

## Source of processing costs of indirect anaphors – self-paced reading and ERP data

Magdalena Repp, Petra B. Schumacher (Universität zu Köln)

Indirect anaphors (*Lisa went to a wedding in Italy. The bride was beautiful.*) encompass two different dimensions of newness: they represent new information and they introduce a new discourse referent into the mental model. Previous event-related potential (ERP) studies show an enhanced Late Positivity effect for indirect anaphors relative to (coreferential) direct anaphors (*A bride<sub>i</sub> bought a wedding gown. The bride<sub>i</sub> was very happy.*), which has been associated with the processing of newness (Burkhardt 2006). An open question remains whether the increased processing costs of indirect anaphors arise from the integration of a *new informational aspect* or through the integration of a *new discourse referent*. This question was addressed in two experiments via a comparison of indirect anaphors and so-called specification anaphors (*Marie<sub>i</sub> bought a wedding gown. The bride<sub>i</sub> was very happy.*). Specification anaphors resemble indirect anaphors in as far as they convey new information (about an already given referent, i.e. *the bride=Marie*) and they resemble direct anaphors by indicating a coreference relation. By contrast, indirect anaphors require the introduction of a new discourse referent.

First a self-paced reading (SRP) experiment was conducted where the reading times (RTs) of direct and indirect anaphors were compared to the RTs of specification anaphors (see Table1). The results indicate that the RTs of specification anaphors pattern with indirect anaphors in the critical region (see Fig.1), suggesting that the increased processing costs of indirect anaphors arise from the integration of new information. However, the RTs in the spill over regions show longer RTs for specification anaphors. We suggest that this indicates that specification anaphors are initially analyzed as new discourse referents and are subsequently recognized as being coreferential with an already given entity, when discourse unfolds. This reanalysis exerts costs. This leads to the conclusion that the increased processing costs of indirect anaphors observed in previous investigations of direct and indirect anaphors arise from the integration of a *new discourse referent*.

To follow up on this, an ERP study was carried out to contrast the three different types of anaphors and shed more light on the functional contribution to newness of the Late Positivity observed in previous research. The material for the ERP study was adapted to preclude that the specification anaphor was interpreted as a new referent: names of famous personalities were used as antecedents and commonly known information about them as the specification anaphor (e.g., *Joanne K. Rowling and the author* in Table1). The ERPs revealed a three-way modulation in the N400-window (300-500ms: indirect anaphor > specification anaphor > direct anaphor), reflecting different degrees of predictability, and a more pronounced Late Positivity over left-anterior electrode sites (600-800ms) for indirect anaphors relative to the other two anaphors (see Fig.2). This confirms the conclusions from the SPR study: The increased Late Positivity of indirect anaphors is associated with the establishment of a new discourse referent, lending support to the view that the positivity signals *newness of the discourse referent* rather than of information per se.

## References

Burkhardt, Petra. 2006. Inferential bridging relations reveal distinct neural mechanisms: Evidence from event-related brain potentials. *Brain and Language* 98(2). 159–168.

**Table 1: Experimental Design & Sample Stimuli**

	Informational aspect	Discourse Referent	Example
Indirect anaphor	new	new	<i>Theo read an article about waste disposal. I heard that <b>the author</b> wrote very well about that topic.</i>
Specification anaphor	new	given	SPR Item: <i>Lisa<sub>i</sub> worked the whole night through. I heard that <b>the author<sub>i</sub></b> is going to publish a new book soon.</i>  ERP Item: <i>Joanne K. Rowling<sub>i</sub> worked the whole night through. I heard that <b>the author<sub>i</sub></b> is going to publish a new book soon.</i>
Direct anaphor	given	given	<i>An author<sub>i</sub> worked the whole night through. I heard that <b>the author<sub>i</sub></b> is going to publish a new book soon.</i>

Figure 1: Reaction times of the SPR Experiment. Standardized logarithmic reaction times on the y-axis and each region of the target sentences on the x-axis. Region 5 (“die Professorin” – the female professor) is the region of interest.

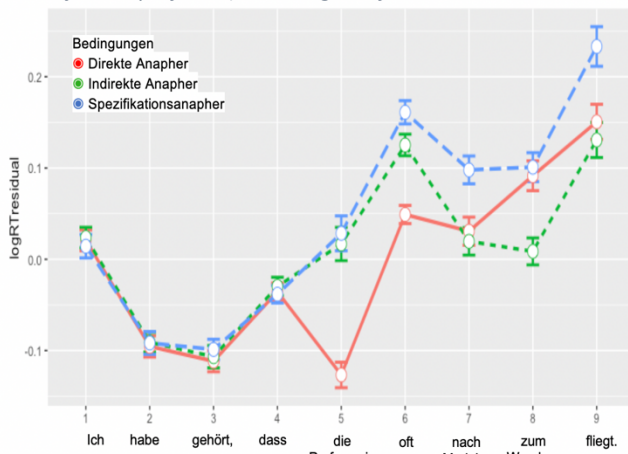


Figure 2: Grand-average-ERPs recorded to the onset of the critical anaphor (onset at the vertical line). Window presentation spans from 200 ms before until 1200 ms after onset of the anaphor. The voltage scale ranges from -4 to 4  $\mu$ V and negative voltage is plotted upward.

