NeuroImage 60 (2012) 179–188

Contents lists available at SciVerse ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/ynimg

Imaging first impressions: Distinct neural processing of verbal and nonverbal social information

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ARTICLE INFO

Article history:
Received 8 July 2011
Revised 12 December 2011
Accepted 15 December 2011
Available online 27 December 2011

Keywords:
Amygdala
Posterior cingulate cortex
Verbal
Nonverbal
Impression formation
Person perception

ABSTRACT

First impressions profoundly influence our attitudes and behavior toward others. However, little is known about whether and to what degree the cognitive processes that underlie impression formation depend on the domain of the available information about the target person. To investigate the neural bases of the influence of verbal as compared to nonverbal information on interpersonal judgments, we identified brain regions where the BOLD signal parametrically increased with increasing strength of evaluation based on either short text vignettes or mimic and gestural behavior. While for verbal stimuli the increasing strength of subjective evaluation was correlated with increased neural activation of precuneus and posterior cingulate cortex (PC/PCC), a similar effect was observed for nonverbal stimuli in the amygdala. These findings support the assumption that qualitatively different cognitive operations underlie person evaluation depending upon the stimulus domain: while the processing of nonverbal person information may be more strongly associated with affective processing as indexed by recruitment of the amygdala, verbal person information engaged the PC/PCC that has been related to social inferential processing.

Introduction

In our everyday life we are ready to make fast and spontaneous judgments about other persons (Uleman et al., 2008), which are determined by our very subjective evaluation of the available information about the target person (Schiller et al., 2009). Furthermore, first impressions are mostly not restricted to inferences about enduring dispositions, e.g., that someone is intelligent because he passed a math test, but also encompass an evaluative component due to the assignment of a rather positive or negative value to someone's individual characteristics. Importantly, the outcome of such an evaluation crucially determines our expectations and behavior toward social others (Delgado et al., 2005; Uleman et al., 2008).

However, little is known about whether the cognitive processes mediating the evaluation of another person differ depending upon the domain of available information. While the traditional person judgment research has relied on verbal stimuli such as action description or trait adjectives, short excerpts of nonverbal behavior have been demonstrated to be equally effective in evoking differentiated assessments (Ambady et al., 2000; Kuzmanovic et al., 2011). But although ratings of other persons may lead to similar outputs across different domains of information, this does not allow for inferences regarding the degree of similarity of underlying cognitive processes. However, comparing the neural correlates of impression formation that relies on verbal and nonverbal person information, respectively, could be used as an index for such conclusions. Thus, the present study explores putative differences in the neural signature of the evaluative component of impression formation dependent upon whether the underlying relevant social information was presented verbally or nonverbally. Given the far-reaching consequences of impression formation within social interactions, elucidating possible domain-specific differences in the related neural processing would extend the understanding of interpersonal behavior and might have significant implications for social decisions.

Theoretical considerations suggest divergent processing streams across domains by stating that language is digitally defined by an explicit semantic code with a complex logical syntax, while the interpretation of analog nonverbal signals appears to be more uncertain as multiple cues may occur simultaneously and extend over time, and are known to have greater impact on the affective, relational level of communication (Kraemer, 2008; Watzlawick et al., 1967). Supporting these assumptions, a recent neuroimaging study indeed

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doi:10.1016/j.neuroimage.2011.12.046

has demonstrated domain-specific neural systems involved when drawing inferences about social targets' affective states: while verbal information processing was associated with the mental state attribution system including the dorsomedial prefrontal cortex (dmPFC), precuneus (PC), temporopolar and temporoparietal regions, the nonverbal information processing related to the right inferior frontoparietal network corresponding to the putative human mirror neuron system, bilateral amygdala, right superior temporal sulcus (STS) and fusiform gyrus (FFG) (Zaki et al., 2010). Direct comparisons between verbal and nonverbal stimuli though cannot identify specific differences in social cognition because of additionally present basic differences in sensory and cognitive processing across domains.

In the specific context of interpersonal judgments, little is known about the neural processing of dynamic nonverbal behavior. However, studies using still neutral faces have provided consistent evidence for the amygdala being crucially involved in their evaluation with respect to judgments of trustworthiness and valence (Todorov, 2008; Todorov and Engell, 2008; Winston et al., 2002). Although being generally associated with salience detection, and with assigning an emotional value to external cues, the response of the amygdala appears to be particularly sensitive for faces that convey significant social cues (Hariri et al., 2002; Sergerie et al., 2008). In contrast, the processing of verbal person information in the context of interpersonal judgments has been consistently associated with the dmPFC (Harris et al., 2005; Mitchell et al., 2002, 2005; Ochsner et al., 2005; Sugiura et al., 2004; Zysset et al., 2002). While this is in concordance with its central role in mental state attribution and person perception (Amodio and Frith, 2006), it has recently been demonstrated that the dmPFC is not specifically involved in evaluative processes of impression formation (Schiller et al., 2009). Instead, evaluation of others has been shown to differentially engage the amygdala and the posterior cingulate cortex (PCC), which were activated stronger by stimuli that guided subsequent judgments (Schiller et al., 2009). Additionally, these regions also exhibited increases in the BOLD signal with increasing strength of the evaluative judgment (Schiller et al., 2009). The study by Schiller and colleagues, however, failed to investigate putative stimulus domain-specific differences as they used simultaneously both verbal and nonverbal stimuli. Our study was conducted to directly address this aspect: Specifically, we were interested in exploring differences in neural processing of verbal and nonverbal social information, which evokes increasing strengths of evaluative person judgment.

Using functional magnetic resonance imaging (fMRI), we employed an experimental paradigm containing verbal (V) and nonverbal (NV) stimuli of different valences (positive, negative, and neutral). Participants were instructed to rate target persons along a global positive–negative scale based on either a) a short video clip showing an animated virtual character displaying dynamic expressive nonverbal behavior; or b) short verbal action description. Additionally, the arousal of all stimuli was assessed after scanning in order to control for this dimension of person perception. We aimed to identify brain regions whose activity correlated with the ‘strength’ of subsequent evaluations of social others based either on verbal or nonverbal information (operationalized as a difference from 0 on the rating scale, i.e., including both positive and negative judgments). Notably, we based this analysis on individual responses in order to take into account that the same piece of information can have different meanings or values for different persons. We expected that brain regions, which are involved in the evaluation of others, would increase their activation with increasingly pronounced impressions. By focusing on the parametric modulation of the neural activity by the ‘strength of evaluation’ (SoE), this paradigm allows to compare different domains, in spite of basic sensory and cognitive stimulus-specific processing differences. The SoE-effect was computed separately for each domain, so that across all events the basic stimulus characteristics were identical and differences related only to the degree to which they, in fact, influenced the subsequent evaluation of the target person.

Methods

Subjects

18 right-handed participants with no reported history of neurological or psychiatric illness were included in the study (9 males, mean age = 24.7, age range 21–29 years). All participants gave informed consent and were naïve with respect to the experimental task and the purpose of the study. The study was approved by the local ethics committee of the University Hospital Cologne.

Stimuli

Positive and negative verbal and nonverbal stimuli were created as reported in detail in Kuzmanovic et al. (2011). Verbal stimuli (V) consisted of sentences describing a social action suitable to induce an impression of a female target person (e.g., “She told the secrets of a colleague to the others.” vs. “She did not tell the secrets of a colleague to the others.”; see Fig. 1B). Nonverbal stimuli (NV) consisted of dynamic video clips of 3 s duration with an animated female virtual character displaying impression-evoking nonverbal signals. While using the same virtual character for all nonverbal stimuli, the following expressive features were systematically varied: Gaze direction (direct vs. averted gaze), facial expression (smile vs. angry face), body movements (forward vs. backward lean), and head movements (lateral vs. backward flexion) (see Fig. 1A). The purpose of the strict control of the target person's physical appearance was to ensure that both verbal and nonverbal stimuli conveyed individuated social information related to idiosyncratic behavior, which is not reducible to more superficial cues like face morphology or hair color. In addition, neutral verbal (non-social action descriptions: e.g., “She opened the drawer of her desktop.”) and nonverbal stimuli (non-expressive facial and body movements) were created in order to enable the comparison between impression-valent and impression-neutral stimuli. In each domain (V, NV), the three valence categories, i.e., negative (−), neutral (0) and positive (+), were matched for complexity. Verbal stimuli did not differ with regard to syntactic complexity as all sentences had a simple structure without any subordinate clauses and the same mean number of words (ANOVA of mean number of words per sentence for −, 0, +, $F(2,33) = .04$, $p = .96$). Furthermore, semantic complexity was also comparable across the valence conditions as there were no differences in the word frequency according to the German vocabulary project of the University of Leipzig (http://wortschatz.uni-leipzig.de/; ANOVA of mean word frequency per sentence for −, 0, +, $F(2,33) = .27$, $p = .76$). Finally, neutral, positive and negative nonverbal stimuli had the same quantity of movement as measured by the mean of frame-to-frame pixel change per stimulus (ANOVA, $F(2,33) = .40$, $p = .67$).

The stimuli were pretested in an independent sample ($n = 14$) with regard to ratings of valence (−3 = very negative to 3 = very positive) and arousal (−3 = not arousing to 3 = very arousing) resulting in mean ratings shown in Table 1. Paired t-tests revealed that positive verbal and nonverbal and negative verbal and nonverbal stimuli did not significantly differ regarding valence or arousal ratings ($p > .05$ for all comparisons). However, although neutral verbal and nonverbal stimuli were comparable concerning the valence ratings ($p > .05$), they differed with regard to arousal ratings ($t(13) = -2.85$, $p = .01$) with neutral verbal stimuli being rated as less arousing than neutral nonverbal stimuli.

Procedure

Stimulus presentation and response recording were performed by the software package Presentation (version 13.1; Neurobehavioral Systems, Inc). Stimuli were projected onto a screen (Optostim, 32-inch, resolution 1280×800) at the end of the magnet bore that