TIMING THE METAPHORIC BRAIN
Contribution of ERPs and Source Localization to Understanding Figurative Language

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Abstract: In a series of studies we examined the processing of unfamiliar metaphors using event related potentials (ERPs). We compared the patterns of brain electrical activity elicited by processing two-word expressions denoting literal, conventional metaphoric, and novel metaphoric meaning, as well as unrelated word pairs. Novel metaphors were drawn from poetry texts. The subjects performed a semantic judgment task in which they decided whether each word pair conveyed a meaningful expression. N400 amplitude to the second word of the pair varied as a function of expression type: literal expressions produced the smallest N400, unrelated pairs elicited the largest N400, and metaphoric expressions elicited N400 of intermediate amplitude. ERPs elicited by novel metaphors differed from those elicited by conventional metaphors both on N400 amplitude and scalp distribution. The effect of expression type was not reflected equally across the scalp, and each showed a particular time course and scalp distribution. These findings are consistent with recent brain imaging studies and complement them by adding the temporal dynamics dimension. The contribution to current models of figurative language processing will be discussed.

Key words: Event Related Potentials, N400, figurative language, metaphors, fMRI, LORETA

1. INTRODUCTION

Cognitive processes, such as language comprehension, are fast and complex and involve the interplay of multiple brain areas. Consequently, the use of behavioral measures such as accuracy and
reaction time alone, which are the end-product of the various mechanisms, cannot give a full representation of the processing dynamics. Inferences about processing stages can be made by experimental manipulation of variables affecting those mechanisms, but they produce only a crude representation of the actual processes. Similarly, brain imaging techniques based on haemodynamic measures, such as fMRI and PET, are more than adequate for determining the brain regions involved in cognitive processes, but their temporal resolution is too low to capture the dynamical aspects. Typical fMRI studies summarize brain activity in the order of seconds, which in cognitive activity terms is too long. Although fMRI techniques keep improving and have occasionally reached sub-second resolution, disentangling the time course of the various processes involved requires temporal resolution in the order of milliseconds. Electrophysiological recordings, such as event-related potentials (ERPs), possess such temporal resolution, and if used correctly can contribute to our understanding of cognitive mechanisms in the brain.

In this chapter we will show how ERPs can enhance our models of one of the most interesting phenomena of human cognition: figurative language. Using ERPs as ‘brain stethoscopes’, which provide a dynamic depiction of the processing of information by the brain, we attempt to elucidate a key question in language: whether the comprehension of metaphors, particularly unfamiliar ones, is achieved by the same mechanisms used for understanding literal expressions.

People encounter and use metaphoric expressions regularly in their daily lives. Expressions such as “that lawyer is a shark” are not meant to be taken literally but entail an alternative meaning. For example, when we say that ‘brain waves are stethoscopes’ we do not mean to say that brain waves (the topic or target of the metaphor) are really stethoscopes (the vehicle or base). Instead, our intention is to suggest that some properties of stethoscopes can be attributed to brain waves; just as cardiologists use stethoscopes to study the workings of the heart, neuroscientists can use brain waves to study the workings of the brain. It is of no surprise that several different models have been postulated to explain how the brain deals with such duality. One of the main issues that distinguish between the various models is whether metaphorical expressions are processed using the same mechanisms that are used for understanding literal meanings. A further matter is the degree of involvement of the right hemisphere (RH) in understanding figurative meaning.