CORTEX 94 (2017) 73–86

Available online at www.sciencedirect.com

ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Research report

Neural correlates underlying the comprehension of deceitful and ironic communicative intentions

Francesca M. Bosco [a,b], *Alberto Parola* [a,*], *Maria C. Valentini* [b,c] *and Rosalba Morese* [a,d]

[a] *Center for Cognitive Science, Department of Psychology, University of Turin, Italy*
[b] *Neuroscience Institute of Turin, Italy*
[c] *Department of Neuroradiology, Hospital/Città della Salute e della Scienza, Turin, Italy*
[d] *Faculty of Communication Sciences, Università della Svizzera Italiana, Lugano, Switzerland*

ARTICLE INFO

Article history:
Received 7 July 2016
Reviewed 2 November 2016
Revised 31 December 2016
Accepted 13 June 2017
Action editor Jordan Grafman
Published online 27 June 2017

Keywords:
Communicative intention
Pragmatics
Deceit
Irony
fMRI
Speech act
Comprehension

ABSTRACT

Neuroimaging studies have shown that a left fronto-temporo-parietal cerebral network is recruited in the comprehension of both deceitful and ironic speech acts. However, no studies to date have directly compared neural activation during the comprehension of these pragmatic phenomena. We used fMRI to investigate the existence of common and specific neural circuits underlying the comprehension of the same speech act, uttered with different communicative intentions, i.e., of being sincere, deceitful or ironic. In particular, the novelty of the present study is that it explores the existence of a specific cerebral area involved in the recognition of irony versus deceit. We presented 23 healthy participants with 48 context stories each followed by a target sentence. For each story we designed different versions eliciting, respectively, different pragmatic interpretations of the same target sentence – literal, deceitful or ironic–. We kept the semantic and syntactic complexity of the target sentence constant across the conditions. Our results showed that the recognition of ironic communicative intention activated the left temporo-parietal junction (lTPJ), the left inferior frontal gyrus (lIFG), the left middle frontal gyrus (lMFG), the left middle temporal gyrus (lMTG), and the left dorsolateral prefrontal cortex (lDLPFC). Comprehension of deceitful communicative intention activated the lIFG, the lMFG, and the lDLPFC. fMRI analysis revealed that a left fronto-temporal network–including the inferior frontal gyrus (IFG), the dorsolateral prefrontal cortex (DLPFC) and the middle frontal gyrus (MFG)–is activated in both irony and deceit recognition. The original result of the present investigation is that the lMTG was found to be more active in the comprehension of ironic versus deceitful communicative intention, thus suggesting its specific role in irony recognition. To conclude, our results showed that common cerebral areas are recruited in the comprehension of both pragmatic phenomena, while the lMTG has a key role in the recognition of ironic versus deceitful communicative intention.

* *Corresponding author*. Department of Psychology, University of Turin, Via Po 14, 10123, Turin, Italy.
E-mail address: alparola@unito.it (A. Parola).

http://dx.doi.org/10.1016/j.cortex.2017.06.010
0010-9452/

1. Introduction

The aim of the paper was to investigate the neural correlates involved in the recognition of the same speech act uttered with different communicative intentions, that is, of being sincere, deceitful or ironic. More in detail, we wanted to investigate the existence of a specific neural correlate involved in the comprehension of the same speech act, uttered with the communicative intention of being ironic versus deceitful.

Pragmatic ability, i.e., the use of language in a specific context (Levinson, 1983) requires the listener to do more than merely decode the literal sense, and involves inferential processes in order to fill the gap that often exists between the literal meaning and the speaker's communicative intention (Bara, 2010; Bosco, Bono & Bara 2017; Grice, 1991; Searle, 1979). The ability to correctly infer the communicative intention that lies beyond a specific speech act is a key process in human communication, since it allows people to distinguish among the possible alternative interpretations of the same utterance. A classical example is irony: a person could say [1] "*What a brilliant performance*!", [a] sincerely to communicate to his partner that he performed brilliantly, or alternatively [b] ironically, to underline that his partner's performance was disastrous, or also in order to deceive, if he thinks the performance was a disaster but he has personal reasons for lying. Thus the same statement could be sincere, ironic or deceitful according to the context in which it is proffered (Bara, 2010; Bosco & Bucciarelli, 2008).

Irony has traditionally been defined as a non-literal form of communication whereby the speaker implies the opposite of what he says (Grice, 1975; Searle, 1979), as in [2] "*What a beautiful day*" uttered while it's raining. Thus a distinctive element characterizing irony is the presence of a contrast between what a speaker literally says and her private knowledge, and in order to understand irony a listener has to understand such contrast (Bara, 2010; Bosco & Bucciarelli, 2008). The notion of irony is close to that of sarcasm, even though the latter is considered to be more bitter and caustic, and is usually directed against an individual (Gibbs, 1986). Sarcasm is thus generally considered a stronger form of verbal irony used to indirectly convey the speaker's criticism of a victim, which is able to provoke in the listener a negative attitude such as scorn or contempt (McDonald, 1999; McDonald & Pearce, 1996).

In the present investigation we considered all forms of irony and did not specifically focus on sarcasm. However, given the relationship between the two pragmatic phenomena we also took studies focusing on sarcasm into consideration.

Some authors have argued that the ability to infer the speaker's mental states, i.e., the theory of mind (ToM, Premack & Woodruff, 1978), is necessary to identify the ironical attitude expressed by a speaker (Sperber & Wilson, 2002). The relationship between ToM and irony is still not completely clear in the current literature: some studies have found this association (Happé, 1993), whereas others have not or have observed that it can be partially mediated by other cognitive functions, such as executive functions (Martin & McDonald, 2005; Mo, Su, Chan, & Liu, 2008). Furthermore, several studies have reported that irony is more difficult to comprehend and to produce than a literal statement, due to the high inferential load that processing irony requires (Bosco, Angeleri, Colle, Sacco, & Bara, 2013; Bosco, Angeleri, Sacco, & Bara, 2015; Colle et al., 2013; Honan, McDonald, Gowland, Fisher, & Randall, 2015; McDonald et al., 2014; Parola et al., 2016; Shany-Ur et al., 2012).

Recent neuroimaging studies have shown that the recognition of communicative intention during the comprehension of a speech act is a high level process that recruits extended cerebral networks (e.g., Bara, Ciaramidaro, Walter, & Adenzato, 2011; Jang et al., 2013; Rapp, Mutschler, & Erb, 2012; Schnell et al., 2016; Shibata, Toyomura, Itoh, & Abe, 2010; Spotorno, Koun, Prado, Van Der Henst, & Noveck, 2012; Uchiyama et al., 2012). In particular, in the last decade an increasing number of studies have explored the neural basis of irony comprehension. Uchiyama et al. (2006) found prominent activation in the inferior frontal gyrus (IFG), in the middle temporal gyrus (MTG) and in the medial prefrontal cortex (mPFC) during irony recognition. The authors interpreted activation in the mPFC as being related to mentalizing activity, and activation in the inferior frontal regions and MTG as being related to activity in the semantic-executive system engaged in semantic retrieval, selection and evaluation during sentence comprehension. Shibata et al. (2010) also observed activations in the mPFC and MTG/superior temporal sulcus (STS) during irony comprehension tasks, confirming the role of these regions in high-order linguistic processing. Spotorno et al. (2012) found irony recognition to be associated with activity in several areas pertaining to the mentalizing network (Frith & Frith, 2006), i.e., MPFC, temporal-parietal junction (TPJ) and the precuneus. The authors also found that irony activated the IFG, MTG and dorsolateral prefrontal cortex (DLPFC), which they suggested was related to the high executive demands and integrative processes involved in the comprehension of complex forms of language. As a whole, these studies have shown that understanding irony is a demanding process involving a cerebral network that includes several fronto-temporal and fronto-parietal areas, as confirmed by recent meta-analyses (Bohrn, Altmann, & Jacobs, 2012; Rapp et al., 2012).

Deceit has been defined as an intentional attempt to modify the listener's mental state in order to create a false belief (Perner, 1991). A deceitful speech act is an insincere form of communication, in which a speaker utters something that she privately thinks is untrue. To distinguish deceit, the listener has to recognize the contrast between the speaker's utterance and the real state of affairs (Bara, 2010; Bosco & Bucciarelli, 2008), and make inferences about the speaker's actual beliefs. For this reason it has been associated with the ability to attribute mental states, i.e., a ToM (Winner, Brownell, Happé, Blum, & Pincus, 1998).

However, difficulties exhibited by typically developed children in recognizing deceit seem to be not only related to ToM ability, but also to the cognitive load that comprehension of deceitful speech acts requires. Indeed, successful recognition of deceit involves the ability to manage conflicting representations, due to the presence of a contrast between what the speaker says and her private knowledge, and inhibitory control (Bosco & Bucciarelli, 2008; Dennis, Purvis, Barnes,