Research Report

The communicative style of a speaker can affect language comprehension? ERP evidence from the comprehension of irony

Stefanie Regel⁎, Seana Coulson, Thomas C. Gunter

Max-Planck-Institute for Human Cognitive and Brain Sciences, PO Box 500 355 D-04303 Leipzig, Germany
Department of Cognitive Science, University of California, San Diego, USA

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ABSTRACT

An important issue in irony comprehension concerns when and how listeners integrate extra-linguistic and linguistic information to compute the speaker’s intended meaning. To assess whether knowledge about the speaker’s communicative style impacts the brain response to irony, ERPs were recorded as participants read short passages that ended either with literal or ironic statements made by one of two speakers. The experiment was carried out in two sessions in which each speaker’s use of irony was manipulated. In Session 1, 70% of ironic statements were made by the ironic speaker, while the non-ironic speaker expressed 30% of them. For irony by the non-ironic speaker, an increased P600 was observed relative to literal utterances. By contrast, both ironic and literal statements made by the ironic speaker elicited similar P600 amplitudes. In Session 2, conducted 1 day later, both speakers’ use of irony was balanced (i.e. 50% ironic, 50% literal). ERPs for Session 2 showed an irony-related P600 for the ironic speaker but not for the non-ironic speaker. Moreover, P200 amplitude was larger for sentences congruent with each speaker’s communicative style (i.e. for irony made by the ironic speaker, and for literal statements made by the non-ironic speaker). These findings indicate that pragmatic knowledge about speakers can affect language comprehension 200 ms after the onset of a critical word, as well as neurocognitive processes underlying the later stages of comprehension (500–900 ms post-onset). Thus perceived speakers’ characteristics dynamically impact the construction of appropriate interpretations of ironic utterances.

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1. Introduction

Understanding the precise meaning of the phrase, “Go ahead, make my day,” depends heavily on the context of utterance, but not, in most cases, on the identity of the speaker. However, when uttered by Clint Eastwood as the character Dirty Harry, the speaker’s identity is very important for comprehending its meaning. In such a case, knowing that Harry used this phrase when he needed an excuse to harm his enemies, helps the listener to interpret the meaning of his famous phrase “Go ahead, make my day.” In fact, there are many situations in everyday life where pragmatic information about the speaker’s relevance for language comprehension, and can often influence the interpretation of a speaker’s intended utterance meaning.

Such extra-linguistic information is especially important for understanding non-literal language such as metaphor or irony.

⁎ Corresponding author. Fax: +49 341 9940 2260.
E-mail address: regel@cbs.mpg.de (S. Regel).
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For instance, imagine a speaker saying “This book is fabulous” after having read several boring passages. In this context, he is rather likely to convey an ironic meaning that differs from that of the literal sentence meaning, and perhaps even expresses the opposite meaning. Considered as a type of figurative language, irony generally implies more subtle and often different meanings that extend the literal sentence meaning by expressing an evaluation of the situational events to which they refer. Consequently, pragmatic (extra-linguistic) information about the speaker’s attitudes and emotional states might be expected to play an important role in irony comprehension. Indeed, behavioral studies have shown that listeners take longer to read ironic utterances made by speakers whose occupation (e.g. priests) makes it unlikely they would speak ironically (Katz and Pexman, 1997; Pexman and Olineck, 2002). Therefore, Pexman et al. (2002) speculated that the more sarcastic a speaker is believed to be, the more likely his or her comments will be interpreted as ironic.

In the present study, we aimed to investigate the effects of speaker-related pragmatic knowledge on literal and figurative language comprehension. In particular, we examined whether the processing of irony is influenced by the speaker’s communicative style, in this case, the relative frequency of a given speaker’s use of ironic comments. In everyday communication, pragmatic knowledge about a speaker is established by the attitudes he or she expresses, and the way he or she reacts to certain events. We hypothesized that listeners might be able to utilize pragmatic knowledge about a speaker’s individual communicative manner in the interpretation of their utterances. For example, it might be easier to interpret a speaker’s ironic remark if the speaker is known to make ironic remarks on a regular basis.

The influence of such extra-linguistic information on figurative language comprehension is a matter of dispute in psycholinguistics. Whereas some authors have suggested that context mainly affects late comprehension processes (see Grice, 1975; Giora, 1999, 2002), others have argued that context influences lexical-semantic processing (see Gibbs, 2002). In the standard pragmatic model (Grice, 1975; Grice, 1989; Searle, 1979), the comprehension of figurative language begins with the activation of the literal meaning of the sentence and its integration with preceding contextual information. The resulting semantic incompatibility then triggers additional inferential processes to yield the contextually appropriate meaning. Similarly, the graded salience hypothesis by Giora (1999, 2002) assumes an activation of the most salient meaning initially, regardless of contextual fit or a sentence’s figurativity. If salient meanings are incongruent with contextual information (processed in parallel), additional comprehension processes are necessary to build up a coherent sentence representation. In contrast, the direct access view (Gibbs, 2002) suggests that contextual information has an immediate influence on language comprehension enabling the direct access of appropriate ironic or literal meanings. According to the direct access model, when contextual information supports a figurative or ironic meaning, no incompatibility phase is predicted.

### 1.1. Event-related brain potentials (ERPs)

Evoked potentials (ERPs) allow the investigation of neurocognitive processes involved in the comprehension of figurative language by imaging the time course of processing and distinguishing underlying comprehension processes. One ERP component related to language processes is the N400 component, a negative-going brain potential whose amplitude peaks around 400 ms after stimulus presentation. The N400 was first observed by Kutas and Hillyard (1980) for semantically anomalous sentence completions. N400 amplitude has also been shown to be modulated by semantic expectancy and contextual constraint (see Kutas et al., 2006 for review). The amplitude of N400 elicited by words in sentence contexts has been shown to be inversely proportional to its cloze probability,\(^1\) a measure of a word’s predictability as assessed by a sentence completion task. N400 amplitude is thus large for unexpected endings with low cloze probability, small for expected completions with high cloze probability, and intermediate in amplitude for words with intermediate cloze probabilities (Kutas and Hillyard, 1984).

Moreover, modulations of the N400 have been reported for pragmatic anomalies (Kuperberg et al., 2003b; Laurent et al., 2006; Otten and Van Berkum, 2007), and violations of world knowledge (Hagoort et al., 2004; Hald et al., 2007). Thus, the N400 appears to be sensitive to lexical-semantic and pragmatic information processing.

Another relevant language-related ERP component is the P600 component, which is controversially debated with regard to its sensitivity. This late positivity emerges around 500 ms post-stimulus and has a centro-parietal scalp distribution. The P600 occurs reliably in response to various syntactic anomalies and has been associated with repair processes of the violated sentence structure (Friederici et al., 1993; Neville et al., 1991). Larger P600 amplitudes seen for non-preferred syntactic structures (Osterhout et al., 1994), or syntactically complex or ambiguous sentence structures (Friederici et al., 1996; Friederici et al., 2002; Kaan and Swaab, 2002) have been suggested to reflect structural reanalysis processes.

Since earliest reports of a syntax-related P600, this ERP component was shown to vary as a function of semantic information and stimulus probability, thus calling a syntax-specific interpretation into question (Coulson et al., 1998; Ericsson et al., 2008; Gunter et al., 1997; Gunter et al., 2000; Vissers et al., 2006). In line with these findings, numerous ERP studies have revealed P600-like effects in response to a variety of non-syntactic anomalies. For example, a late positivity was elicited by sentences such as “The cat that fled from the mice” which contained a semantic reversal anomaly (Kolk et al., 2003; van Herten et al., 2005). Modulations of P600 have also been reported for pragmatically incongruous sentences (Kuperberg et al., 2003a) or thematic role violations (Hoeks et al., 2004; Kuperberg et al., 2003b; Nieuwland and Van Berkum, 2005).

The emergence of P600 to several types of linguistic information (i.e. semantic, syntactic and pragmatic information) provides evidence that this ERP component might be a reflection of more general language comprehension processes.

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\(^1\) The cloze probability of a given word in a sentence context is the proportion of participants who completed the sentence with that word on a sentence completion task known as the cloze procedure (Taylor, 1953). Contextually expected words thus have high cloze probabilities, while unexpected words have low cloze probabilities.
A large amount of research on figurative language comprehension concentrates on the comprehension of metaphors and idioms (e.g. Coulson and Van Petten, 2002; Coulson and Van Petten, 2007; Ferretti et al., 2007; Laurent et al., 2006; Pynte et al., 1996). Most of these studies reported greater amplitudes of the N400 for comprehending metaphoric or idiomatic sentences in relation to literal ones. Findings suggest that the semantic processing indexed by the N400 is more demanding for figurative than for literal language comprehension.

A differential pattern of brain activity has been observed for the processing of irony. In an ERP study by Cornejo et al. (2007), an N400 was reported for irony relative to literal sentences whose occurrence was dependent on the processing strategy applied for the comprehension of irony. An N400 emerged when participants were asked to focus on sentence plausibility (i.e. holistic interpretative strategy), but not when they were required to judge whether the sentence was related to the context (i.e. analytic strategy). Another recent study comparing ERPs to irony and equivalent literal sentences found no differences in the N400, but rather a larger late positivity for irony (Regel et al., in press). These findings suggest that the comprehension of irony need not involve difficulty at the stage of semantic integration (at least, as indexed by the amplitude of the N400), but rather requires effortful pragmatic interpretation indexed by the increased amplitude of the P600. While such studies clearly suggest contextual information plays an important role in the comprehension of irony, the extent to which irony comprehension is influenced by extra-linguistic information about the speaker is currently unknown.

A number of studies, however, have addressed anomalies resulting from explicit contextual knowledge about a speaker, and have typically reported N400 effects (Fischler et al., 1983; Van Berkum et al., 2008). For example, in one study participants learned social facts about fictitious characters (e.g. their occupation), and ERPs were recorded as they read sentences ostensibly uttered by those characters. The amplitude of the N400 was larger when sentences were inconsistent with a speaker’s occupation than when they were consistent with it (Fischler et al., 1983). In a recent study by Van Berkum et al. (2008), it was shown that information about a speaker’s identity (i.e. his or her gender as indicated by a male or female voice) was rapidly incorporated in sentence processing. Van Berkum et al. reported an increase of the N400 component (with a latency onset between 200 and 300 ms) for sentences that contrasted with expected speakers’ gender such as “I always rent movies with lots of violence in it!” uttered by a female voice. In contrast, Lattner and Friederici (2003) reported that stereotypical male or female utterances elicited a larger P600 when said by a speaker whose gender did not match the stereotype relative to one whose gender did (e.g. a male versus a female saying “I like to wear lipstick”). Similarly, in a study by Oosterhout, Bersick and McLaughlin (1997) stereotypical information about a male or female agent that was incongruent with a subsequent reflexive pronoun evoked an enhancement of the P600 component.

The present study was constructed to explore the influence of pragmatic knowledge regarding a speaker’s communicative style on the comprehension of ironic and literal sentences. Short discourses were created in which two particular speakers interacted with other interlocutors, and who could be expected to comment on described events in a different way, i.e. either ironically or literally. In these discourses, one of the speakers makes frequent use of irony, and consequently appears to be highly ironic; the other speaker appears to be rather sincere by using irony quite rarely. In this sense, both speakers differed from each other in their communicative style in expressing attitudes about the events described in a short discourse context. In order to avoid strategic processing whereby participants might focus on respective sentences uttered by one or the other speaker, specific characteristics of the speakers are not explicitly introduced but had to be detected implicitly by attentive reading of the stimuli. In this regard, the experimental setting used here remains comparable to real life settings in which listeners must implicitly note a speaker’s preferred way of expressing his or her attitudes.

Moreover, the question of whether this subtle pragmatic information serves as a reliable cue for language comprehension is central to the present study. Accordingly, we examine whether listeners continue to utilize speaker information when the communicative styles of the original speakers have noticeably changed (i.e. when both speakers reply ironically as often as they do literally). To explore this question the experimental paradigm included two sessions in which the speakers’ use of irony (frequently vs. infrequently) was manipulated. In the first session, listeners could perceive a clear difference in the communicative style of the two speakers. In the second session, this difference was balanced as both speakers were equally likely to make ironic versus literal statements. Thereby, it was investigated whether particular pragmatic knowledge can be acquired implicitly, and whether it is integrated into the processing of sentence meanings when a speaker’s communicative style has changed.

The ERP results mentioned above suggest the following predictions for the two experimental sessions of the present study. First, if information about a speaker’s communicative manner serves as an interpretive cue for listeners, a larger N400 component might be observed for incongruent conditions as reported in previous studies (Fischler et al., 1983; Van Berkum et al., 2008). Thus, a larger N400 for ironic utterances made by the non-ironic speaker would suggest that encountering utterances inconsistent with the speaker’s communicative manner can lead to difficulty in semantic integration. An increased N400 in response to literal language of the ironic speaker is not predicted, as it seems unlikely that this speaker would be perceived as completely insincere. Moreover, as previously observed, a larger late positivity is predicted for irony compared to literal language (Gunter et al., 2005; Regel et al., in press). If this irony-related positivity is modulated by speaker, it would suggest that pragmatic knowledge of the speaker’s communicative manner affects late processing stages in irony comprehension in which different types of information seem to be integrated (cf. Lattner and Friederici, 2003).
Behavioral and ERP data are described separately for Sessions 1 and 2 below.

### 2. Results of Session 1

#### 2.1. Comprehension task

A behavioral measure of participants’ comprehension of the discourses was obtained by the comprehension task. Therein the accuracy of a test statement concerning the discourse content had to be judged. Participants showed an excellent performance with a mean accuracy rate of 96.7% (SD 2.54). Behavioral results for all conditions are displayed in the left column in Table 1. An ANOVA with the factors Context and Speaker revealed a significant interaction between both factors ($F(1,39)=36.33$, $p<0.0001$). Separate analyses for the two speakers showed main effects of Context for both the ironic and non-ironic speaker ($F(1,39)=9.51$–$36.36$, $p<0.004$) indicating that participants made slightly more errors for congruent items (i.e. for irony of the ironic speaker as well as for literal utterances of the non-ironic speaker) than for incongruent ones. This result might be caused by the probability manipulation in which the majority of items was congruent (i.e. 70%) increasing error probability.

#### 2.2. Post-test questionnaire

After completion of the experimental session participants were asked to fill out a questionnaire in stating whether they perceived one speaker as more ironic than the other, and if so to name this speaker. Eight experimental items were presented that had to be completed with an ironic or literal sentence to control for reliability of participants’ reported perception. Analysis of the post-test showed that 78% (SD 0.42) of the participants correctly perceived the ironic speaker as being very ironic, 15% (SD 0.36) estimated the non-ironic speaker as the more ironic one, and 5% (SD 0.22) felt neither speaker was more ironic (see Table 2).

#### 2.3. Event-related brain potentials

Grand average ERPs at the target sentence final word seen for Session 1 are displayed in Figs. 1–3. ERPs for ironic compared to literal sentences show a slightly enhanced P200 amplitude on frontocentral electrode sites. An increased N400 component related to irony was not present. Instead a larger late positivity was evoked by utterances of the non-ironic speaker. ERPs elicited by the ironic speaker seem to be identical for both his ironic and literal sentences. Moreover, effects of Speaker are seen in the N400 time window in showing a larger frontocentral negativity for the non-ironic speaker relative to the ironic speaker.

#### 2.3.1. Statistical ERP analyses

Statistical analyses of the P200 latency window (200–300 ms) showed a three-way interaction of the factors Speaker, Context and ROI ($F(6,34)=5.49$, $p<0.001$). Follow-up analyses for the ironic and non-ironic speaker separately revealed interactions of ROI and Context, which were present for both speakers ($F(6,34)=2.51$–$3.56$, $p<0.04$). In separate analyses of each ROI, a marginally significant effect of Context was found for the ironic speaker in the central ROI, i.e. RS ($F(1,39)=3.58$, $p<0.07$). Since no further effects of Context were found ($F(1,39)=0.19$–$2.63$, n.s.), these early interactions between Context and ROI for both the ironic and non-ironic speaker cannot be clarified. ERPs for both speakers seem to vary by sentence type, and to differ in scalp distribution.

Analysis of the N400 time window of 300–500 ms revealed significant three-way interactions of Context with Anterior/Posterior and ROI ($F(6,34)=2.82$, $p<0.02$), as well as of Speaker with Anterior/Posterior and ROI ($F(6,34)=2.66$, $p<0.03$). Resolving the former interaction with Context by Anterior/Posterior revealed a marginal interaction of Context with ROI posteriorly ($F(6,34)=2.20$, $p<0.07$). Separate analyses for each posterior ROI showed no further effects of Context ($F(1,39)=0.05$–$1.11$, n.s.) indicating that an N400 effect was not present. The latter interaction with Speaker was resolved by Anterior/Posterior, and showed a marginally significant interaction between Speaker and ROI for anterior sites ($F(6,34)=2.07$, $p<0.08$). Separate analyses for anterior ROIs revealed a main effect of Speaker in the most central anterior ROI, i.e. A4 ($F(1,39)=9.62$, $p<0.004$). The analysis confirms that a frontocentral negativity was evoked by utterances of the non-ironic speaker.

Regarding the P600 time window of 500–900 ms, interactions between Context and ROI ($F(6,34)=2.48$, $p<0.04$), and between Context, ROI and Anterior/Posterior ($F(6,34)=4.91$, $p<0.002$) were found. The two-way interaction of Context with ROI was resolved by separate analyses for each ROI, and showed significant effects of Context in the two most central ROIs, i.e. R4 and RS ($F(1,39)=4.25$–$4.53$, $p<0.05$). The analysis confirms that an irony-related late positivity was present on frontocentral and centroparietal scalp sites. Analysis of this time window revealed a further interaction of Context, Speaker and ROI ($F(6,34)=2.99$, $p<0.02$). On the basis of this interaction, separate analyses were performed for each speaker. Significant two-way interactions of Context with ROI were found for both speakers ($F(6,34)=

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### Table 1 – Mean accuracy rates of all conditions obtained in the comprehension task for Sessions 1 and 2.

<table>
<thead>
<tr>
<th>Speaker</th>
<th>SESSION 1</th>
<th>SESSION 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ir. (SD)</td>
<td>Non-Ir. (SD)</td>
</tr>
<tr>
<td><strong>Ironic context</strong></td>
<td>97.0 (3.71)</td>
<td>97.8 (3.50)</td>
</tr>
<tr>
<td><strong>Literal context</strong></td>
<td>96.0 (4.26)</td>
<td>96.8 (3.73)</td>
</tr>
</tbody>
</table>

### Table 2 – Participants mean perception of speakers’ communicative style for Sessions 1 and 2 as obtained by the post-test questionnaire.

<table>
<thead>
<tr>
<th>Perception of speakers’ use of irony (in % (SD))</th>
<th>SESSION 1</th>
<th>SESSION 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The more ironic speaker</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ironic speaker</td>
<td>78 (0.42)</td>
<td>44 (0.50)</td>
</tr>
<tr>
<td>Non-ironic speaker</td>
<td>15 (0.36)</td>
<td>33 (0.47)</td>
</tr>
<tr>
<td>None of both speakers</td>
<td>5 (0.22)</td>
<td>25 (0.44)</td>
</tr>
</tbody>
</table>
3.82–4.01, \( p < 0.005 \). Separate analyses for each of the ROIs showed effects of Context for the non-ironic speaker in the three most central ROIs, i.e. R3–R5 (\( F(1,39) = 4.06–9.08, p < 0.05 \)) indicating that an irony-related late positivity was elicited by the non-ironic speaker. For the ironic speaker, no effects of Context were seen in any of the ROIs (\( F(1,39) = 0.03–1.76, \text{n.s.} \)), suggesting that ERPs in response to ironic and literal sentences were identical for this speaker. A late positivity was seen for both his ironic and literal utterances that was comparable in amplitude to the irony-related P600 of the non-ironic speaker.

3. Results of Session 2

3.1. Comprehension task

For Session 2 the mean accuracy rate on the comprehension questions was 96.3\% (SD 1.33), similar to that of Session 1 (see Table 1). The statistical analysis showed a main effect of Context (\( F(1,39) = 49.77, p < 0.0001 \)) indicating that participants had slightly more difficulty in responding to ironic discourses than to literal ones. In addition, a marginally significant interaction between Context and Speaker (\( F(1,39) = 3.13, p < 0.08 \)) was found. This interaction was resolved by Speaker, and revealed a main effect of Context for both the ironic and non-ironic speaker (\( F(1,39) = 12.45–49.36, p < 0.001 \)). Slightly more errors were made when both speakers replied in an ironic way relative to their literal utterances.

3.2. Post-test questionnaire

The results of the post-test showed that participants’ perception of the speakers’ characteristics changed in Session 2 (cf. Table 2). Only 25\% (SD 0.44) of the participants correctly noticed that neither speaker was more ironic than the other. Forty-four percent (SD 0.50) still perceived the ironic speaker as the more ironic one, and 33\% (SD 0.47) considered the non-ironic speaker more ironic than the other.

Fig. 1 – Grand average ERPs for Session 1 elicited by the sentence final word that pointed to an ironic sentence meaning (red line), or a literal meaning (blue line) with respect to the foregoing discourse context. The visual onset of the critical word is at 0 ms on the x-axis. In this and all subsequent figures, negativity is plotted upwards. The topographic map on the right side shows the scalp distribution of P600 in response to irony.
as highly ironic in the second session. Compared to Session 1, the correct perception of speakers’ use of irony was significantly reduced ($t(39)=5.55, p<0.0001$).

### 3.3. Event-related brain potentials

Grand average ERPs for Session 2 are shown in Figs. 3–5. Visual inspection of the ERPs suggests the P200 was larger when the meaning of the target sentence was congruent with the respective speaker (i.e. the non-ironic speaker replying literally, and the ironic speaker replying ironically). In the N400 latency range, a slightly increased negativity seems to be present for irony used by the non-ironic speaker compared to irony used by the ironic speaker. As in Session 1, a late positivity in response to irony was again seen. However, unlike Session 1 in which the irony-related positivity was evident only for the non-ironic speaker, in Session 2 this irony-related late positivity was apparent only for the ironic speaker.

**Fig. 2** – Grand average ERPs at the sentence final word to sentences uttered by the ironic speaker (dotted line), or the non-ironic speaker (solid line) for Session 1.

3.3.1. **Statistical ERP analysis**

In the P200 time window of 200–300 ms, a three-way interaction of Context with Speaker and ROI ($F(6,34)=2.54, p<0.04$) was obtained. This interaction was resolved by separate subanalyses for each ROI showing significant interactions of Context with Speaker in all ROIs ($F(1,39)=5.53–16.28, p<0.02$). On the basis of these interactions, further analyses were conducted for the two speakers. Main effects of Context were found for the non-ironic speaker in all ROIs ($F(1,39)=4.26–8.20, p<0.05$). For the ironic speaker a significant effect of Context was obtained in the most central ROI, i.e. R4 ($F(1,39)=5.09, p<0.03$) and marginally significant effects in adjacent ROIs, i.e. R2, R3, and R5 ($F(1,39)=2.97–3.56, p<0.09$). This analysis indicates that a larger P200 was evoked when speakers’ communicative style was congruent with respective sentence interpretations.

Statistical analysis of the N400 time window showed a two-way interaction of Context and Speaker ($F(1,39)=5.98, p<0.02$). Follow-up analyses for each speaker type separately showed a significant effect of Context solely for the ironic speaker ($F(1,39)=4.86, p<0.05$). This analysis confirms that for the ironic speaker, less negative ERPs were observed for irony than literal statements. Moreover, an effect of Speaker was also obtained in this time window ($F(1,39)=4.08, p<0.05$), as ERPs in response to the non-ironic speaker were slightly more negative than those to the ironic speaker.
Analysis of the P600 time window of 500–900 ms revealed a three-way interaction of Context with Anterior/Posterior and ROI ($F(6,34)=2.58$, $p<0.04$), and a two-way interaction of Context with Speaker ($F(1,39)=4.90$, $p<0.03$). Based on the three-way interaction, further analyses were carried out for anterior and posterior sites separately. For both regions, effects of Context were obtained ($F(1,39)=5.13–12.56$, $p<0.03$). In addition, on anterior electrode positions an interaction of Context with ROI was significant ($F(6,34)=3.95$, $p<0.004$).

Separate analyses for each of the anterior ROIs showed main effects of Context in the most central and right lateral anterior ROIs, i.e. A3–A6 ($F(1,39)=4.71–11.73$, $p<0.04$). The analysis confirms that an irony-related late positivity was replicated in Session 2. This positivity was distributed over central and right lateral anterior electrode sites, and more broadly over posterior electrode sites. Based on the above mentioned two-way interaction of Context with Speaker, individual analyses were carried out for each speaker. These analyses revealed a main effect of Context for the ironic speaker ($F(1,39)=14.61$, $p<0.001$), but not for the non-ironic speaker ($F(1,39)=0.60$, n.s.). Thus, an irony-related positivity for the non-ironic speaker seen for Session 1 was not replicated in Session 2. Rather, a late positivity in response to irony was elicited only by the ironic speaker.

3.4 Summary of the ERP results obtained for Sessions 1 and 2

Between both experimental sessions, characteristics of two particular speakers were varied concerning their use of irony. In the first session, speakers’ use of irony differed in the proportion of 30% to 70%. This difference was balanced in Session 2, in which each speaker uttered an equivalent number of ironic and literal sentences.

In Session 1, ERPs varied as a function of both Context (ironic versus literal) and Speaker (ironic versus non-ironic). Early interactions of Speaker with Context and ROI were obtained in the 200–300 ms time window suggesting that ERPs in response to the ironic and non-ironic speaker differed by sentence type and in topography. ERPs in the 300–500 ms time window were modulated by Speaker, as a frontocentral negativity was evoked by the non-ironic speaker relative to the ironic one. ERPs in the 500–900 ms latency range revealed an irony-related P600 for the non-ironic speaker, but not for the ironic speaker. For the latter, a large positivity was evoked both by ironic and literal sentences, suggesting that the rarity of literal utterances by the ironic speaker enhanced the positive-going response to this type of sentence. These effects imply participants were sensitive to each speaker’s proclivity to produce ironic versus non-ironic remarks.

In Session 2, ERPs varied both as a function of Context and Speaker. Most strikingly, an increased amplitude of P200 was observed in response to items congruent with a speaker’s communicative style. P200 was larger for ironic utterances by the ironic speaker, and for literal utterances by the non-ironic speaker. Ironic utterances also elicited a larger centroparietal negativity 300–500 ms when uttered by the non-ironic than the ironic speaker, suggesting the speaker’s communicative manner influenced the integration of ironic utterances. The amplitude of this negativity displayed a centroparietal maximum, which was distinct from the frontocentral negativity elicited by the non-ironic speaker seen for Session 1.

Finally, ironic utterances elicited a larger posterior positivity than literal ones (irony-related P600), an effect observed only for the ironic speaker.
An irony-related late positivity resembling a P600 component was observed for both Sessions 1 and 2. In Session 2, where the proportion of literal and ironic sentences was balanced for both speakers, interactions of Context and Speaker were nonetheless observed in that a large P600 occurred for irony by the ironic speaker, but not for irony by the non-ironic speaker. Thus, the irony-related P600 seen for the second session appeared to be modulated by prior pragmatic information about each speakers’ communicative style in using irony.

4. Discussion

The current study investigated whether pragmatic information about the speakers’ communicative style can be acquired (i.e. Session 1), and whether such information sets up a reliable cue for the perception and interpretation of sentence meanings (i.e. Session 2). The ERP data for both sessions are discussed separately in the following sections.

4.1. Acquiring pragmatic knowledge

The question whether speaker-related information can be acquired implicitly via attentive reading was addressed in the first experimental session in which the proportion of ironic and literal utterances between two particular speakers differed. The ERP data obtained for Session 1 provide evidence that participants learned each speaker’s communicative style with respect to the use of irony, and that such communicative differences affected language comprehension processes. The current findings indicate that both ironically and literally intended sentences were processed differently depending on who said them. Indeed, a significant interaction between speaker type and figurativity of sentences was found as early as 200 ms post-stimulus onset suggesting that particular speakers’ frequent versus infrequent use of irony affected early stages of the comprehension processes.

Note that participants may have formed an expectation for a speaker’s particular communicative style only after experiencing a larger number of trials.
Results from Session 1 are thus in line with studies reporting early effects of extra-linguistic information on language comprehension. In a study by Van Berkum et al. (2008), gender specific utterances (e.g. “If I only looked like Britney Spears”) that were incongruent with the expected gender of the speaker (e.g. spoken in a male voice) elicited an N400 component with an onset latency of around 200 ms post-stimulus presentation. This ERP effect has been taken as evidence for an early impact of stereotypical information on language comprehension. The present study suggests that prior experience with particular speakers can also exert an early influence on sentence processing, and indicates that such findings are not unique to spoken stimuli as visual presentation was employed in the current study.

Surprisingly, the pragmatic manipulation in Session 1 did not modulate the N400 component. This suggests that semantic information processing indexed by this component was not affected by a speaker’s communicative style during the acquisition phase of pragmatic knowledge. Instead, we observed a frontocentral negativity that was larger for the non-ironic speaker. Further, modulations of pragmatic information were present in the late positivity. This positivity was seen for irony and emerged around 500 ms post-stimulus presentation thereby resembling previously observed P600 effects in response to irony (Gunter et al., 2005; Regel et al., in press).

The current findings show that this irony-related positivity can be modulated by speaker-specific pragmatic information as a larger P600 amplitude was present for ironic statements made by the non-ironic speaker, but was similar for both ironic and literal statements made by the ironic speaker. While this might suggest an influence of speakers’ communicative style on the construction of appropriate sentence meanings (presumably reflected in the late positivity), it cannot be clearly disentangled in how far the probability manipulation applied for the current session contributed to the results. An increased P600 component was seen for irony of the non-ironic speaker, which had a probability of 30%, in comparison to his literal utterances that had a probability of 70%. A number of ERP studies have reported an influence of probability of stimulus occurrence on the amplitude of the late positivity whereby a larger late positivity was evoked for stimuli with a lower probability relative to those with a higher probability (Coulson et al., 1998; Gunter et al., 1997; Hahne

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**Fig. 5** – Grand average ERPs measured at the sentence final word for sentences uttered by the ironic speaker (dotted line), or the non-ironic speaker (solid line) for Session 2.
Friederici, 1999). Thus, it might be possible that the current finding of P600 resulted from the lower probability of ironic utterances of the non-ironic speaker relative to literal utterances of this speaker. Still, when comparing ERPs for the ironic speaker no differences were seen in the late positivity for his literal and ironic utterances although both sentence types also differed in probability by 30% to 70%. This finding implies that probability of stimulus occurrence cannot have caused this late positivity for irony of the ironic speaker as this type of utterance had a high probability. While ironic utterances made by the ironic speaker seemed to require an effortful processing, it remains unclear what factor, i.e. probability of occurrence, or presumably pragmatic interpretation of utterance meaning, contributed to our observation in Session 1 of P600 for irony of the non-ironic speaker.

Based on the findings of Session 1, it can be concluded that speaker-specific pragmatic information was acquired rapidly (as shown by the post-test data and the ERP effects seen already during the first experimental (learning) session) without an explicit introduction to the ironic proclivities of each speaker, and without any task demands that would draw attention to the manipulation. While information about the speakers’ use of irony needed to be extracted by attentive reading of discourses, these data suggest that participants spontaneously associated the occurrence of ironic and literal comments with particular speakers.

4.2. Implications for language comprehension

The second experimental session addressed the question of whether prior pragmatic knowledge about two particular speakers was established, and used in sentence processing. In Session 2 the speakers’ use of irony was completely balanced so that both speakers replied equally often in an ironic or literal manner. Thus, previously acquired pragmatic knowledge about these two speakers as being high or low ironic (i.e. throughout Session 1) was no longer supported. ERP effects of Context differed as a function of speaker in every interval measured, beginning 200 ms and ending 900 ms after the onset of the critical word, indicating that this sort of pragmatic information affects irony comprehension during both early and late phases of processing.

The main result of Session 2 was that the influence of speakers’ communicative style was evident during initial phases of sentence processing in showing an increase in P200 amplitude when a speaker’s communicative manner was consistent with respective sentence interpretations (i.e. when the non-ironic speaker made literal statements, and the ironic speaker made ironic statements). This finding suggests participants were able to utilize subtle pragmatic information that they implicitly extracted the day before during Session 1. Pragmatic information about the speaker seems to provide a relevant cue that appeared to influence sentence processing as early as 200 ms after stimulus onset.
With regard to the literature, behavioral evidence (by means of response times) for the rapid incorporation of stereotypical gender information into readers’ representation of a person has been reported in a study by Oakhill, Garnham and Reynolds (2005). Oakhill et al. (2005) showed that certain role or profession terms affected response times for subsequent words that set up congruent or incongruent word pairs with occupation or role terms (e.g. “sister/father–typist”). Early ERP effects of pragmatic knowledge have also been reported for violations of speakers’ gender with respect to stereotypical messages (Van Berkum et al., 2008). In this study, an increased N400 component starting around 200 ms post-stimulus has been reported for anomalous sentences suggesting that speakers’ voice-inferred information was rapidly extracted and used during initial sentence comprehension.

Our finding of an early ERP effect suggests that even implicitly provided information can set up certain pragmatic knowledge, on which participants might rely when encountering utterances of a particular speaker. The P200 currently obtained emerged by means of information about a speaker’s communicative style, and did not result from figurativity of sentences per se. It might be possible that an implicit categorization occurred concerning the consistency of speakers’ utterances with pragmatic knowledge after encountering the critical word.

Effects of implicit categorization affecting P200 have previously been reported for the distinction between categories of distractor items (Pernet et al., 2003). Note that the stimuli in the study by Pernet et al. were objects clearly distinguishable on basis of their visual features. The finding of P200 for linguistic information shows that this component apparently also reflects more higher-order cognitive processes. In language studies, P200 has been reported to be sensitive to sentence constraint and expectancy for a particular word, being larger for expected items (Federmeier et al., 2005; Wlotko et al., 2003). Our finding of larger P200 for stimuli consistent with each speaker’s communicative manner may reflect the influence of speaker-specific pragmatic knowledge on participants’ ability to categorize the stimuli according to a speaker’s communicative style. Such implicit categorization processes might have been possible due to the constrained variability in expressing either an ironic or literal communicative intention by those particular speakers.

In the latency range of 300–500 ms, a less negative response was observed for irony relative to literal statements by the ironic speaker. Whereas this effect suggests that pragmatic information affected the processing of semantic information, it might have resulted from a greater pragmatic expectancy for irony by the ironic speaker since this speaker primarily replied in an ironic way in the first session. Behavioral data obtained by the post-test accord with this suggestion in showing that a plurality of participants in Session 2 still perceived the ironic speaker as the more ironic one (to about 44%). Thus, the acquired pragmatic knowledge seems to bias expectancy for irony of the ironic speaker but not for irony of the non-ironic speaker.

Our observation of a larger negativity between 300 and 500 ms for literal than ironic utterances made by the ironic speaker differs from the findings reported in the Cornejo et al. study (2007), where an N400 component emerged for irony compared to literal language. Cornejo and colleagues (2007) speculated that differences in semantic expectancy between ironic and literal sentences led to this result. In the present study, semantic expectancy was similar for the critical words in ironic and literal sentences in these discourses, and thus any differences are presumably due to knowledge about each speaker’s communicative manner.

The second session also showed an irony-related P600 but this effect occurred for the ironic speaker only, and not for the non-ironic one. This suggests that pragmatic knowledge seems to influence the interpretation of communicative intents, and further substantiates the irony-related P600 as a reliable effect for figurative language comprehension. Late positivities have previously been elicited by other figurative language phenomena, including metaphors (Coulson and Van Petten, 2002; Coulson and Van Petten, 2007) and jokes (Coulson and Kutas, 2001; Coulson and Lovett, 2004; Coulson and Williams, 2005; Coulson and Wu, 2005). This positivity might be a function of pragmatic information processing whereby appropriate sentence interpretations are derived.

Comparable P600 effects were found for inconsistencies between a speaker’s gender (conveyed in the auditory presentation modality by voice information) with stereotypical statements that referred to a female or male speaker (Lattner and Friederici, 2003). For sentences such as “I like to wear lipstick” spoken by a male speaker no N400 but a larger P600 amplitude was seen in comparison to the same sentence expressed by a female speaker. Lattner and Friederici (2003) interpreted this late positivity as a function of reintegration of semantic meaning and stereotypical beliefs based on extra-linguistic speaker information.

Likewise, processes of reintegration might be reflected in the irony-related P600 obtained for both experimental sessions. As ironic sentences were pragmatically more complex by implying an opposite meaning than literally stated, reintegration of various types of information could have been required for complete utterance comprehension. Particular sentence interpretations became obvious with respect to prior contextual information making reintegration of semantic (literal) information as well as prior contextual and pragmatic information likely. Thus, it is not unreasonable to assume that further interpretation processes might have occurred for deriving appropriate sentence interpretations (i.e. on the message level).

### 4.3. Conclusion

The current experiment showed an influence of subtle pragmatic information about speakers’ characteristics (concerning their use of irony) on literal and figurative language processing. An impact on initial phases of processing was found as early as 200 ms, which indicates that pragmatic

| Table 3 – The experimental design applied for Sessions 1 and 2. |
|-------------------|-------------------|
| **SESSION 1**     | **SESSION 2**     |
|                   | Speaker           | Speaker           |
| Ironic            | Non-ironic        | Ironic            | Non-ironic        |
| Ironic context    | 70%               | 30%               | 50%               | 50%               |
| Literal context   | 30%               | 70%               | 50%               | 50%               |
information about two particular speakers had an early influence on the processing of sentence final words. Moreover, the findings also indicate that pragmatic knowledge affected later phases of processing in showing modulations of P600 in response to irony of the respective speaker, and that this information once established seems to set up a reliable cue for potential interpretations of someone’s utterances. ERPs provided evidence that the interpretation of irony is influenced by a speaker’s communicative behavior as well as the knowledge about it in showing a larger P600 for irony of the ironic speaker compared to ironic utterances of the non-ironic speaker. This indicates that subtle information about particular speaker characteristics (occurring in addition to contextual information) appeared to establish a relevant cue for potential sentence interpretations affecting initial as well as late comprehension processes.

5. Experimental procedures

5.1. Stimulus material

Materials consisted of 100 experimental sentences such as “The game was fantastic” that were embedded in two types of discourse contexts, which biased either an ironic or a literal sentence meaning. Discourses comprised two or three context sentences that were followed by the target sentence. The sentence final word (e.g. “fantastic”) was critical for respective interpretations. All discourses were presented visually.

In order to induce different speaker characteristics as being ironic or non-ironic, literal and ironic sentences were uttered by two individual speakers (i.e. Marcus vs. Lars) to varying extents. In Session 1, ironic sentences were mainly expressed by the ironic speaker (i.e. Lars) to about 70%, and occasionally by the non-ironic speaker (i.e. Marcus) to about 30% (see Table 3). For literal sentences this proportion was reversed whereby the non-ironic speaker uttered 70% of all literal sentences, and the ironic speaker only 30% of it. In Session 2, the proportion of ironic and literal sentences was balanced between both speakers so that each speaker expressed 50% of each sentence type. For experimental presentation the 100 items were pseudo-randomized and divided into two item versions (one for each session). Each target sentence meaning occurred only once in each version. Each participant viewed both sentence types (within-subject design), and both versions within an interval of 24 h between the first and second session. The experimental factors Context (ironic/literal) and Speaker (ironic/non-ironic) were fully crossed (see Table 3).

5.1.1. Pretests

To test the experimental sentences on semantic–pragmatic expectancy as well as acceptability, two pretests were carried out. Cloze probability was assessed by using a sentence completion task in which 22 participants (10 females, mean age 23.7 years (SD 2.68)) took part. In this test, participants read discourse contexts followed by the target sentence except for the sentence final word. Participants were asked to fill in the missing word with the first appropriate word that came to their mind. All potential experimental items were divided across two lists, so that each participant saw only one version of an item. Whenever sentence completions for ironic and literal target sentences were comparable in semantic meaning, potential items were included as experimental items. The mean cloze probability for ironic sentences was 87.4% (SD 12.87), and for literal sentences 96.5% (SD 7.12). The difference of about 9% was significant ($t(99) = 6.90$, $p < 0.0001$). An average cloze probability of more than 85% is very high, and is less likely to cause substantial differences in the ERPs.

A second pretest was performed to control for potential acceptability differences between ironic and literal sentences. Twenty subjects (10 females, mean age of 23.6 years (SD 2.72), who did not take part in the cloze test) participated in the acceptability test. Participants were asked to evaluate each item either on its degree of acceptability on a 5-point scale (1 for less acceptable, 5 for high acceptable), or to state whether an item was unacceptable. The mean acceptability for ironic sentences was 3.6 (SD 0.49), and for literal sentences 3.8 (SD 0.67). The difference of about 0.2 was still significant ($t(99) = 2.11$, $p < 0.04$) showing that literal sentences were slightly more acceptable than ironic sentences.

5.2. Procedure

Discourse contexts were presented in blocks of three to four lines on a monitor in front of the participants. After reading the contexts participants were instructed to press a button to continue with the presentation (automatic continuation after 20 s). Target sentences were then presented word-by-word. The presentation onset was introduced by the occurrence of a fixation cross for 200 ms at the center of the monitor. Each word appeared in a rapid serial visual presentation mode for 300 ms and was followed by a blank screen for 200 ms. All words were presented in light grey on a dark background. After sentence offset there was a blank screen for 1500 ms before presentation onset of the comprehension task. Sessions 1 and 2 were carried out in the same way. There was an interval of 24 h between sessions. Before an experiment session started, participants received a short training session comprised of six trials to familiarize with the experimental procedure. Instructions for the two experimental sessions included a short introduction of both speakers by presenting two discourse examples on which the two speakers commented in an ironic or literal way, respectively. At the end of each session participants were asked to complete a post-test questionnaire in which eight experimental discourses had to be filled in by the most appropriate utterance for the respective speakers. Thus, a measure of participants’ perception of the speakers’ characteristics was obtained.

5.3. Electrophysiological recording

The electroencephalogram (EEG) was recorded with 52 Ag-AgCl electrodes that were embedded in an elastic cap, and...
referred to the left mastoid. Bipolar horizontal and vertical EOG was recorded. Electrode resistance was kept under 5 kΩ. The signals were recorded continuously with a band pass between DC and 70 Hz, and digitized at 250 Hz. Average ERPs were computed for the critical word (i.e. at sentence final position) for each electrode position for each of the four experimental conditions. All averages started 200 ms before and lasted 1000 ms after the critical event. Only correctly answered trials were included in the average. EEG rejections due to ocular artifacts (EOG rejection ±40 μV) comprised about 9% of all trials for Session 1, and 10% for Session 2. Averages were aligned to a 200 ms pre-stimulus baseline. Within-subject factors were Context (ironic/literal) and Speaker (ironic/non-ironic).

For statistical analysis of potential ERP effects, the 300–500 ms latency window comprising the N400 component, and the 500–900 ms latency range for a potential late positivity effect were chosen. After visual inspection of the ERPs an additional time window of 200–300 ms covering P200 was analyzed. All dependent variables were quantified using multivariate analyses of variance (MANOVAs). The multivariate approach to repeated measurements was used to avoid problems concerning sphericity (Dien and Santuzzi, 2005; Vasey and Thayer, 1987). For distributional ERP analyses two topographical factors Anterior/Posterior and Region of Interest (ROI) were defined and completely crossed, yielding 14 different ROIs each containing three electrodes (see Fig. 6). Within-subject factors were Anterior/Posterior (2), ROI (7), Context (2) and Speaker (2). Whenever interactions were found, further analyses were carried out.

Accuracy rates are reported for the behavioral performance, and were used for ERP evaluation. For the statistical analysis of accuracy rates a repeated-measures ANOVA with the factors Context (2) and Speaker (2) was calculated.

5.4. Participants

Forty students (19 females, mean age 24.1 years (SD 2.61)) from the University of Leipzig participated in the experiment and were paid for their expenses. All were right handed, native speakers of German with normal or corrected-to-normal vision.

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**Appendix**

Five samples from the stimulus set in the original German version, and in the English corresponding translation. Target sentences are in Italics.


English translation of the stimuli (correspondingly).

(1) Lars was looking forward to the Italian pizza that Markus even cut into to two halves. When he noticed that Markus kept the larger piece for himself, he looked disappointedly at his slice and said: That's exactly half.

(2) Lars and Markus had a barbecue with their friends. Lars was really

**5. Technical details**

EOG was recorded. Electrode resistance was kept under 5 kΩ.
Appendix (continued)

<table>
<thead>
<tr>
<th>Ironic discourses</th>
<th>Literal discourses</th>
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</thead>
<tbody>
<tr>
<td>(2) During lunch Markus nearly ate nothing of his meal. He only tasted a little of the potatoes. As Lars had already finished, he watched him picking at his food. After a while he said with amusement: You eat like a horse.</td>
<td>hungry and looked forward having a burger. When they were ready, he quickly shifted two big burgers. Markus watched him with astonishment and said: You eat like a horse.</td>
</tr>
<tr>
<td>(3) In the introductory seminar Professor Taylor gave a very complicated talk. He made many mental leaps, so that most of the students could not follow. Lars had already given up, and mumured annoyed: This is so informative.</td>
<td>(3) At the Technology Institute Lars listened to a talk about the latest developments. Interested in the topic he followed all the statements. He found out many new things and said impressed: This is so informative.</td>
</tr>
<tr>
<td>(4) At the platform Lars had to wait more than 20 minutes for the train. A number of announcements were made, begging customers to be patient. Lars was tired of waiting in the cold and said angrily: You can always rely on the railway.</td>
<td>(4) On the radio they warned of heavy snowfalls and black ice. Because of that Marcus decided to go by train instead of taking his car. When he arrived on time at work, he thought pleased: You can always rely on the railway.</td>
</tr>
<tr>
<td>(5) Markus had to spend a lot of time to finish the essay. When he was nearly done, the computer suddenly broke down. Nothing was saved, so he had to start over from the beginning. He shouted upset: This is great.</td>
<td>(5) Lars waited a long time for the written reply. Every day he looked impatiently into his mailbox to see if he had received the letter. When he saw the envelope, he felt quite relieved and said: This is great.</td>
</tr>
</tbody>
</table>

REFERENCES


