

# *Reading Brecht and talking to the espresso:* Electrophysiological investigations of conventional and novel metonymy

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## Abstract

We present a series of three experiments on the comprehension of metonymy that sought to tease apart the role of contextual information and conventionality during the processing of expressions that require a transfer of meaning for proper interpretation. Event-related brain potentials (ERPs) were recorded while participants read or listened to sentences including metonymic expressions and literal controls. The ERP data indicate that contextual support facilitates early processing stages (reflected by context-induced N400 modulations) but cannot block subsequent processes of pragmatic enrichment (reflected by a Late Positivity for the metonymies relative to literally interpreted expressions). This implies that enriched composition occurs independently from contextual licensing. In addition, conventionality did not have a bearing on the ERP signals, indicating that conventional and novel metonymies are subjected to pragmatic enrichment.

**Keywords:** Metonymy; context; conventionality; ERPs.

## Introduction

Many different processes and information sources are engaged in the construction of meaning. To investigate their particular contribution to meaning composition, metonymy and coercion have received increasing attention in the literature. The current paper presents electrophysiological data from language comprehension, drawing a distinction between context-induced language processing and the use of pragmatic mechanisms during the composition of figurative meaning. To this end, we present a series of three experiments that investigated the comprehension of metonymy and explored the role of context (Experiment 1 & Experiment 2) and conventionality (Experiment 3).

Previous psycho- and neurolinguistic research has reported processing demands for mismatches between verbs and their arguments in complement and aspectual coercion as well as in metonymy (for an overview see Pylkkänen & McElree, 2006). There is a general consensus that the costs observed may be viewed as enrichment of the interpretation either from a literal to a figurative meaning or from an underspecified to a context-specific meaning. Furthermore, the experimental research has identified numerous factors that influence composition – for instance that context can

guide interpretation (e.g., Traxler et al., 2005) or that different types of metonymy may come with varying processing demands (e.g., McElree et al., 2006). Yet, the exact nature and locus of the involved operations is controversial, and enriched composition has either been discussed with reference to lexical-semantics (qualia structure), extra-lexical semantic rules, or pragmatically motivated principles (cf. e.g., Asher & Lascarides, 1995; Copestake & Briscoe, 1995; Pustejovsky, 1995; Egg, 2004). In the present investigation, we wanted to tease apart some of these aspects and also focus on the time course of the processing of metonymies by measuring event-related brain potentials (ERPs).

When looking at typical metonymies – as in *the waitress talked to the espresso* or *the student read Brecht* – the literature lists numerous features that support – and might even be necessary for – interpretation, including noteworthiness, salience, distinctness, functional correspondences between expressions and their intended referents, contextual licensing, and so on (see Nunberg, 1995; Jackendoff, 1997). In the current investigations, we addressed the influence of contextual support and the strength of the functional correspondence in conventionalized (*Brecht*) and non-conventionalized usages (*espresso*).

## Electrophysiological Background

Based on previous ERP research in semantics and pragmatics, there are two central processes that may reflect processing costs associated with metonymies. The first one can be characterized to reflect expectation-driven parsing that is guided by all kinds of information associated with context. The second one reflects operations related to the maintenance and organization of discourse representation structure (see Schumacher, 2009 for more details about this two-stage model of discourse processing including linking and updating mechanisms).

**N400 (“Discourse Linking”)** The first mechanism is reflected in a negative potential peaking around 300 ms after the presentation of a critical stimulus, and its amplitude is modulated by the fit of the stimulus with prior context. This N400 signature is highly correlated with the expectations

generated by prior discourse and also reflects lexical-semantic demands (cf. e.g., Kutas & Federmeier, 2000; Schumacher, 2009). Crucially, while the early N400-research has generated a lot of evidence for lexical-semantic influences, more recent investigations point towards a broader conception of the N400, whereby contextual information (including cotexts, interlocutors, genres, tasks, etc.) feeds into the expectations for upcoming words.

Accordingly, if processing costs associated with metonymies are primarily driven by the lexical mismatch between verbs and arguments, an N400 should be observable. Context effects may further modulate the N400 during the comprehension of metonymic expressions.

**Late Positivity (“Discourse Updating”)** A subsequent positive deflection has been associated with the maintenance and reorganization of the discourse representation structure. This Late Positivity has for instance been observed when event structures must be updated during complex inferencing, and the underlying processes have been suggested to result from conflicting information sources, which are resolved in a cooperative manner (Burkhardt, 2007; Schumacher, 2009; cf. also Bornkessel & Schlesewsky, 2006 for generalized mapping).

In this respect, the processing decisions reflected by the Late Positivity may reflect compositional demands beyond lexical processing. If arriving at a metonymic interpretation requires such extra-lexical composition, a Late Positivity may be observable during the processing of metonymies.

## Experiment 1

In Experiment 1 (cf. Schumacher, 2011), we compared the processing of non-conventional metonymies (*the espresso*) to their literal controls (see (1) and (2) below). The metonymies were expressions that represented a salient characteristic of the individual they referred to. To this end, context sentences set up a scene (e.g., restaurant) to license the metonymic use. Our predictions were as follows. First, if context information served as a necessary cue for interpretation (as suggested for this type of metonymy), metonymic expression might engender a more pronounced N400 than their literal controls. Second, if the processing of metonymies was driven by pragmatic processes, a Late Positivity for metonymies should be observable.

### Methods and Materials

Pairs of forty German passages consisting of two sentences each were constructed. The first sentence set up a specific situation to license the metonymic use of an expression by introducing two individuals typically found in a certain context (e.g., *waitress* and *barkeeper* introduce a restaurant context, in which a customer may be referred to by a salient and distinct property such as *the espresso*). The context sentence included a *wh*-word to generate an expectation for either a person-denoting expression (1) or an object-denoting expression (2). This allowed us to measure

potential costs arising from the metonymic interpretation at the noun phrase.

- (1) Die Kellnerin fragt den Barkeeper, wer gerne bezahlen möchte. Der Barkeeper antwortet, dass **der Espresso** gerne bezahlen möchte.  
*The waitress asks the barkeeper who wanted to pay. The barkeeper says that **the espresso** wanted to pay.*
- (2) Die Kellnerin fragt den Barkeeper, was heute ausverkauft ist. Der Barkeeper antwortet, dass **der Espresso** heute ausverkauft ist.  
*The waitress asks the barkeeper what was out of stock today. The barkeeper says that **the espresso** was out of stock today.*

The experimental passages (2x40 in total) were interspersed with 120 filler passages and presented visually in a pseudo-randomized order in five blocks of 40 passages each. Passages were presented in segments at the center of a computer screen. The critical expression (e.g., *the espresso*) was presented as one segment, and ERPs were time-locked to the onset of this segment.

Twenty-three monolingual native speakers of German participated in this study (mean age 22.5 years). Their task was to read the passages for comprehension and to respond to a comprehension question after each passage. This task allowed us to assess whether participants processed the stimuli attentively and accurately.

### Results

ERP responses to metonymic expressions (1) were contrasted with those to the literal control expressions (2). Only trials with correctly answered comprehension questions entered the analyses. Statistical analyses were computed for mean amplitude values in predetermined time windows. To this end, we calculated repeated measures analyses of variance (ANOVAs) for the time windows between 300-500 ms (N400 window) and 650-800 ms (Late Positivity window) after the onset of the critical expression (e.g., *the espresso*). Figure 1 illustrates the grand average ERPs at a selected scalp electrode.

**N400 window** The analysis of the ERP data revealed no reliable differences between 300-500 ms (all  $F_s < 1$ ). This suggests that the situation set up by the context sentence was sufficiently strong to generate an expectation for an expression such as *the espresso* in both the metonymic context (1) and the control context (2). In other words, lexical-semantic support allowed for a metonymic continuation without any further computational costs.

**Late Positivity window** Between 650-800 ms, the analysis registered a main effect of condition ( $F(1,22)=9.11, p < .01$ ), which was reflected in a more pronounced positive deflection for the metonymic (1) relative to the control condition (2). This finding indicates that the computational

mechanisms required for the metonymic interpretation of an expression exert demands above and beyond contextual integration, which are considered to reflect processes of enriched composition.

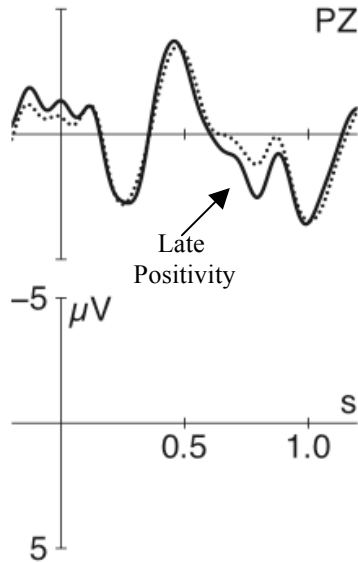


Figure 1: Grand average ERPs for contextually licensed metonymy at an exemplary electrode sites (PZ – posterior midline electrode). Metonymic expressions (1) are plotted in solid line; the literal control (2) is plotted in dotted line. The onset of the critical expression is at the vertical bar. Time axis ranges from 200 ms before until 1200 ms after the critical expression. Here and in all further figures, negative voltage is plotted upwards.

## Discussion

The electrophysiological data obtained in Experiment 1 revealed a Late Positivity for the processing of metonymic expressions, but no differences with regard to the N400 signature. Under the assumption that N400 differences reflect contextually driven expectations and lexical-semantic processes, the absence of an N400 modulation suggests that metonymic expressions are as easily integrated as their non-metonymic counterparts at this early processing stage. The subsequently observed Late Positivity demonstrates that additional processing demands are exerted during the processing of metonymies. To assess whether these demands are independent from context-induced processes, Experiment 2 investigated the processing of metonymies in passages without strong contextual support.

## Experiment 2

The literature on metonymy and other enrichment processes diverges when it comes to the contribution of lexical-

semantics, context-driven expectations and pragmatic inferencing. Experiment 2 therefore sought to explore the role of context in more depth. The data from Experiment 1 may be taken to suggest that context has an important facilitatory role during the integration of referential expressions. However, it is not evident whether context is a necessary prerequisite for the comprehension of metonymy. We therefore examined what happened when the predictive power of the context was reduced. We hypothesized to find N400 modulations for more difficult contextual integration. Regarding the Late Positivity, the predictions were two-fold. On the one hand, if context is a necessary requirement, later processes might be blocked in its absence. On the other hand, if costs for enriched composition – reflected by the Late Positivity – were independent from context driven processes, the Late Positivity effect should remain independent of the contextual manipulation.

## Methods and Materials

The passages from Experiment 1 were modified to include more neutral context sentences by replacing the professional terms with proper names.

- (3) Kristen fragt Geoff, wer gerne bezahlen möchte. Geoff antwortet, dass **der Espresso** gerne bezahlen möchte.  
*Kristen asks Geoff who wanted to pay. Geoff says that **the espresso** wanted to pay.*
- (4) Kristen fragt Geoff, was heute ausverkauft ist. Geoff antwortet, dass **der Espresso** heute ausverkauft ist.  
*Kristen asks Geoff what was out of stock today. Geoff barkeeper says that **the espresso** was out of stock today.*

Twenty-four monolingually raised native speakers of German took part in this investigation (mean age 25.3 years). Except for the changes in the context sentence, all parameters and procedures were kept as in Experiment 1. ERPs were time-locked to the critical noun phrase (e.g., *the espresso*).

## Results

ERP signals to metonymic expressions (3) were compared with those to the literal control expressions (4). Only trials with correct answers to the comprehension questions were analyzed. ANOVAs were computed for mean amplitude values in the time windows tested in Experiment 1, i.e. 300-500 ms (N400 window) and 650-800 ms (Late Positivity window) after the onset of the critical expression. Grand average ERPs are exemplified in Figure 2 at a selected electrode site.

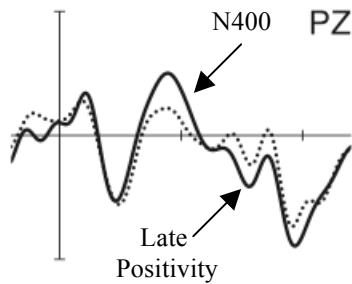


Figure 2: Metonymy with neutral context at a selected electrode (PZ – posterior midline site). Metonymic expressions (3) are plotted in solid; the literal controls (4) are displayed in dotted line. The vertical bar marks the onset of the critical expression.

**N400 window** Statistical analysis registered a main effect of condition in the temporal window spanning from 300-500 ms post-onset, with a more pronounced negative amplitude for metonymic expressions compared to their non-metonymic counterpart ( $F(1,23)=15.99, p<.001$ ). This difference indicates that the integration of a metonymic expression like *the espresso* is encumbered when the context does not make available a supporting scenario that clearly situates the exchange in a licensing environment (such as a restaurant setting).

**Late Positivity window** As in Experiment 1, the analysis revealed a significant difference between 650-800 ms ( $F(1,23)=6.52, p<.02$ ), which was evidenced by a more positive-going signal for the metonymic expressions (3) relative to their literal controls (4). This difference confirms the findings from Experiment 1 and suggests that the observed computational demands are independent from processes that are guided by contextual information.

## Discussion

Experiment 2 investigated whether context effects could be dissociated from processes of pragmatic enrichment. Metonymy – especially the type of reference transfer investigate in this study – has been considered by a number of accounts as a pragmatic operation that is highly contingent on contextual support (cf. e.g., Nunberg, 1995). This was confirmed by the present data, where in the absence of facilitating contextual information, an enhanced N400 was observable for the metonymies relative to their literal controls. Given that both conditions lack supporting context, the N400 differences indicate that metonymies indeed rely on contextual information for integration to a larger extent than non-metonymic expressions. However, even though the data demonstrate that contextual support facilitates integration, they also show that this is not a necessary prerequisite for enriched composition. This is evidenced by the fact that a Late Positive potential was

evoked by the metonymies in Experiment 2 as well, despite the absence of rich contextual support.

## Experiment 3

The comparison of Experiment 1 and Experiment 2 indicates that context information is an important, yet not sufficient, ingredient for the processing of metonymy. While referring to a person with a salient property such as *the espresso* may depend on a particular situation of utterance, be constrained by the unique identifiability of this property, and be constructed ad hoc, there are more conventional metonymies such as producer-for-product metonymies, where for instance the author (*reading Brecht*) or composer (*playing Mozart*) refers to a book or piece of music and must be enriched. In Experiment 3, we tested whether conventional metonymies pattern with the novel metonymies investigated in the previous two experiments. Such an investigation can shed further light on the nature of the two processes observed in the previous experiments. On the one hand, the novel metonymies tested there, may be considered highly marked and one might argue that some of the processes observed reflect unacceptability rather than enriched composition. In contrast, producer-for-product metonymies are frequently used in everyday conversation and are highly conventionalized. Finding similar patterns for novel and conventional metonymies would then strengthen the interpretation of the data laid out above. On the other hand, the notion of conventionality poses additional questions for our conception of metonymy and enriched composition, since previous research reported no costs for conventional metonymies and their literal counterparts, supporting the view of underspecified representation at least with respect to conventional metonymies (e.g., Frisson & Pickering, 1999; McElree et al., 2006).

## Methods and Materials

Forty pairs of sentences were created, including the name of an author, composer, painter, etc. In one condition this name was used as a producer-for-product metonymy (5); in the other it referred to the person (6).

- (5) Tims Onkel lass einst **Brecht** während einer Vorlesung.  
*Tim's uncle once read **Brecht** during a lecture.*
- (6) Tims Onkel traf einst **Brecht** während einer Vorlesung.  
*Tim's uncle once met **Brecht** during a lecture.*

The sentences were auditorily presented<sup>1</sup> and ERPs were time-locked to the onset of the recognition point of the

<sup>1</sup> Note that we switched to the auditory modality in Experiment 3 because it was embedded in a study utilizing a masked priming paradigm, which made it necessary to present sentences auditorily.

famous name (e.g., *Brecht*). The experimental trials (2x40 in total) were mixed with 200 filler trials and presented in eight blocks to the participants.

Twenty-four monolingual native speakers of German participated in this study (mean age 24 years). Their task was to listen to the sentences for comprehension and perform a word recognition task afterwards.

After EEG recording, participants were asked to fill out a questionnaire in which they had to identify the profession of the famous people used in the experiment. All critical names from the ERP study were included in this questionnaire. 88.8% of the names were correctly categorized. Participants who failed to identify *Brecht* as author or *Mozart* as composer and so on in more than 25% of the cases were discarded from the ERP analysis. This amounted to the exclusion of one participant.

## Results

ERP responses to conventional metonymies (5) were contrasted with those to the literal referential expressions (6). Only trials with correct answers to the word recognition task were analyzed. Since auditorily evoked responses typically show an earlier onset latency, statistical analyses were calculated for the windows between 200-350 ms and 400-600 ms for the N400 and Late Positivity respectively. Grand average ERPs are depicted in Figure 3.

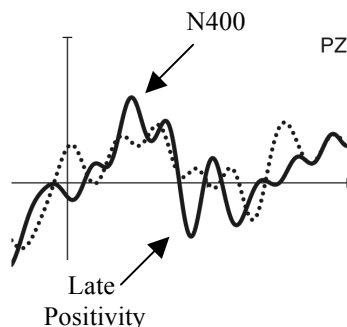


Figure 3: Conventional metonymy at an exemplary electrode location (PZ – posterior midline site). Solid line represents metonymic expressions (5), dotted line the literal controls (6). The onset of the critical expression is at the vertical bar.

**N400 window** Between 200-350 ms after the onset of the critical expression, the statistical analysis registered a main effect of condition ( $F(1,22)=4.45$ ,  $p<.05$ ), which was reflected by a more enhanced negativity for the conventional metonymies (5) relative to their literal control expression (6). This effect suggests that comprehending a conventional metonymy such as *Brecht* exerts processing effort during the integration with information from the

sentential context and lexical-semantics. It further does not support strict accounts of underspecification.

**Late Positivity window** Statistical analysis for the time window from 400-600 ms post-onset further demonstrated a reliable difference ( $F(1,22)=4.96$ ,  $p<.05$ ), which was reflected by a more enhanced positivity for the metonymy (5) compared with the literal reference (6). This finding converges with the data obtained in Experiment 1 and Experiment 2, indicating that enriched composition exerts processing demands, and crucially, that these are independent from notions of conventionality or context.

## Discussion

The findings from conventional metonymy in Experiment 3 converge with those from the processing of novel metonymy. The biphasic N400 – Late Positivity pattern indicates that irrespective of the degree of conventionality, weak contextual support hampers the processing of metonymies, but cannot block subsequent enrichment. Interestingly, while one might expect that a verb like *to read* is sufficiently strong to license a conventional metonymic interpretation, the N400-differences – together with the findings from Experiment 2 – indicate that this is not the case.<sup>2</sup> Moreover, in contrast to findings from eye movement measures that did not register differences between conventional metonymies and their literal controls, the present data show that ERPs are sensitive to subtle processing differences.

The comparison of conventional and novel metonymies further indicates that the source of the Late Positivity cannot be the apparent anomaly of the referential expression. While the novel metonymies may sound unusual in certain contexts, and possibly anomalous following a neutral, unsupported context sentence, the conventional metonymies occur frequently in everyday conversation and are perfectly acceptable. Yet, the fact that similar Late Positive potentials were observed in all three experiments, irrespective of their apparent adequacy and conventionality, strongly suggests that this signal reflects a common mechanism during the processing of metonymies.

## General Discussion

The electrophysiological data presented here confirm the general idea that the processing of metonymies is computationally demanding. The fact that this is observable in two dissociable ERP signatures indicates that distinct information sources are recruited at discrete moments in time, and therefore extends previous findings from other

<sup>2</sup> We are currently conducting a fourth investigation that contains more context information – in analogy to Experiment 1 – to determine whether the N400 difference can be reduced. This would further substantiate our claims of context-induced N400-modulations.

experimental paradigms. The ERP data show first that contextual information eases the processing of metonymies (see N400 attenuation in Experiment 1), but that it does not suffice for proper integration. Rather, extra-lexical costs are exerted for all kinds of metonymies, reflected in a Late Positivity (Experiment 1-3). Crucially, the corresponding mechanism is activated irrespective of context or conventionality. Thus, the fact that all three experimental manipulations generated a Late Positivity is strong evidence for a powerful, uniform mechanism of pragmatic enrichment that is initiated whenever the parser encounters a mismatch between a verb and its arguments. It also speaks against a strict lexically-based account of metonymy.

The data further converge with previous ERP research in semantics and pragmatics, which has identified the N400 as a measure of context-induced expectations and the Late Positivity as a reflection of discourse updating costs (cf. e.g., Burkhardt, 2007; Schumacher, 2009). They indicate that contextual influences must be dissociated from mechanisms of enrichment in models of language comprehension.

The ERP findings thus support the idea that the observed costs arise from the online construction of a discourse representation (i.e. discourse updating). Previous work has shown that the construction and reorganization of event structures is costly. Crucially, this has been demonstrated in the literature on coercion (cf. e.g., Piñango et al., 1999; McElree et al., 2001), but also on complex inferencing (Burkhardt, 2007). The current data add to these findings and suggest that the underlying mechanisms are generalizable across a range of phenomena at the syntax-semantics-pragmatics interface.

Future work can make use of this methodology to assess whether other interface phenomena are subjected to pragmatic enrichment to the same extent as the metonymies investigated here, or whether some mismatches may in fact be resolved via semantic pathways alone.

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