

# Novel Metaphor Comprehension in Brain: Electrophysiological insights

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**Abstract:** Novel metaphors symbolize the innovation of language, and their processing has become one of the focal issues in the field of cognitive science. This paper summarizes ERP studies and finds that the current processing models for novel metaphor processing are more in favor of the Structure Mapping Model. Relevant empirical studies reveal that the comprehension process of novel metaphors is influenced by syntactic elements, the nature of mapping, contextual cues, subjects' level of creativity, and experimental tasks. Future research should refine the processing of novel metaphors based on controlling for the influence of variables and improve theoretical and empirical studies.

**Keywords:** Novel Metaphor, ERP Studies, Comprehension.

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## 1. Introduction

Lakoff (1980) claims that the purpose of a metaphor is to help us comprehend and experience the present through something else. It can be divided into conventional metaphor with high familiarity and novel metaphor with low familiarity. Conventional metaphor can be easily understood, such as time is money. Novel metaphor, rarely employed in daily life, is an essential tool to understand unfamiliar situations and pick up new ideas, which also shows how flexible language is cognitively encouraging creative thinking in people (Abraham, Rutter, & Hermann, 2021). For an example of job is hell, it seems difficult to process the metaphor but precise to retrieve meanings of job through the concept of hell.

Research methods, like event-related potentials, fMRI, and eye-movement techniques, have used to neurocognitively investigate novel metaphor processing and evaluate brain activities, in which ERP, namely event-related potential, provides a non-invasive way to measure human brain activity (Lopez-Calderon, J, 2014). This paper reviews and summarizes the research results of ERP experiments for novel metaphor, and analyzes the limitations of the related theories, as well as the future research directions of novel metaphors.

## 2. Theoretical Models Related to Novel Metaphor

Since Lakoff and Johnson (1980) changed the metaphor of representation into the metaphor of thinking from a single linguistic level to the cognitive processing level of human thinking, many academics have proposed some theoretical models of novel metaphor processing.

### 2.1. Gradient Salience Model

According to the Gradient Salience Model (Giora, 2003), language salience, extracted from mental lexicon, influences how soon an expression of language is understood. Vicky (2009) indicates that the metaphorical processing did not adhere to the Gradient Salience Model because the metaphorical sentences were different from the literal sentences at the start of processing with N400 components. It is a common model to explain language processing phenomena, however, ERP studies have found that this model

is not applicable to metaphorical processing, probably because metaphorical processing symbolizes another linguistic cognitive mechanism and salience does not affect or interfere with metaphorical sentence comprehension.

### 2.2. The Structure Mapping Model

The Structure Mapping Model (Gentner & Wolff, 1997) introduces the process of metaphor processing in details. It can be divided into three stages: the first stage: Matching the two representations of ontology and metaphor without considering the structural consistency; Phase II: These local matches form structurally consistent kernels; Phase III: These cores merge into one or more of the largest structures consistent with interpretation. The experiment of Vicky (2009) demonstrated the first structural alignment of the Structure Mapping Model. However, the premise for the applicability of the model is that the audience has knowledge of the source domain and the target domain, but occasionally we can understand the connotation of this metaphorical sentence only through the source domain. For example, lawyers are sharks, we can understand the sentence although we do not know the specific characteristics of lawyers.

### 2.3. The Career of Metaphor Hypothesis

The Career of Metaphor (Bowdle & Gentner 2005) describes a metaphor's entire lifespan from a novel metaphor to a conventional metaphor and to a dead metaphor. Abraham (2021) conducted a study suggesting that under the certain conditions people are able to conventionalize novel metaphors. These findings might offer hints for comprehending the processes that support creative thinking, but they also reveal that The Career of Metaphor are not sufficiently detailed to explain the process of metaphor development.

## 3. Factors Affecting Novel Metaphor Processing

By combining the ERP experimental studies of novel metaphors, it has been determined that contextual clues, the nature of domain mapping, and the syntax of the metaphor all have an impact on how well the metaphor is processed. The subjects' level of creativity and the nature of the experimental

activity, in addition to the novel metaphor itself, have an impact on how quickly the novel metaphor is processed.

### **3.1. Syntactic constructions of Novel Metaphors**

Metaphors can be classified into nominal metaphors, verbal metaphors and adjective metaphors according to their syntactic structure. According to Vicky (2013), they used life can sometimes be bumpy, and novel verbal metaphors like every second of our time was attacked were designed to explore novel metaphor processing (Vicky, 2009). Columbus et al. (2015) demonstrated that a subject/verb metaphorical expression with an unfamiliar verb takes longer to read than a literal expression with the same verb when there is no supporting context. Taken together, the current study largely revealed substantial differences in the processing time of nominal and verbal novel metaphors. However, there haven't been any studies specifically focusing on adjectival metaphors, Future research should focus further on how adjectival metaphors are processed and how the three different forms of metaphors relate to one another.

### **3.2. Concreteness of Mapping Between Two Domains**

It is generally acknowledged that there is a mapping relationship between target domain and source domain, which facilitates understanding of metaphors, and research from the past few years has discovered that the type of mapping also influences how novel metaphors are processed.

According to Harris' (2005) experimental investigation, abstract metaphors appeared to be more acceptable. Li(2020) conducted ERP experiments to show that the response times for perceptual metaphors were significantly longer than for physical-psychological metaphors, supporting their conclusion that the classification is based on the concreteness of the mapping, with the mapping of the source domain to the target domain being a perceptual metaphor if it is concrete and a physical-psychological metaphor if it is abstract. From these empirical studies, it can be found that the nature of the mapping of metaphor domains, i.e., abstract or concrete, can influence metaphor processing in both novel and traditional metaphors.

### **3.3. Contextual Clues**

Through the gradual development of the study of metaphor, it has been discovered that the presence or absence of congruent contextual information can affect how novel metaphors are processed. Li (2020) discovered that perceptual metaphors with contextual clues induced more negative N400 components in the anterior position and more positive LPC components in the middle compared to those without contextual cues, indicating that processing metaphorical sentences with contextual cues is quicker and more efficient of cognitive resources. This empirical study found that different nature of metaphorical sentences triggered different brain area brain potential changes with or without contextual cues, which means that contextual cues made the syntax and semantics of the sentences more complex.

### **3.4. Different Creativity Levels of Participants**

Novel metaphors are a type of language innovation, and people with varying levels of creativity have different knowledge of novel metaphors. Anna (2021) conducted a study showing that the more creative group displayed more

positive waveforms in novel metaphors. This shows that highly creative people more readily integrate fresh and relevant links into conceptual knowledge networks and they are easily to create mapping paths between source domain and target domain, shortening processing time. However, there aren't enough ERP studies on the cognitive impacts of various levels of creativity on metaphor processing, most of which are focusing on other linguistic facts related to creativity, therefore additional research on diverse metaphors may be done in the future to supplement the existing evidence.

### **3.5. Different Tasks in Metaphor Comprehension**

The task subjects were asked to perform was also a variable in the experiment, and different experimental tasks also elicited differential brainwave changes in ERP studies that understood novel metaphor processing. Most ERP studies on metaphors have asked participants to judge the meaning of the given sentences. Coulson (2002) and Van Petten (2007) employed this reading task. Through two smaller studies, Karolina (2018) looked into how people process novel metaphors, and difference in amplitude between anomalous and novel metaphorical sentences was found to be widely distributed in the parietal region in the semantic judgement test, whereas it had a left bias effect in the reading task. This discovery might point to a distinction between semantic and recall processes and might serve as an inspiration for further study.

## **4. Discussion**

At present, with the development of metaphor-related research, the time course of metaphor processing and various factors affecting metaphor processing have been gradually clarified, but there are still problems that need to be further investigated.

Theoretically, there is no single theoretical framework for the processing of novel metaphors; the theoretical applicability of the Gradient Salience Hypothesis seems not to be applied to metaphorical systems, and the focus is on the sequential aspects of metaphorical processing; the Career of Metaphor Hypothesis describes the evolution of novel metaphors from birth to death metaphors, but without much details; the Structure Mapping Model remains problematic - one does not need to have specific knowledge of the two domains.

At the experimental level, just as the factors affecting novel metaphor processing part above, all kinds of influencing factors should be treated as an important variable to be controlled when doing ERP experiments in order to gain important gains in the process of verifying the theory.

## **5. Future Research Directions**

### **5.1. Follow-up Studies to Support the Theory**

Only a few ERP experiments have confirmed that the first stage of metaphor comprehension belongs to structural alignment in structural mapping, but research on the second and third stages has not been carried out effectively. The Structure Mapping Model describes how metaphors are processed in the brain through three stages. The Career of Metaphor Hypothesis also backtracks the inadequacies of the theory and only confirms the first of these steps; going forward, the entire metaphoric process should be

scientifically followed.

## 5.2. Experiments on Affecting Elements

Future studies should focus more on the reasons why these factors affect novel metaphor processing and use them as a breakthrough to find the specific modality. The processing of complex metaphorical sentences should also be studied, along with other aspects of metaphor, such as whether there are differences between the processing of complex metaphorical sentences and the processing of simple metaphorical sentences.

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