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(Sense Ability: Psycho- and Neuro- Linguistic Processing II)

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Sense Ability: Psycho- and Neuro- Linguistic Processing (II)

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SUMO   WordNet

, SUMO, WordNet

Abstract

This past year, we investigated two questions:

(1) Are conventional metaphors and novel metaphors processed in different hemispheres?

(2) Can we systematically extract conceptual metaphors from large scale corpora to determine their source domain and generate their mapping principles?

Neuro-imaging studies can now look at whether conventional and anomalous metaphors are processed in different locations in the brain. We created a block-randomized design in Mandarin Chinese containing three conditions: conventional metaphor sentences, literal sentences, and anomalous metaphor sentences. Right hemisphere activation was found and suggests that remote associations are being formed while reading the anomalous metaphor sentences, and that metaphors will vary in recruitment of cortical function depending on their type.

Second, we systematically extract the conceptual metaphors and mapping principles via SUMO and WordNet from both English and Chinese corpora.

To sum up, we can better understand the mechanism of processing conceptual metaphors through conducting the neuro-imaging and corpus-based studies. Our project will aid in understanding how the meanings of lexical items are stored and represented in the mental lexicon.

Keywords: fMRI experiment, conceptual metaphor, novel metaphor, mapping principles, SUMO, WordNet

Where are metaphors processed in the brain? Bottini et al. (1994) ran a positron emission tomography activation study to

explore the role of the right hemisphere in metaphor processing. They asked six male subjects to evaluate the plausibility of both metaphorical and literal sentences by raising their left index finger to indicate plausible sentences and to do not do anything for implausible sentences. Examples of the four sentence types are given below.

Metaphorical sentences
The close friends were elastic bands.(Implausible)
Tim had been poured into his clothes and forgotten to say when (Plausible)
Literal sentences
The teacher used her glasses as a blackboard. (implausible)
The policeman taught that arteries can be routes. (plausible)

They found significant activation in the right hemisphere in the prefrontal region (BA46), middle temporal gyrus (BA21) and precuneus (BA31), anterior and posterior cingulate (BA 32/31). They suggested that their findings argued for a role of the right hemisphere in performing complex language operations, such as interpreting connotative meaning.

Bottini's study, while important for its contribution to understanding the right hemisphere's role in language processing, has methodological issues that need to be addressed. One main issue is that the level of plausibility for the metaphorical sentences is overall lower than that of the literal sentences (i.e. 79% versus 95%). That is to say, it was harder for subjects to decide if the metaphorical sentences were plausible or not. This could mean that the right hemisphere activation was not a result of processing metaphors, it was instead a result of the difference in difficulty to making a plausibility decision. Newman et al. (2002) and Stowe et al. (1998), for example, argue that the right frontal gyrus is recruited for problem-solving.

Thus, in this project, we will look again at the location of metaphor processing in the brain, but we will only ask subjects to read the sentences to themselves and to press a button when they are done reading. The study will have three conditions: a literal sentence condition, a conventional conceptual metaphor condition, and an anomalous metaphor condition.

In the following, we, first, will report the fMRI study. Second, we will give a brief summary of how we extract conceptual metaphors systematically via SUMO and WordNet.

1. fMRI Study

Method
Participants
Participants were 8 right-handed, neurologically normal males students from Chang Keng University (mean age = 21). They were all native speakers of Mandarin Chinese and right-handed by self-report. All gave informed consent using a form approved by Chang Keng University Hospital and were paid for their participation.

Materials and Procedures
Three types of sentential stimuli were created: conventional metaphor sentences, anomalous metaphor sentences and literal sentences. Each condition had 36 sentences, for a total of 108 sentences (please see Ahrens 2004 for further information on the methods and procedures.)

Results
Behavioral Performance
The average reaction time to the literal condition was 1483.75 ms, to the conventional metaphor condition was 1539.76 ms and to the anomalous metaphor condition was 1657.32 ms. Reaction times were tested by one-way ANOVA. The statistical results shows that there is a significant difference between each group ($F(2, 841) = 8.016$, $p < .01$). The Bonferroni post-hoc test also shows that the anomalous metaphors are significantly responded to slowly than the conventional metaphors and literal sentences. However, there is no significant difference in reaction times between the conventional metaphors and literal sentences.

Brain Activations
Conventional metaphors – literal sentences condition. There was greater activation in the left inferior temporal gyrus (BA21) and right inferior temporal gyrus (BA 20) when the conventional metaphor condition was compared with the literal sentences condition.

Anomalous metaphors – literal sentences condition. There was greater

activation throughout the right frontal gyrus (BA8, 9, 47) and right middle temporal gyrus (BA46) as well as activation in the left middle frontal and temporal gyrus (BA46, BA21), precuneus (BA 19) and fusiform gyrus (BA18).

Anomalous metaphors – conventional metaphor condition. There was greater activation throughout the right frontal gyrus (BA 8, 9, 46) and precuneus (BA 19), as well as activation in the left middle frontal gyrus (BA 46), and left fusiform gyrus (BA 37).

Discussion

The results presented here demonstrate that conventional metaphors are recruiting some additional left and right hemisphere areas in the inferior temporal gyrus as compared with literal sentences. This finding is unexpected given the conceptual metaphor theory (Lakoff, 1993), which postulates no additional effort for conventional conceptual metaphors.

However, the results presented here could be a result of the block design that we used. In a block design, subjects see sentences from the same condition (in our case, six sentences of the same type). It is possible that subjects are adopting different cognitive strategies when reading these sentences one after another than they would if they were not aware (or less aware) that the sentences they were reading involved conceptual metaphors. It is the nature of the block design to emphasize the sameness of the stimuli under study, and is an implicit confound of block-design experiments. In order to test see if this confound is leading to unwarranted activation effects, we are planning to carry out an event-related fMRI study with the same stimuli in which we will randomly present the stimuli in order to see if these effects disappear.

In contrast to the conventional versus literal condition, when the anomalous condition is compared with the literal condition, increased activation is extensive, occurring in the left and right middle temporal gyrus, as well as throughout the right frontal gyrus (superior, middle and inferior), and the left middle frontal gyrus and precuneus. Although it has been suggested that the right frontal lobe is involved in active responses or judgments (Bookheimer 2002) and problem-solving in relation to working memory constraints (Newman et al., 2002; Stowe et al., 1998),

the task here was simply a reading task. No problem solving or judgments were involved.

Our findings thus point to the idea that the right frontal lobe is involved in semantic processing, especially involving unusual semantic relationships (Seger et al. 2000) as well as in the processing of distant meaning associations (Beeman, 1998; Beeman et al., 1994). These studies by Beeman and colleagues have suggested that the right hemisphere treats meaning associates equally, while the left hemisphere involves semantic processing of close meaning associates. This hypothesis concerning the right hemisphere being recruited to process unusual semantic relationships is further supported by the comparison between the anomalous and conventional metaphor conditions, where the anomalous condition shows comparative activation throughout the right frontal gyrus (superior, middle and inferior) and precuneus. The right hemisphere activation here suggests that remote associations are being formed while reading the anomalous sentences.

This difference in activation volume and area for anomalous metaphors as compared with conventional metaphors is further evidence for theories of metaphor processing that allow for and can explain differences among metaphor types, such as the *conceptual mapping model* (Ahrens 2002c) and the *conceptual blending theory* (Fauconnier & Turner 1998), and evidence against psycholinguistic theories such as a the *property attribution model* that defines metaphors as class inclusion statements (i.e. Glucksberg, 1998; Glucksberg & Keysar 1990). When metaphors are defined as class inclusion statements, there is no room for different types – all metaphors are created equal, which is the opposite of what we are arguing here, that there are different types of metaphors, and different gradations of novelty that can be measured both behaviorally and in terms of brain activation once the linguistic criteria for differentiating them can be explicated, as discussed in Ahrens (2002c). However, the fact that there was frontal activation found for anomalous metaphors (as compared with the conventional condition) indicates that this is not, in fact, the case.

2. Corpus Study

The corpora-based analysis of conceptual metaphors started with the work

of Chung, Ahrens, & Sung (2003). In this work, they calculated the frequency of conceptual metaphors in the Chinese and English corpora based on the Conceptual mapping Model (Ahrens 2002a, 2002c). The frequency account of conceptual metaphors was then assisted with the Suggested Upper Merged Ontology (SUMO) in Ahrens, Chung & Huang (2003) and Chung, Huang & Ahrens (2003), Chung, Ahrens, & Huang (2003), Chung, Ahrens, Sung (2003) and Chung, Ahrens & Huang (2004a, 2004b). In these studies, the Mapping Principles (MPs) between the source and target domains were verified through observing the related SUMO nodes of the most prototypical (i.e., the most frequent) mappings. The incorporation of SUMO was the first step to make the generation of MPs more automatized. This helped reduce the manual work that was carried out based on intuition.

In 2004, Chung, Ahrens, & Huang (2004a and 2004b) further proposed that the manual selection of the source domains can be made computational through observing their definitions in WordNet and SUMO. This is a crucial step as it proposed that the metaphorical items in a single source domain are inter-connected with one another. Ahrens, Chung & Huang (2004) suggested that the recurrence of the lexical items in the WordNet and SUMO definitions can be used to verify the MPs generated previously. These studies will lead us to systematizing the extraction of conceptual metaphors in corpora. The ultimate goals of these studies will contribute to field such as lexical semantic programming, lexicography and on-line lexical databases.

This past year, we followed our project schedule and achieved satisfying results. First, we completed the fMRI experiment. In addition, we have published the results at the well-known conference "Mind, Language and Metaphor: EURECO Conference on the processing of Metaphor and metonymy – From computers to neurospychology" at Granada, Spain, on May (Ahrens 2004). Finally, we have published what we extract from SUMO and WordNet at a number of conferences in this past year (Ahrens 2003c, Ahrens, Chung & Huang 2003, 2004, Chung, Huang & Ahrens 2003, Chung, Ahrens, & Huang 2003, Chung, Ahrens & Sung 2003, Chung, Ahrens & Huang 2004a and 2004b).

In the next year, we are going to continue two tasks. First, since we used the block design in our fMRI study, we are going to use the same stimuli to run another fMRI experiment with event-related design. Furthermore, we will continue to extract the conceptual metaphors via comparing with the lexical and domain information in SUMO and WordNet.

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