prepared by the metaphoric scenarios to read a metaphoric target sentence. Perhaps the final metaphors were simply read faster because they were preceded by other metaphors.

Recall that, although Nayak and Gibbs (1990) had argued that matched conventional metaphors were judged better continuations than were mixed metaphors, Glucksberg et al. (1993) found no difference in comprehension time when final metaphors were matched rather than mixed. However, as noted above, Glucksberg et al. used conventional metaphors as target sentences. Reading measures for such sentences may not be sensitive to effects of metaphor activation because the interpretation of conventional metaphors is, by definition, highly practiced. Facilitation effects might be difficult to measure in such cases. We therefore developed a new set of materials in which pairs of scenarios were constructed using different sets of conventional metaphors (e.g., anger is heat; anger is a wild beast). These scenarios (and a third, non-metaphoric, version) were each paired with one of two novel-metaphor target sentences instantiating one or the other of the metaphor structures. If the content of the conventional metaphors is important rather than metaphoricity, itself, then reading comprehension times ought to be facilitated when the novel metaphors are related to the conventional metaphors that precede them, but not when such metaphors are unrelated to those preceding them.

Methods

Participants

Seventy-two Swarthmore College undergraduate students who were native speakers of American English participated in the study for money or credit in their introductory psychology class. None was a participant in the earlier experiments.

Materials

We developed 15 scenario sets with the goal of maintaining conceptual parallelism across each of three scenarios within each set (conventional A, conventional B, and non-metaphoric). The constraints of the experiment (two sets of conventional metaphor families for each scenario set) required that we use conventional metaphors from sources other than Lakoff and Johnson. During stimulus development we asked naïve informants to flag any metaphors that struck them as unconventional or unusual. The full stimulus set is presented in Appendix D. The average conceptual parallelism rating for the triads of scenarios was 6.89 ± 0.14, which did not differ from those of Experiment 2 (6.77). Because novel-metaphor target sentences served as their own controls, we did not require conceptual parallelism among target sentences. Practice and filler items were similar to those of Experiment 2 except that questions no longer asked explicitly about metaphors. Instead they asked about comprehension. For example, participants were asked questions like "Did the professor's comments help?" and "Does the narrator read fiction?" following metaphor-laden fillers.

Procedure and design

The procedure and design were similar to the previous experiments, except that rather than contrasting conventional and novel metaphor scenarios, pairs of conventional-metaphor scenarios instantiating different metaphor families were compared with non-metaphor scenarios. For each triad of scenarios there were two possible target sentences, each instantiating one of the two metaphor families in a novel way. Because of the 3×2 design for each stimulus item, there were six different groups of scenarios used—with each scenario assigned to a different condition for each of the six groups. There were 15 experimental stimuli sets, so each group of stimuli included 5 mixed metaphors, 5 matched metaphors and 5 preceded by non-metaphoric language. As before, the order of presentation was randomized for each person (except that five fillers served as initial practice trials). We gave the same instructions and the format on the computer was the same as in Experiments 1 and 2.

Results and discussion

The raw data were trimmed to remove reading times of less than one second[4] (anticipations, 4%) and greater than 6 s (1%). Mean reading times were then computed for the targets sentences following each scenario-target pairing type for each participant. These data are shown in Fig. 6. As expected, there was a main effect of stimulus type, $F(2,71) = 3.14$, $p < .05$. Planned comparisons indicated that novel metaphors were read faster when they followed a scenario including conventional metaphors from the same metaphor family than when they followed scenarios utilizing conventional metaphors instantiating a different conceptual mapping, $t(71) = 2.20$, $p < .05$, or followed scenarios in which no metaphors were used $t(71) = 2.11$, $p < .05$. Thus, the present data show that the mere presence of metaphoric language was not the controlling factor in Experiment 2;

[4] This cut-off is less than half the average reading time and was selected to eliminate noisy data presumed to reflect key presses that preceded actual comprehension. Even if the cutoff is reduced so that the lower end data exclusion is only 3%, the statistical results are materially the same.

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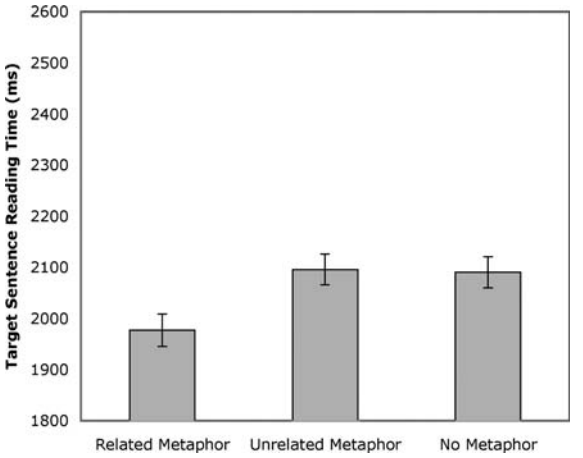

Fig. 6. Average reading times for target sentences by scenario condition in Experiment 3. The same target sentences appeared in all three conditions across subjects. Standard errors, computed with respect to within-subject differences, are shown.

conventional metaphor content mattered for the facilitation of novel metaphor comprehension. There was no cost, on the other hand, for the use of unrelated conventional metaphors.

General discussion

Experiments 2 and 3 have shown that comprehending novel metaphors is facilitated by first reading related conventional metaphors. Though efforts to measure the processing advantage for conventional metaphors using reading measures have not proved effective in the past, using novel metaphors in the target sentence has produced significant differences in reading time. Demonstrating that there is a processing advantage when extending conventional to novel metaphors supports the notion that metaphor ''families,'' documented as a linguistic reality by Lakoff and Johnson, also represent a cognitive reality. Further, we speculate on the psycholinguistic process involved in the creation of metaphor ''families''—encountering a metaphor, novel or conventional, may encourage the speaker and prepare the listener to use other related metaphors, both novel and conventional.

In debates over the conceptual status of metaphors, cognitive linguists have often argued that concrete domains are used to structure abstract ones because primary experiences provide primary conceptual material. For example, Gibbs (1996) argues that we experience the liquid in our bodies as increasing in temperature and pressure as we get angry, and this serves as a primary experience underlying the ANGER IS HEATED LIQUID IN A CONTAINER metaphor. But this seems backwards to us (see also Murphy, 1997). It strikes us that an alternative view supposes that certain domains are used to structure others primarily for purposes of communication, not representation (see, also, Gerrig & Gibbs, 1988). In the absence of other vocabulary, one person's experience of (and level of) physiological arousal during an angry moment can be communicated to another person by appealing to shared concrete referents that can stand in for private ones. Moreover, it seems that much of our experience of the category *anger* is through the faces and actions of others. That is, we gauge their level of arousal (and threat) and then we use shared idioms to describe it.

Our view does not deny that the use of metaphoric language can end up influencing our conceptual understanding of a situation or domain. On the contrary, the present results reinforce the idea that the use of conventional metaphors has effects quite different from conventional literal speech. But the conglomeration of idioms in language that share common conceptual mappings may reflect communicative needs rather than conceptual underpinnings. Having sets of highly conventionalized (even lexicalized) metaphor domains may be a property of human language systems because metaphoric categories are productive—and act like a conceptual alphabet in which existing structural mappings can be extended on the fly—though most of us are content to use the models sold off the shelf. Studies of patterns of metaphor production during speech could be quite relevant to further evaluating our productivity hypothesis.

Implications for other theories of metaphor comprehension

Our findings have developed from a long line of research on metaphor processing, which started with the three stage processing model. According to the three stage model, understanding a metaphor requires three stages: the listener first interprets the statement literally, then evaluates the literal meaning in context, and then, if necessary, reevaluates the statement. The major downfall of the three-stage processing model is that it predicts metaphoric language will always take longer to comprehend than literal language, which is not true (Harris, 1976; Verbrugge, 1977; Ortony, Schallert, Reynolds, & Antos, 1978; Gibbs, 1980; Glucksberg, Gildea, & Bookin, 1982; Keysar et al., 2000). As a result, most research conducted on metaphors after the introduction of the three-stage processing model either tried to amend the theory's conclusions or reject them altogether.

One model that grew out of such criticism was the superordinate categorization model (also known as the property attribution model and the class-inclusion model) proposed by Glucksberg and his associates (Gernsbacher et al., 2001; Glucksberg & Keysar, 1990;

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Glucksberg, McGlone, & Manfredi, 1997; Keysar et al., 2000; McGlone, 1996). According to the model, processing metaphors involves invoking attributive or superordinate categories of the vehicle to the target of the metaphor (e.g., in *My job is a jail*, from *jail* to *job*). An extension of this model claims that conventionalized metaphor categories (like *shark* and *jail*) are actually polysemous words. This notion is supported by many modern dictionaries which provide entries for shark and jail that refer to such categories. When told that a particular lawyer is a shark, the intended entailments are readily available and the irrelevant ones (e.g., good swimmer) may even be suppressed (Gernsbacher et al., 2001).

However, this version of superordinate categorization theory suggests that conventional metaphors (including those that Lakoff and Johnson identified as belonging to metaphor families) no longer invoke their source content. The results of Keysar et al. (2000) and of Glucksberg et al. (1993) had seemed to support this idea, but the present results do not. Note that we do not dispute these earlier results, per se, but we have provided reasons for doubting that they were adequate tests. Although conventional metaphors certainly provide a privileged path for comprehension, they nonetheless continue to activate mappings that can be extended to the comprehension of novel metaphors, as Experiments 2 and 3 have demonstrated. For this reason, though categorization theory is clearly correct in one sense (see Brown, 1958), it is not a complete account of metaphor inasmuch as it fails to account for shared conceptual mappings. This apparent failing may be because categorization itself is not well-enough understood. Evidence that metaphor aptness strongly predicts reading time (Jones & Estes, 2006) suggests that metaphor categories must retain a great deal of structure.

Gentner (1983), who has noted problems with claims made by both the three-stage process model and the superordinate categorization model, has emphasized the importance of structure-mapping theory for understanding metaphors in language. But she too emphasizes distinctions in people's ability to process novel versus conventional metaphors (Bowdle & Gentner, 2005; Gentner, Bowdle, Wolff, & Boronat, 2001; Gentner & Markman, 1997; Gentner & Wolff, 1997; Wolff & Gentner, 2000). The difference between conventional and novel metaphors on the structure-mapping account is that for conventional metaphors there already exists a known mapping between the source domain and the target of metaphoric extension; for novel metaphors this mapping must be derived. Clearly a structure mapping view is compatible with the idea that conventional metaphors activate mappings that can be extended to novel metaphors using similar or related mappings. Moreover, the finding that irrelevant source content may be suppressed (Gernsbacher et al., 2001) is consistent with the structure mapping view as well because such suppression could be used to exclude irrelevant structural properties.

Notice that our productivity principle could be related to Bowdle and Gentner's (2005) "career of metaphor" hypothesis. They showed that instantiating a novel figurative base in two ways (e.g., "An acrobat is like a butterfly" and "A figure skater is like a butterfly", p. 206) and requiring the subject to provide a third ("___ is like a butterfly"), caused a fourth instantiation of the same figurative base presented later (e.g., "a ballerina is (like) a butterfly", p. 206) to be rated as more metaphorical on their simile-metaphor scale than it was without such exposure. The productive metaphor-family claim simply takes this process to the level of clusters of metaphor. It is easier to understand how this might be possible using structure mapping rather than superordinate categorization (but cf., Jones & Estes, 2006).

Taken together our findings support the view that the processing of conventional metaphors can indeed activate conceptual mappings thereby facilitating the processing of related metaphors. We further suggest that the present findings provide a sufficient basis for explaining the existence of metaphor "families" such as those identified by Lakoff and Johnson (1980a). The families could arise as a result of the productivity phenomena: interpreting metaphoric ideas activates conceptual mappings between the target and base; this should encourage the speaker to use, and prepare the listener to understand, other metaphors that rely on the same mapping (see, for example, Boroditsky, 2000). That is, the needs of efficient communication can be met more easily by a system of metaphoric speech in which families of metaphor exist or are developed. The productive nature of metaphoric mapping leads naturally to the development of standard sets of metaphoric mappings that can become a common part of language.

Priming

Keysar et al. (2000) tested for lexical priming in a control experiment for their novel metaphor result and reported no priming effects (see also Gentner et al., 2001). Although we have not, ourselves, conducted such tests, we believe that the results of Gernsbacher et al. (2001) can be interpreted as suggesting that conventional metaphors do, in fact, prime relevant conceptual content. Because our theory of communicative facilitation is neutral with respect to the mechanism by which related metaphors facilitate each other, we accept that priming could play an important role in this process, but emphasize that the functional outcome of such priming probably corresponds closely to structure mapping (Bowdle & Gentner, 2005; Gentner, 1983; Gentner et al., 2001; Gentner & Markman, 1997).

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Conclusion

Conventional metaphors remain productive. Rather than representing isolated superordinate categories or even dead metaphors, families of conventional metaphors, such as those identified by Lakoff and Johnson (1980b), can facilitate the mapping of relevant conceptual structures when interpreting novel metaphoric language. We have conducted variants of experiments originally conceived by Keysar et al. (2000) and by Glucksberg et al. (1993) in order to show that, contrary to their conclusions, conventional metaphors do, in fact, seem to activate structural mappings that facilitate the comprehension of related metaphors. We have suggested that this facilitation can only be measured in reading experiments using novel metaphors but we do not exclude the possibility that more subtle facilitation effects may occur even in the comprehension (and production) of related conventional metaphors.

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Appendix A. Analysis of stimuli materials from Keysar et al. (2000)

Here we consider the conventionality and conceptual parallelism of the stimuli used in Keysar et al. (2000). In order to operationalize conventionality Keysar et al. chose to use metaphor expressions exclusively from Lakoff and Johnson (1980a, 1980b). However, many of the stimuli used in the experiment were not consistent with the Lakoff and Johnson sources. Two coders independently examined the conventional metaphors used in the Keysar et al. experiments and determined whether each metaphor usage was from Lakoff and Johnson's work and, if so, whether it was a consistent usage.

One coder was the first author; the second coder was a Swarthmore College student who believed she was helping us to evaluate new stimuli that we were developing. Each coder was provided with the conventional metaphor scenario on the same page with the novel metaphor version and the non-metaphoric version. The phrases that differed among the three were underlined and numbered. The page also provided relevant metaphors from Lakoff and Johnson (1980a, 1980b) showing all the phrases they had listed as representative of the metaphor family. The coders were asked to determine (1) whether or not each underlined conventional metaphor phrase could be considered a minor edit of a phrase in the source list and (2) whether or not the usage was consistent with the meaning of the source.

Both coders found that fewer than half of the metaphor phrases were attributable to Lakoff and Johnson (e.g., "let [ideas] jell" became "jell [ideas] together"; a search on Google showed that "jell together" is a conventional metaphor for teams of people, but not for ideas). In the event that target-sentence reading times were not enhanced by the use of conventional metaphors (a null result), it is possible that this was because many of the phrases used were not members of the intended family of conventional metaphors.

Consider, next, the issue of conceptual parallelism. Unless scenarios lead to the same interpretation of events, differences in the reading time for a final target sentence may reflect differences in the relationship between the target sentence and the meaning of the scenarios, rather than the metaphoric properties of the scenarios. Therefore, we feel it is important to note that in several cases, the novel and conventional phrasings in the Keysar et al. (2000) stimuli result in different interpretations. We found two kinds of unparallel scenarios. First, there were cases in which the lead-up scenario in the novel version introduced concepts relevant to interpreting the target sentence that were not present in the conventional version. Second, there were cases for which the target sentence may have appeared as a non sequitur following the conventional but not novel version of the lead-up scenario.

For example, in stimulus A in Table 1, the target sentence uses a casino as a metaphor for a hospital. In leading up to this target sentence, the novel metaphor scenario explains that "the house always won" to convey the idea that the surgery would be dangerous; the corresponding conventional metaphor read "her chances were slim". In this case, the novel scenario, but not the conventional one, makes use of a non-central aspect of the gambling metaphor (the house) that is then used in the target sentence (casino). In other cases the target sentence fit well with the novel lead-up scenario, but may have appeared as a non sequitur following the conventional lead-up scenario. For example, in stimulus B in Table 1, the intended metaphorical meaning of the target sentence "she is currently weaning her latest child" is unclear to us, when applied to ideas. In the conventional version, readers may have interpreted it as a literal statement (about an actual child), whereas the intended metaphorical status of "child" in the target sentence is made explicit in the novel scenario, because the metaphor ("theories [are] children") is identified in the first sentence. A difference in reading times, in this case, might have been due to apparent violations of norms of discourse (non sequitur) rather than to slower metaphor comprehension. Indeed, as reported in the results of Experiment 1, in our replication using these stimuli, judgments of "fit" between target sentences and scenarios accounted for the differences we found in reading times for the targets.

Appendix B. Conventionality and fit questionnaires

In Experiments 1 and 2, questionnaires testing the "conventionality" of the various versions of the experimental scenarios as well as the "fit" between the target sentences and the various

versions of the scenarios were administered. Data were collected concerning the three conditions involving metaphoric target sentences. The instructions and the practice materials used in Experiment 1 are shown in this appendix.

Conventionality

The instructions for the "conventionality" judgments were: "Expressions can vary in conventionality with respect to the idea that they are supposed to communicate. For example, consider the following two descriptions of a person running fast: a conventional way, *he was running like the wind*, and a much less conventional way, *he was running like a Porsche on a German highway.* The following is a list of 18 (14 for Experiment 2) stories or parts of stories. They all vary in conventionality. Please rate them on the conventionality of their language from 1 (conventional) to 7 (very *un*conventional). Please circle your choice on the scale below each story."

The first two scenarios (presented below) were practice items that were judged to vary in both conventionality and fit and kept the same for all participants. The same examples were used in both experiments.

I was unsure about my paper thesis, so I decided to talk to my professor. He told me, "Your analysis is definitely headed in the right direction. I think you should continue on this track, but just make sure to avoid misleading information"

1 2 3 4 5 6 7
Conventional Very unconventional

"Before I got a credit card my mom warned me that they were mouse traps," said David. "Banks promise reward points and low interest rates as cheese to lure you to their credit card programs. You don't realize that one missed payment means the spring snaps in place confining you to a life of debt." David got one anyway.

1 2 3 4 5 6 7
Conventional Very unconventional

Fit

Once participants finished rankings for conventionality, they were asked not to turn back to that section. In rankings for fit, the instructions read as follows: "In the next section you will be asked to read the same stories as before, but this time a final sentence has been added after each one. Some of the final sentences fit the stories well and some do not. Independent of conventionality, how well does the final italicized sentence seem to follow the preceding story in each case below from 1 (poor fit) to 7 (good fit). Please circle your choice below the story.

In the case of fit, the practice scenarios read as follows.

I was unsure about my paper thesis, so I decided to talk to my professor. He told me, "Your analysis is definitely headed in the right direction. I think you should continue on this track, but just make sure to avoid misleading information"

My express train was cleared for departure.

1 2 3 4 5 6 7
Poor fit Good fit

"Before I got a credit card my mom warned me that they were mouse traps," said David. "Banks promise reward points and low interest rates as cheese to lure you to their credit card programs. You don't realize that one missed payment means the spring snaps in place confining you to a life of debt." David got one anyway.

He is good at scurrying around traps.

1 2 3 4 5 6 7
Poor fit Good fit

Appendix C. Stimulus materials for experiment 2

Note that "/" is used to indicate line breaks that appeared within sentences.

A. Experimental stimuli

Target sentences (which concluded each scenario) appear first, followed by the four scenario types that preceded them in the experiment.

1. ANGER IS HEAT

Target sentence: *Otherwise my boiler would burst.*

Novel: *I was sizzling. My roommate had borrowed my car without asking/and got into an accident. I had to take a moment and release my pressure valve.*

Conventional: *I was fuming. My roommate had borrowed my car without asking/and got into an accident. I had to take a moment and let off some steam.*

Non-metaphor: *I was furious. My roommate had borrowed my car without asking/and got into an accident. I had to take a moment and relax a little.*

Literal-reading: *I was scared. The steam heater in my basement was getting dangerously pressurized. I had to find the release valve quickly.*

2. ARGUMENT IS WAR

Target sentence:*They mobilize their armies nearly every time they talk.*

Novel: *Stan and Jake often get into arguments. But Stan rarely fortifies his position adequately. As a result, Jake is almost always able to take out Stan's claims.*

Conventional: *Stan and Jake often get into arguments. But Stan's position is often indefensible. As a result, Jake is almost always able to shoot down Stan's claims.*

Non-metaphor: *Stan and Jake often get into arguments. But Stan's theories are usually badly reasoned. As a result, Jake is almost always able to contradict Stan's claims.*

Literal-reading: *Sometimes arguments can turn into wars. Pakistan and India are longtime foes/who are always spoiling for a fight.*

3. EMOTIONAL EFFECTS ARE PHYSICAL CONTACT

Target sentence: *I was black and blue for several days.*

Novel: *I went to Ed's mother's funeral today. Her tragic death punched everyone in the stomach. It slapped me really hard.*

Conventional: *I went to Ed's mother's funeral today. Her tragic death bowled everyone over. It hit me really hard.*

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Non-metaphor: *I went to Ed's mother's funeral today. Her tragic death affected everyone deeply. I was really saddened by it.*

Literal-reading: *I went to Ed's mother's funeral today. The church steps were rotten and I fell through. I hit my legs pretty hard. I'm feeling better now/but I had to wear long pants for a while.*

4. IDEAS ARE FOOD

Target sentence: *Otherwise, they give him indigestion.*

Novel: *David has a hard time ingesting new ideas. He has to gnaw on them for days.*

Conventional: *David has a hard time swallowing new ideas. He has to stew them over for days.*

Non-metaphor: *David takes a while to fully understand new ideas. He has to think about them for days.*

Literal-reading: *David has a weak stomach. He has to take his time when eating meals.*

5. LIFE IS A GAMBLING GAME

Target sentence: *She loved to gamble.*

Novel: *Joan knew that surgery was a very dangerous option. She could lose it all. Nevertheless, Joan decided to ante up and have the operation.*

Conventional: *Joan knew that surgery was a very dangerous option. The stakes were high. Nevertheless, Joan decided to take her chances and have the operation.*

Non-metaphor: *Joan knew that surgery was a very dangerous option. The survival rate was low. Nevertheless, Joan decided to go ahead and have the operation.*

Literal-reading: *Joan knew she should retire from playing professional poker. She had made a decent amount of money and she wanted to raise a family, but late night card tournaments had become a compulsion for her.*

6. LOVE IS MADNESS

Target sentence: *I'm talking to my doctor about medication.*

Novel: *The current object of my affections is Beth. I'm rabid about her. She makes me psychotic with desire.*

Conventional: *The current object of my affections is Beth. I'm wild about her. She drives me out of my mind with desire.*

Non-metaphor: *The current object of my affections is Beth. I am completely in love with her. She overwhelms me with desire.*

Literal-reading: *I have a severe balance problem. I often injure myself bumping against walls. I have decided to do something about it.*

7. THE MIND IS A MACHINE

Target sentence: *Hopefully the problem is not beyond repair.*

Novel: *Every year on the first day of school we have a math quiz. I don't think I did very well this time/because over summer vacation I got a little corroded. I even had a hard time milling out solutions to easy equations.*

Conventional: *Every year on the first day of school we have a math quiz. I don't think I did very well this time/because over summer vacation I got a little rusty. I even had a hard time grinding out solutions to easy equations.*

Non-metaphor: *Every year on the first day of school we have a math quiz. I don't think I did very well this time/because over summer vacation I got out of practice. I even had a hard time solving easy equations.*

Literal-reading: *My computer keeps crashing. I don't know what the problem is. But I hate taking it in for maintenance. So I am going to try and fix things myself.*

8. A RELATIONSHIP IS A JOURNEY

Target sentence: *They are in serious need of a jumpstart.*

Novel: *Bill and Lauren have been together for three years. There have been potholes along the way and now they are at a junction. Their relationship is stalled.*

Conventional: *Bill and Lauren have been together for three years. It has been a long, bumpy road and now they are at a crossroad. Their relationship isn't going anywhere.*

Non-metaphor: *Bill and Lauren have been together for three years. They have had problems in their relationship and now they have to make a choice. Their relationship isn't good.*

Literal-reading: *Bill and Lauren got in a car, and headed for the shore. They stopped at a hotel for the night and left the car lights on. Now the battery is dead.*

9. THEORIES ARE BUILDINGS

Target sentence: '*Make sure your blueprints are exact.'*

Novel: *The professor told me my argument was wobbly: 'As a student of physics,/you have to level the ground beneath your theoretical models. Use facts to brace your theory.*

Conventional: *The professor told me my argument was shaky: 'As a student of physics,/you have to construct stronger foundations for your theoretical models. Use facts to support your theory.*

Non-metaphor: *The professor told me my argument was not well thought out: 'As a student of physics,/you have to carefully justify your theoretical models. Use absolute facts to explain your theory.*

Literal-reading: *In his first lecture the professor said, 'The new hotel downtown took years to put up. It turned out that the foundation was weak because the plans were wrong. Some people never learned the importance of precision.*

10. TIME IS MONEY

Target sentence: *'I'll refund your capital with interest.'*

Novel: *My boss growled, 'I deposited a lot of hours training you. So stop throwing away your time!' Relax,' I grinned.*

Conventional: *My boss growled, 'I invested a lot of hours training you. So stop wasting your time!' 'Relax,' I grinned.*

Non-metaphor: *My boss growled, 'I've been training you for weeks. So stop fooling around!' 'Relax,' I grinned.*

Literal-reading: *My boss decided that the money he had supplied for my new restaurant/would be better spent on a new car. He marched into my office and/angrily demanded his money back, all $5,000.'Relax,' I grinned.*

11. UNDERSTANDING IS SEEING; IDEAS ARE LIGHT SOURCES; DISCOURSE IS A LIGHT-MEDIUM

Target sentence: *'You have the output of a 100 Watt bulb!'*

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Novel: *Ms. Armstrong, my history teacher, paid me a compliment the other day saying,/'Your remarks on Columbus were a ray of sunshine. You made the ideas really translucent.' And she wrote at the end of my assignment*:

Conventional: *Ms. Armstrong, my history teacher, paid me a compliment the other day saying,/'Your remarks on Columbus were brilliant. You made the ideas really clear.' And she wrote at the end of my assignment*:

Non-metaphor: *Ms. Armstrong, my history teacher, paid me a compliment the other day saying,/'Your remarks on Columbus were fantastic. Your ideas were well explained.' And she wrote at the end of my assignment*:

Literal-reading: *At the lamp store, one of the employees was taking inventory of all the desk lights. I found him particularly amusing/because he would talk to the lamps as he wrote about them. I heard him tell one light*:

12. VITALITY IS A SUBSTANCE

Target sentence: *I'm glad to have my vitality refill.*

Novel: *Even though I just sit at a desk, my job empties my energy wells. I'm out of oil by the end of the day. But when I do aerobics my tanks overflow.*

Conventional: *Even though I just sit at a desk, my job drains me. I don't have any energy left at the end of the day. But when I do aerobics I'm brimming with vim and vigor.*

Non-metaphor: *Even though I just sit at a desk, my job is extremely tiring. I feel like I can barely move at the end of the day. But when I do aerobics I feel perky again.*

Literal-reading: *I used to have low energy at the end of the day. I saw my doctor about it and he prescribed a pill called 'vitality' to reduce my fatigue. I just got the prescription renewed and now I feel much better.*

B. Fillers and questions

1. Friends are lifesavers. Last week, I got a flat tire on my way to an important meeting and gave up hope of making it to the office by nine. But my friend Julie came and revived me. She offered to lend me her car as a lifeline.

Was Julie compared to a lifeguard? YES

2. Politics is a roller-coaster. Ted got on the ride when he decided to campaign for mayor of his small town. After flipping, rolling, and shaking for the public for eight weeks, he finally felt like he was in control. But as he watched the exit polls reported on TV, he plummeted. He had lost in a landslide.

Was the candidate running for mayor in a big city? NO

3. Bureaucracy is quicksand. This morning I went to the Department of Motor Vehicles/thinking that I would be able to get my drivers license renewed in an hour. Boy was I wrong. I started sinking when I saw the line of people that led out the door. But I had to be pulled out of the office with a stick/when I realized I didn't have all the necessary paperwork.

Was there sand at the DMV? NO

4. A good book is a vacation for me. I run through the pages, leaping from chapter to chapter. Travel time is short, I just open the cover. At the end of my itinerary I am refreshed and ready to get back to work.

5. John's friends think of his house as a hotel. The three story building can lodge at least fifteen to twenty people comfortably. And John's mom, the chef, is willing to cook up room service late into the night. Best part about the stay is that it is always free.

6. "Your analysis is definitely headed in the right direction," the professor told me. "I think you should continue in this vein, but watch out for the pitfalls that may occur due to misleading information." I told him how much I appreciated his input. "Thank you so much. This will really help me get back on track."

Did the professor's comments help? YES

7. James grew up in the country-side and now can't stand living in a city. He complains that the endless screeching of its many inhabitants is sometimes deafening. Cars roar down streets, charging at pedestrians.

Is James living in the jungle? NO

8. Some people say that seeing is communicating. I can understand that. The other day, I noticed Ron glaring at me. He couldn't take his eyes off me. I saw he was really mad from the way he kept his gaze glued to mine.

Did Ron's eyes communicate his anger? YES

9. Aaron's stomach is a bottomless pit. He can eat pizza for hours without getting full. We joke that he could probably throw back a gallon of ice cream without any problem.

10. My accounting job is a jail. I have been putting in my time for the last twenty years—8 h a day. Next year I will be able to retire though and I will be free.

11. Feeling good is a question of balance. Sometimes I like to relax with a good book. Other times I like to take walks on the beach. Regardless, I never forget to set aside time for myself. Indulgence is my philosophy of life.

Does the author like to read? YES

12. The reef habitat is full of life. The popular surgeon fish is named for the two sharp spines, like a surgeon's scalpel, found at the base of the tail. These colorful fish really catch the eye. But be careful not to be slashed by a sweeping tail.

Is the fish named after a type of doctor? YES

13. A woman who can issue an ultimatum is brave indeed. Meryl, 33, always wanted kids. But her long-term partner consistently refused. She told him it was either kids or goodbye. She explained, "He was a bit stunned by my bluntness but gave in. It was an enormous risk, but I'm really glad now I went the whole way."

Is Meryl older than 35? NO

14. "Life was completely different after the boating accident," explained Carol. "When I was told that my husband would never walk again, I couldn't believe it. I remember saying that John was

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fit and healthy, that he'd recover. But the doctor explained about the damaged nerves. Now he spends most of his time in a wheel chair.''

Was Carol's husband injured in a car accident? NO

15. Parents often try and entertain their children too much. Instead they should encourage their children to amuse themselves. Leaving them to their own devices might be a good thing. Boredom can generate creativity.

Appendix D. Materials for experiment 3

Note that "/" is used to indicate line breaks that appeared within sentences.

A. Experimental stimuli

Target sentences (which concluded each scenario) appear first, followed by the three scenario types that preceded them in the experiment.

1. ANGER IS HEAT—ANGER IS A DANGEROUS ANIMAL

Target sentence A: *Otherwise my boiler would burst.*

Target sentence B: *Otherwise my claws would come out.*

Conventional A: *I was fuming. My roommate borrowed my car without asking and got into an accident. I had to take a moment to let off some steam.*

Conventional B: *I was bristling. My roommate borrowed my car without asking and got into an accident. I had to take a moment to leash my anger.*

Non-metaphor: *I was furious. My roommate had borrowed my car without asking and got into an accident. I had to take a moment to relax.*

2. AN ARGUMENT IS A WAR—AN ARGUMENT IS A SPORTS CONTEST

Target sentence A: *When they start to argue, their friends head for a bunker.*

Target sentence B: *When they start to argue, their friends head for the stands.*

Conventional A: *Stan and Jake often get into arguments. But Stan's position is often indefensible. As a result, Jake is almost always able to shoot down Stan's claims.*

Conventional B: *Stan and Jake often get into arguments. But Stan's reasoning is often well off the mark. As a result, Jake is almost always able to knock out Stan's claims.*

Non-metaphor: *Stan and Jake often get into arguments. But Stan's theories are usually poorly reasoned. As a result, Jake is almost always able to contradict Stan's claims.*

3. IDEAS ARE FOOD—IDEAS ARE PLANTS

Target sentence A: *They are exquisite gourmet meals for him.*

Target sentence B: *They are exotic tropical plants for him.*

Conventional A: *When David hears new ideas, he takes his time digesting them completely. He likes to chew them over slowly.*

Conventional B: *When David hears new ideas, he takes his time letting them come to full flower. He likes to cultivate them slowly.*

Non-metaphor: *When David hears new ideas, he takes his time fully appreciating them. He likes to deliberately think them through.*

4. LIFE IS A GAMBLING GAME—LIFE IS A JOURNEY

Target sentence A: *She put her chips in the pot.*

Target sentence B: *She boarded the train.*

Conventional A: *Joan knew that surgery was a very dangerous option. The stakes were high. Nevertheless, she decided to take her chances with the operation.*

Conventional B: *Joan knew that surgery was a very dangerous option. The road ahead was uncertain. Nevertheless, she decided to go ahead with the operation.*

Non-metaphor: *Joan knew that surgery was a very dangerous option. It was a risky procedure. Nevertheless, she decided to have the operation.*

5. LOVE IS MADNESS—LOVE IS MAGIC

Target sentence A: *I never want to be sane again.*

Target sentence B: *I hope her potion never runs out.*

Conventional A: *The current object of my affections is Beth. I'm wild about her. She drives me out of my mind.*

Conventional B: *The current object of my affections is Beth. I'm entranced by her. She's cast her spell over me.*

Non-metaphor: *The current object of my affections is Beth. She fascinates me. I am completely in love with her.*

6. A RELATIONSHIP IS A JOURNEY—A RELATIONSHIP IS A PATIENT

Target sentence A: *They need a better navigation system.*

Target sentence B: *They'd better find some medicine fast.*

Conventional A: *Bill and Lauren have been together for three years. It has been a long, bumpy road, and now their relationship seems to be heading toward a dead end.*

Conventional B: *Bill and Lauren have been together for three years. Their relationship has been unhealthy before, but now it is nearly dead.*

Non-metaphor: *Bill and Lauren have been together for three years. They have had problems in their relationship in the past, but now it is really not good.*

7. THEORIES ARE BUILDINGS—ARGUMENTS ARE JOURNEYS

Target sentence A: *Make sure your blueprints are exact.'*

Target sentence B: *Make sure your map is accurate.'*

Conventional A: *The professor told me my argument was shaky: 'As a student of physics,/you have to construct stronger foundations for your theoretical models. Use facts to support your theory.*

Conventional B: *The professor told me my argument was off track: 'As a student of physics,/you have to proceed step-by-step toward your theoretical models. Use facts to arrive at your theory.*

Non-metaphor: *The professor told me my argument was not well thought out: 'As a student of physics,/you have to carefully justify your theoretical models. Use facts to explain your theory.*

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8. IDEAS ARE LIGHT SOURCES—IDEAS ARE CUTTING INSTRUMENTS

Target sentence A: '*Your pen is a floodlight.*'

Target sentence B: '*Your pen is a razor.*'

Conventional A: *Ms. Armstrong, my history teacher, paid me a compliment the other day saying,|'Your remarks on Columbus were brilliant. You made the ideas really clear.' And she wrote at the end of my assignment*:

Conventional B: *Ms. Armstrong, my history teacher, paid me a compliment the other day saying,|'Your remarks on Columbus were incisive. You cut right to the heart of the matter.' And she wrote at the end of my assignment*:

Non-metaphor: *Ms. Armstrong, my history teacher, paid me a compliment the other day saying,|'Your remarks on Columbus were fantastic. Your ideas were well explained.' And she wrote at the end of my assignment*:

9. CRIME IS A DISEASE—CRIME IS A WILD ANIMAL

Target sentence A: *No treatment is strong enough to stop it.*

Target sentence B: *No cage is strong enough to restrain it.*

Conventional A: *In big cities across America, crime has become an epidemic that can't be cured. It is beginning to infect small towns as well.*

Conventional B: *In big cities across America, crime has become a beast that is roaring out of control. It is beginning to prey on small towns as well.*

Non-metaphor: *In big cities across America, crime has become a problem that can't be solved. It is beginning to affect small towns as well.*

10. A LAWYER IS A SHARK—A LAWYER IS A BOXER

Target sentence A: *I sensed blood in the water.*

Target sentence B: *I started the ten-count.*

Conventional A: *Going in, I was really worried about the trial. But during the cross-examination, the main defense witness turned out to be little more than shark bait. Once my lawyer sunk his teeth into him, there was no way we were going to lose.*

Conventional B: *Going in, I was really worried about the trial. But during the cross-examination, the main defense witness turned out to be little more than a featherweight. Once my lawyer had him up against the ropes, there was no way we were going to lose.*

Non-metaphor: *Going in, I was really worried about the trial. But during the cross-examination, the credibility of the main defense witness turned out to be questionable. Once my lawyer confronted him with the contradictions in his testimony, there was no way we were going to lose.*

11. A PROFESSOR IS AN OILWELL—A PROFESSOR IS A GOLDMINE

Target sentence A: *His classes are a valuable gusher.*

Target sentence B: *His classes are full of gleaming nuggets.*

Conventional A: *I struck oil when I met Professor Jacoby. I love his lectures. He is a deep well of information.*

Conventional B: *I struck gold when I met Professor Jacoby. I love his lectures. He is a rich mine of information.*

Non-metaphor: *I am really lucky to have met Professor Jacoby. I love his lectures. He is incredibly knowledgeable.*

12. LONELINESS IS A DESERT—LONELINESS IS AN ISLAND

Target sentence A: *I need a caravan to save me.*

Target sentence B: *I need a passing ship to save me.*

Conventional A: *Ever since my girlfriend left me, my life has become a wasteland. I don't talk to anyone. I am wandering in the desert.*

Conventional B: *Ever since my girlfriend left me I have been completely at sea. I don't talk to anyone. I'm washed up.*

Non-metaphor: *Ever since my girlfriend left me, I have been really solitary. I don't talk to anyone. I'm a loner.*

13. LIES ARE A SPIDER WEB—LIES ARE A SWAMP

Target sentence A: *His spider silk fooled no one.*

Target sentence B: *The rest of us kept to solid ground.*

Conventional A: *I don't trust Joe anymore. I always suspected that he was a compulsive liar, but yesterday the web he spun was absolutely absurd. He got completely tangled in his own lies.*

Conventional B: *I don't trust Joe anymore. I always suspected that he was a compulsive liar, but yesterday the story he told turned to quicksand under his feet. He got completely mired in his own lies.*

Non-Metaphor: *I don't trust Joe anymore. I always suspected that he was a compulsive liar, but yesterday the story he told was full of contradictions. He got completely confused by his own lies.*

14. DIVORCE IS AN EARTHQUAKE—DIVORCE IS A TORNADO

Target sentence A: *No early tremors had prepared me for this.*

Target sentence B: *No tornado warning had prepared me for this.*

Conventional A: *The fault-lines in our marriage were clear early on, but I never anticipated how devastating things would become. I was so shaken by the divorce. The ground seemed to come out from under me. My life collapsed.*

Conventional B: *Our marriage was clearly stormy early on, but I never anticipated how devastating things would become. I was caught in a whirlwind by the divorce. The ground seemed to come out from under me. My life was blown to pieces.*

Non-metaphor: *There were problems in our marriage early on, but I never anticipated how terrible things would become. The divorce caused confusing and unpleasant emotions. I felt that I could not understand what was happening to me. Day-to-day living was extremely difficult.*

15. HARD WORK IS A LADDER—HARD WORK IS A KEY

Target sentence A: *But I think the rungs of her efforts will continue skyward.*

Target sentence B: *But I think the corporate gates will continue to swing wide for her.*

Conventional A: *Maddie is making progress in the corporate world. Her hard work is getting her to the top. As she climbs higher on the ladder, though, she has started to worry that she'll never reach the heights of real power.*

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Conventional B: *Maddie is making progress in the corporate world. Hard work is the key to her success. As more doors open for her, though, she has started to worry that she will get locked out of real power.*

Non-metaphor: *Maddie is making progress in the corporate world. Her hard work is responsible for her success. As her promotions continue, though, she has started to worry that she will never be a powerful executive.*

B. Fillers and questions

1. Last week, Fred got a flat tire on his way to an important meeting and gave up hope of making it to the office by nine. But his friend Julie came and saved him. She offered him her car as a lifeline.

Did Fred make it to the office? YES

2. Ted went on a politics rollercoaster when he decided to campaign for mayor of his small town. After trying to please the public for eight weeks, he finally felt like he was on top. But as he watched the exit polls reported on TV, he plummeted. His ride was unexpectedly over.

Was the candidate running for mayor in a big city? NO

3. A good novel is a vacation for me. I run through the pages, leaping from chapter to chapter. Travel time is short; I just open the cover. At the end of my itinerary I am refreshed and ready to get back to work.

Does the narrator read fiction? YES

4. John's friends think of his house as a hotel. The three-story building can lodge at least fifteen to twenty people comfortably. And John's mom, the chef, is willing to cook up room service late into the night. The best part about the stay is that it is always free.

5. Technology is a crutch for most corporations. At first, computers helped hobbling businesses work more efficiently and overcome their weaknesses. But reliance on technology has become so great that without digital support businesses would collapse.

6. 'Your analysis is definitely headed in the right direction,' the professor told me. 'I think you should continue in this vein, but watch out for the pitfalls that may occur due to misleading information.' The advice really helped me get back on track.

Did the professor's comments help? YES

7. James grew up in the country-side and now he can't stand living in the city. He complains that the endless screeching of its many inhabitants is sometimes deafening. Cars roar down streets, charging at pedestrians.

Does James dislike living in a rural area? NO

8. My accounting job is so confining. I have been putting in my time for the last twenty years—8 h a day. Next year I will be able to retire, though, and I will be free.

Does the narrator like his job? NO

9. Some people say that seeing is communicating. I can understand that. The other day, I noticed Ron glaring at me. He couldn't take his eyes off me. I could tell he was really mad from the way he kept his gaze glued to mine.

10. Aaron's stomach is a bottomless pit. He can eat pizza for hours without getting full. We joke that he could probably throw back a gallon of ice cream without any problem.

11. Feeling good is a question of balance. Sometimes I like to relax with a good book. Other times I like to take walks on the beach. Regardless, I never forget to set aside time for myself. Indulgence is my philosophy of life.

Does the author like to read? YES

12. A woman who can issue an ultimatum is brave indeed. Meryl, 33, always wanted kids. But her long-term partner consistently refused. She told him it was either kids or goodbye. He gave in.

Is Meryl older than 35? NO

13. 'Life was completely different after the boating accident,' explained Carol. 'When I was told that my husband would never walk again, I couldn't believe it. I remember saying that John was fit and healthy, that he'd recover. Unfortunately he never did.'

Was Carol's husband injured in a car accident? NO

14. Parents often try to entertain their children with television too much. Instead, they should encourage their children to amuse themselves. Leaving them to their own devices might be a good thing. Boredom can generate creativity.

15. I love to watch the Olympics. I prefer the summer games, but I enjoy watching some of the winter events too. Downhill skiing is pretty fun to watch because the athletes go so fast.

Does the narrator prefer to watch the summer Olympics? Yes

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