The Role of Conventionality in the Real-time Processing of Metaphor

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Abstract

This project is intended to ascertain the role of conventionality in the use of metaphors in natural language processing. It examines the relationship between the degree of conventionality of a metaphor and the degree of difficulty in processing metaphorical meanings. The overall purpose is to obtain evidence regarding the metaphoric knowledge approach (Martin 1990) which asserts that the interpretation of novel metaphors can be accomplished through systematic extension, elaboration, and combination of knowledge about already well-understood metaphors. Subjects were tested on parsing sentences with different degrees of metaphorical novelty. Reaction times along with their responses were analyzed. The results suggest that a) degrees of conventionality in metaphorical use have a significant effect on the processing of the metaphor, b) degrees of novelty are proportionally related to the degrees of difficulty in processing, and c) conventional metaphors are as privileged in sentence processing as the "literal meaning" uses.

Recent work on metaphor in linguistics (Lakoff and Johnson 1980, Lakoff 1987, Lakoff and Turner 1989) and in natural language processing (Martin 1990) has emphasized the role of conventional metaphor. Conventional metaphors are taken to mean metaphors that are already commonly accepted as a part of the language and novel metaphors are those that are newly "created". The main thrust of Martin (1990) is that normal processing of metaphoric language proceeds through the direct application of specific knowledge about the metaphors in the language, i.e. when processing metaphoric language, people will make *direct* use of their knowledge of the conventional metaphoric meaning and apply it in the process of interpreting a sentence rather than having to give priority to the so-called "literal meaning" and resorting to metaphoric use only when the "literal meaning" is not compatible. Correspondingly, the interpretation of novel metaphors can be accomplished through the systematic extension, elaboration, and combination of knowledge about already well-understood metaphors.

There are, of course, approaches in which metaphors are not considered to be a conventional part of the language, e.g. the "literal meaning first" approach. (cf. Wilks 1975, 1978, Fass 1983, 1988, Russell 1976). The principle characteristic of these approaches is that metaphor is treated as a novel departure from conventional language. In these approaches the only conventional meaning is the literal meaning and a metaphorical interpretation is attempted only if the input is clearly not compatible with a literal interpretation. This incompatibility is typically manifested by a violation of one or more of the semantic constraints posed by the literal interpretation, usually in the form of selectional restriction violations. Because metaphor is not considered to be a conventional part of the language, explicit knowledge about the metaphors in the language is not available to these approaches.

The "literal meaning first" approach goes hand in hand with the literal meaning hypothesis, which assumes that sentences have well-defined literal meanings and that computation of the literal meaning is a necessary first step on the path to understanding speakers' utterances (Gibbs 1984). One version of the literal meaning hypothesis is found in Searle (1975, 1979), where he developed a set of principles by which a hearer is able to infer what a speaker means when using metaphors, ironies, idioms, or indirect speech acts. His principles are 1) the hearer first computes the literal meaning of the sentence; 2) the hearer decides if the literal meaning is defective, given the context; and 3) if the literal meaning is inappropriate, the hearer is led to seek an alternative meaning, which, depending on the principle of convention and his/her knowledge of speech acts, should lead him/her to the speaker's conveyed meaning.

A number of experimental studies have been conducted which suggest that literal meaning does not enjoy a privileged status in sentence processing. Gibbs' studies (1979, 1984, 1986) show that indirect requests take *no* longer to read than either literal sentences or direct requests. Ortony et al. (1978) and Inhoff, Lima and Carroll (1984) have shown that the computation of metaphorical sentences in contexts does not take longer than the computation of comparable literal sentences.

Another implication of the assumption is that a non-literal interpretation is optional because it depends on special triggering factors such as the violation of cooperative maxims. Glucksberg, Gildea and Bookin (1982) suggest that metaphorical meanings are not optional. Instead, metaphorical meanings seem to be computed involuntarily, even when the task requires only literal interpretations.

Keysar (in press) further supports Glucksberg, Gildea and Bookin's position by concluding that metaphorical and literal interpretations are functionally equivalent in comprehension. Firstly, metaphorical interpretations are constructed non-optionally in reading, just as are literal interpretations. They are produced when they make sense in context. Secondly, the metaphorical interpretations do not take on an implied simile form. Like literal interpretations, they do not need a transformation into a simile form. And therefore models that give priority to literal interpretation in sentence computation may be rejected, especially stage

models which assume that metaphorical interpretation occurs only as a secondary or optional stage.

Note that all of these studies are designed to address the literal/non-literal distinction. As such, they do not shed any direct light on the issue of the effect of degrees of conventionality. It is to achieve evidence with regard to this and related issues that brings us to conduct the present study. By examining the role assumed by conventionality in a metaphoric use, we can find out about the mechanism that relates and/or distances the metaphors within a set.

Assuming metaphor is a basic, conventional part of the language, the conventionality of a metaphor should be privileged in processing a sentence containing the metaphor and that the conventionality of the metaphor in question is proportional to the ease of its processing, i.e. the more conventional a metaphor is, the easier it should be to process it. So the present study boils down to testing the following hypotheses:

1) Conventionality is privileged in metaphor processing;

2) Degree of conventionality is proportional to the ease of metaphor processing;

3) Literal meaning may not be privileged in real-time processing of a metaphoric use. Instead, what is privileged is conventional metaphor.

Method

Subjects

Seventy freshman psychology students from the University of Colorado at Boulder served as subjects. All were native speakers of English and none had participated in any similar studies.

Materials and Procedures

The test sentences were designed to exhibit metaphors with different degrees of novelty. There were five sentence types: least novel use of metaphor, less novel use of metaphor, most novel use of metaphor, literal meaning use, and a control sentence. The five types of sentences were designed with the closest approximation possible in terms of syntactic structure and complexity. An example of the five sentence types is given below:

- *Paraphrase:* *John caught his cold from Mike.*
- Least Novel: Mike gave John his cold.
- Less Novel: Mike passed his cold to John.
- Most Novel: Mike threw his cold to John.
- Literal: Mike infected John with his cold.
- Control: Mike died of John's cold.

As is clear from the example, the control sentence is interpretable as inconsistent with paraphrase sentences and is apparently incompatible with the meaning that the other four sentences share. There is a decreasing conventionality in the metaphoric sentences, from the most conventional to the least conventional. The degrees of conventionality are designed with serious consideration of word use frequency. Also considered are the levels from which a metaphorical meaning is extended. Three linguistic professors were asked to judge the so designed degrees of conventionality of metaphoric use and they all agree on the designs.

There were five of these sets, each designed this way. For each set, we designed a *paraphrase sentence* that is not the same in form to any of the five sentences in the set. Take the above set for example, we designed the paraphrase sentence "*John caught his cold from Mike*". The paraphrase sentence is then paired to each sentence in the set. So, there were 25 pairings of the stimuli sentence and test sentence.

The pairings were presented *randomly*. The subject first sees on the CRT a paraphrase sentence, which stays on the screen for 2 seconds. Then comes the test sentence. When the subject has made his/her judgments, he/she presses the space bar and proceeds to the next pair. Every subject went through the same procedure, the only difference being the order in which the sentence pairs were presented.

Presumably, for sentences other than the control sentences, we would ideally hope for a "yes" response, and for the control sentence, a "no" response. The control sentences were designed to determine the sincerity of the subjects in performing the task and to assure them that the answers were not all "yes"-- they do have to do some thinking!

Reaction times as well as correct responses in making the judgments were recorded and analyzed for interpretation.

Apparatus

Five IBM personal computers in the research lab of the Department of Psychology, University of Colorado, Boulder were used to conduct this experiment.

Results

The result obtained confirms that conventionality of metaphor does have significant effect on processing the metaphoric use. This is reflected in the mean percentages of correct responses for sentences of the five different types, which are shown in Figure 1.

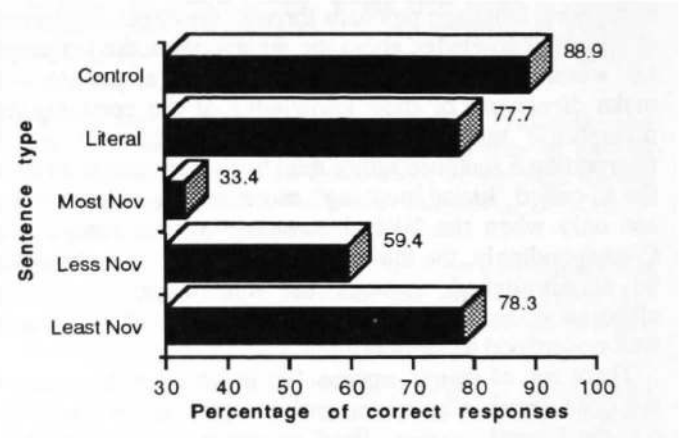

Figure 1. Average percentage of correct responses in all sentence types

As illustrated, there was the highest percentage of correct responses for the least novel (78.3%). As the metaphor gets more novel, the percentage gets lower (59.4%) and for the most novel metaphor, it reaches the lowest point (33.4%).

When it comes to literal meaning sentences, the percentage goes up again (77.7%) and for the control sentences, the percentage jumps to the highest point (88.9%). A one-factor analysis of variance yields significant effect of sentence types on correct responses, $\underline{F}$ (2.37) = 71.34, $p <$ .05. This meets our prediction that the more conventional a metaphor is the more agreements on its conveyed meaning one would expect and, moreover, it supports the claim that the more conventional a metaphor is the easier it is to process it and that the conventionality of a metaphorical meaning does affect the processing of a sentence containing the metaphor.

A 3-factor repeated measures analysis of variance of sentence type, set number and reaction time/response yields *no* significant interaction between sentence type and set number, $\underline{F}$ (1.64) = .646, $p >$ .05.

The results of this analysis also show that no significant difference exists among set numbers, $\underline{F}$ (2.37) = 2.318, $p <$ .05. However, significant effect is found to exist between different sentence types, $\underline{F}$ (2.37) = 4.965, $p <$ .05.

The results at this stage of analysis are certainly not totally reliable for any meaningful conclusion because what has been analyzed includes reaction times for both correct and incorrect responses. Nevertheless, looking at the percentage of correct responses in each of the five sets, one could see that they all fall close to the average line, as can be well illustrated in Figure 2.

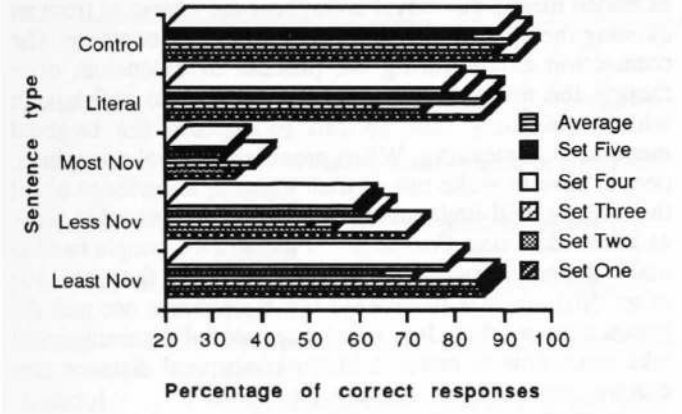

Figure 2. Percentage of correct responses for each of the five sets.

And, a two-way analysis of variance in terms of the percentage of correct responses yields *no* significant interaction between set numbers and sentence types, $\underline{F}$ = (1.64) 1.53, $p >$ .05. The difference between sentence sets are not significant either, $\underline{F}$ (2.37) = 2.325, $p >$ .05.

A similar phenomenon is found when looking at the means of reaction times for each of the five sets. They also tend to cluster together along the average, as is shown in Figure 3.

As with percentage of correct responses, we performed a two-way analysis of variance in terms of reaction times, since the percentage of correct responses of the five sets all fell along the average. Incidentally, we find no significant interaction existing between sentence type and set number,

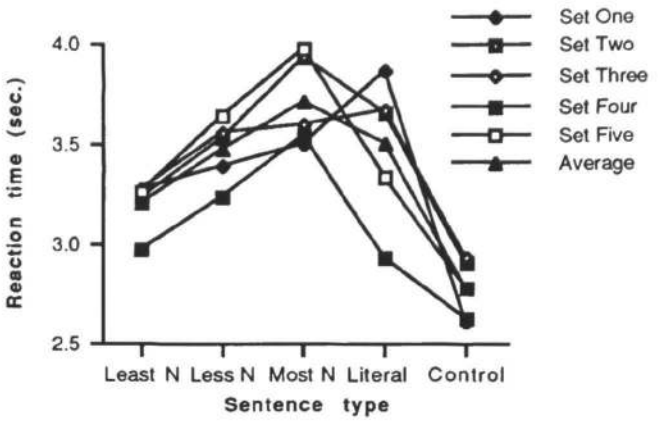

Figure 3. Mean reaction times for each of the five sets.

$\underline{F}$ (2.37) = .693, $p >$.05, though slightly significant effect is found among set numbers, $\underline{F}$ (2.37) = 2.737, $p <$ .05. Significant differences, however, are found between different sentence types, $\underline{F}$ (2.37) = 13.988, $p <$ .05.

Given that no significant interaction exists between sentence type and set number we can disregard the factor of set difference, since we are not interested in the differences between sentence sets anyway. We now look at only the correct responses for their reaction times. A one-factor analysis of variance of the correct responses yields a significant effect existing between different sentence types, $\underline{F}$ (2.37) =3.374, $p <$ .05 . The means of subjects' reaction times to the five sentence types are illustrated in Figure 4.

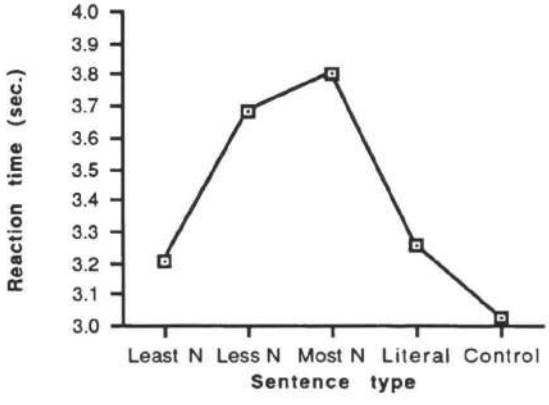

Figure 4. Mean reaction times of correct responses in all sentence types.

Interestingly, the plot of mean reaction times for the correct responses to the five sentence types shapes approximately like a mirror image of the plot of average percentages of correct response: for the most conventional use the mean reaction time is the lowest of the three metaphoric uses (3.208 sec.); the less conventional ones take a bit longer (3.686 sec.) and for the least conventional ones, reaction time climbs up to highest point (3.801 sec.). When it comes to literal meaning use, reaction time drops down again (3.256 sec.), but not as low as the most

conventional. For the control sentence, the reaction time sinks to the lowest point (3.025 sec.).

Also, the reaction time tends to show a proportional increase as the metaphor gets more novel. So a positive correlation is found to exist between the novelty of a metaphoric use and the difficulty in processing it. As is shown by Figure 4, difficulty in processing as measured by reaction times increases as the novelty of a metaphoric use increases.

Further analysis of the least significant difference (LSD) indicates that the difference between each sentence type is significant (LSD = .113). Not considering the literal meaning sentence type, the rest of the four are all significantly different, the smallest difference (.115) being larger than the LSD (.113). The fact that reaction time of literal meaning sentences comes close to the most conventional metaphoric sentences fits right into our prediction: they should enjoy similar ease of processing. What is interesting is that the mean reaction time for the most conventional metaphoric sentences is somewhat less than that of the literal meaning sentences (3.208 sec. vs. 3.256 sec.). This may indicate which of the two enjoys more ease in real-time processing.

Also note that the percentage of correct responses, as shown in Figure 1 previously, is another dimension which demonstrates the fact that degrees of difficulty in processing increases as the conventionality of the metaphoric use decreases.

Discussion and Conclusions

The purpose of this research was to examine the role and the nature of conventionality in the use of metaphors in natural language processing. Our particular focus was 1) the relationship between different degrees of conventionality and degrees of difficulty in processing sentences of metaphoric use; and 2) the assessment of processing status of conventional metaphoric use and "literal meaning" use. To summarize the results, conventionality appeared to have a significant effect on subjects' performance when interpreting the sentence. Given the same syntactic structure and the same syntactic complexity, the more conventional a metaphor a sentence contains, the shorter it takes to process the sentence and the fewer errors the subjects make. There is a positive correlation between the degree of novelty of a metaphoric use and the degree of difficulty in processing it. This suggests that there exists a larger conceptual distance for interpreting the more novel metaphoric use, i.e. a novel metaphor "travels" more conceptual distance before it is understood. These results are supportive of the assertion that the interpretation of novel metaphors can be accomplished through systematic extension, elaboration, and combination of knowledge about already well-understood metaphors, which could well be demonstrated by the longer reaction times that are taken to process those sentences. The larger the conceptual distance there is, the longer the reaction time it takes to "travel through".

The differences that lie in the ease of processing sentences with different degrees of novelty in metaphoric use can be accounted for in terms of spreading activation (as defined in Anderson 1976) in the metaphoric associations between the source domain and target domain. The mapping of the metaphoric associations is a highly interconnected structure. The basic mechanism at work is this: some of the dimensions of the source domain get extended and sprout and connect to a target domain, just in the same way a pointer connects to a different node. That target domain may later acquire the status of being a source domain when one of its dimensions gets extended to a newer node, which then becomes a target domain. Hence the process of interpreting a novel use of a metaphor involves the making of a massive metaphoric association net. Take the following examples from Martin (1990).

a) Mary *has* a cold.
b) John *got* his cold from Mary.
c) Mary *gave* John a cold.

The conventional metaphor Infection-As-Possession as in *Mary has a cold* serves as a source domain. It gets extended to the target domain and acquires new metaphorical uses, i.e. Becoming-Infected-As-Getting as in *John got his cold from Mary*, and Causing-Infection-As-Transferring as in *Mary gave John a cold.* Both extended meanings are built on the basis of the source domain. The primary metaphorical meaning is Infection-As-Possession. Becoming-Infected-As-Getting and Causing-Infection-As-Transferring are secondary to the primary metaphorical meaning. The target domain exists on the basis of the source domain.

That the conventional metaphor can usually serve as the source domain from which a newer metaphoric use gets extended means that novel metaphors are *extended* from an existing metaphor rather than *created* out of nowhere. The connection exists during the process of extension, even though the reader/hearer may not be able to make it, in which case they tend to fail to capture the targeted metaphorical meaning. When processing novel metaphors, people have to make use of their existing knowledge about the already well-understood metaphors, the ones that serve as source domains. For the novel metaphors, people need to make the connections. Thus the more nodes there are, the more difficult it is to process the metaphoric use and the longer time it takes. Just as a larger spatial distance would take more time to cover, a larger conceptual distance also requires more time to complete the "travel".

The results showed no apparent advantage in processing "literal meaning" sentences as compared to conventional metaphors. In fact, the most conventional metaphoric use took less time to process than the literal meaning sentences, even though the difference may not be significant. (3.208 sec. vs. 3.256 sec.). The results of the percentage of correct responses also demonstrated this fact (78.3% vs. 77.7%). These results refute the claim that metaphorical meaning is secondary to literal meaning in processing. They also delimit the boundary between the so-called "literal meaning" and the most conventional metaphoric meaning.

The present results on the role and nature of conventionality of metaphoric use lend support to the metaphoric knowledge approach in natural language processing. In particular, they reveal the connections of metaphoric uses that are otherwise thought to be unconnected, and more importantly, they suggest that the

connections are systematic and meaningful. These results would certainly help build knowledge representations to account for those otherwise seemingly distinct and unrelated word senses.

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Appendices: Stimuli and Test Sentences

Set 1

Paraphrase	*John caught his cold from Mike.*
Least Novel	Mike gave John his cold.
Less Novel	Mike passed his cold to John.
Most Novel	Mike threw his cold to John.
Literal	Mike infected John with his cold.
Control	Mike died of John's cold.

Set 2

Paraphrase	*Beth created the idea.*
Least Novel	Beth produced the idea.
Less Novel	Beth manufactured the idea.
Most Novel	Beth assembled the idea.
Literal	Beth formulated the idea.
Control	Beth disliked the idea.

Set 3

Paraphrase	*That politician was accused of promoting dissent.*
Least Novel	That politician was accused of spreading dissent.
Less Novel	That politician was accused of sowing dissent.
Most Novel	That politician was accused of planting dissent.
Literal	That politician was accused of motivating dissent.
Control	That politician was accused of opposing dissent.

Set 4

Paraphrase	*Can you tell me how to terminate the process?*
Least Novel	Can you tell me how to kill the process?
Less Novel	Can you tell me how to wipe out the process?
Most Novel	Can you tell me how to slay the process?
Literal	Can you tell me how to stop the process?
Control	Can you tell me how to start the process?

Set 5

Paraphrase	*Teachers help their students to learn.*
Least Novel	Teachers cultivate their students.
Less Novel	Teachers garden their students.
Most Novel	Teachers fertilize their students.
Literal	Teachers teach their students.
Control	Teachers spoil their students.

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