Ontological features constrain anaphoric processing: *This finding* / **This event* is intriguing.

Petra B. Schumacher[1,2], Manfred Consten[3] & Mareile Knees[3]

[1] University of Marburg, [2] University of Mainz, [3] University of Jena

petra.schumacher@uni-mainz.de

Introduction

Anaphoric expressions do not only refer to individuals and objects, but they can also refer to propositionally structured referents (such as facts, states, processes, events). Anaphors that condense propositionally structured antecedents to nominal expressions are called *complex anaphors* (Schwarz, 2000) or *abstract object anaphors* (Asher, 1993). Examples of complex anaphors are given in (A-C), where *this development* or *this phenomenon* refer to the previously mentioned situation referent (i.e. *the destruction of the cichlid species*).

Complex anaphors differ in their ontological types, which can be categorized in terms of a linear hierarchy indicating increasing abstractness (cf. e.g. Asher, 1993; Maienborn, 2003). The abstractness scale (Figure 1) is defined with respect to the boundedness of complex referents to space, time, agents and worlds. The less bound a referent, the more abstract it is. For instance, events – representing the least abstract entities – are defined as spatio-temporal entities with certain agents and a focus on the result [+telic]. Processes emphasize the temporal duration [+dynamic]. States are neither telic nor dynamic, but are bound to experiencers within a certain time (and partly space) interval.

During referential resolution, a complex anaphor can confirm the ontological type assigned by the antecedent (e.g. a process anaphor refers to a process (A)) or it can shift the ontological type to a more abstract one (e.g. a state anaphor refers to a process (B)). Crucially, however, it cannot shift the ontological type to a less abstract type (e.g. an event anaphor cannot refer to a process (C)) (cf. Consten et al., 2007 for evidence from corpus data). This abstractness constraint arises because ontological features that are not specified by the antecedent cannot be (re)constructed by a complex anaphor.

Here, we investigate the real-time implications of the abstractness constraint on referential processing.

Design

(A) **Process – Process Anaphor (p ← p):**
Die Nilbarsche im Viktoriasee vernichten nach und nach die meisten Buntbarscharten. Naturschützer beobachten **diese Entwicklung** heute mit großer Besorgnis.

(B) **Process – State Anaphor (p ← s):**
Die Nilbarsche im Viktoriasee vernichten nach und nach die meisten Buntbarscharten. Naturschützer beobachten **dieses Phänomen** heute mit großer Besorgnis.

(C) **Process – *Event Anaphor (p ← *e):**
Die Nilbarsche im Viktoriasee vernichten nach und nach die meisten Buntbarscharten. #Naturschützer beobachten **dieses Ereignis** heute mit großer Besorgnis.

[The Nil perch in Lake Victoria gradually destroy most of the cichlid species.]$_{PROCESS}$ Conservationists observe

(A) ***this development*** $_{PROCESS}$
(B) ***this phenomenon*** $_{STATE}$
(C) ****this event*** $_{EVENT}$

nowadays with great apprehension.

Method

- Reading study with word recognition task
- Visual presentation (600 ms per segment, 150 ms ISI)
- 24 Ag/AgCl electrodes; 250 Hz sampling rate
- Time-locked to onset of the complex anaphor
- Complex anaphors matched for length and frequency
- 24 (12 male) right-handed native speakers of German (mean age: 24)

Hypotheses

N400 as a measure of referential integration difficulties

- Violation of the abstractness constraint (**C**):
  enhanced N400 (**C > A**)
- Ontological reduction (**B**):
  - No extra processing cost, if ontological types are implicationally related (**B = A**)
  - Or: pronounced N400, if shifting the ontological type is generally costly (**B > A**)

Abstractness scale

proposition (pp)	[unspecified truth value]		
fact (f)			
state (s)	[-dynamic, -telic]	*dependent*	*dependent*
process (p)	[+dynamic, -telic]	*on time*	*on world*
event (e)	[+dynamic, +telic]	*and space*	

Figure 1. Ontological categories with increasing abstractness.

Abstractness constraint

x ← y if x > y

x cannot be higher on the abstractness scale than *y*, where *x* represents the ontological type assigned by the antecedent and *y* that of the anaphor.

Results

- **Violation of abstractness constraint** (C) elicited a more pronounced negativity between 420-580 ms for event anaphors (**Event > Process**)
- **Ontological reduction** (B) registered no significant differences compared to maintaining the ontological type (**State = Process**)
- Interaction Anaphor Type x ROI ($F(6, 126)=5.16$, $p<.001$)
- Planned comparisons revealed main effect for
  - Event vs. Process
  - Event vs. State
- Good performance in word recognition task (92% correct)

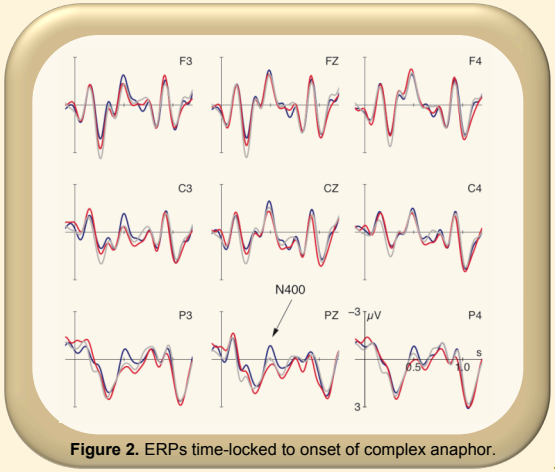

Figure 2. ERPs time-locked to onset of complex anaphor.

Discussion

Ontological types and reference resolution

The ontological type assigned to an entity impacts referential interpretation during early processes of dependency formation that activate lexical-semantic networks (e.g. van Berkum et al., 2003; Burkhardt, 2006).

Ontological features are specified for each referent and missing features cannot be reconstructed during reference resolution; e.g. a process is [-telic], hence the property [+telic], which is specific to events, cannot be added, yielding a feature mismatch.

Altering the ontological type is not costly in and of itself, but violating the abstractness constraint is. This reveals that the direction of possible ontological shifts is restricted.

Violation of the abstractness constraint

Results in processing difficulties (enhanced N400):
an anaphor cannot pick up an antecedent expression whose ontological type is higher on the abstractness scale (e.g. Process ← *Event).

Ontological reduction

Absence of additional processing cost indicates that ontological types are implicationally related:
a more abstract ontological type represents a reduction of the ontological properties of the less abstract type (e.g. Process ← State).

References

Asher, N. (1993). *Reference to abstract objects in discourse*. Dordrecht/Boston: Kluwer.
Burkhardt, P. (2006). Inferential bridging relations reveal distinct neural mechanisms: Evidence from event-related brain potentials. *Brain Lang*, *98*(2), 159-168.
Consten, M., Knees, M., & Schwarz-Friesel, M. (2007). The function of complex anaphors in texts. In M. Schwarz-Friesel, M. Consten, & M. Knees (Eds.), *Anaphors in Text* (pp. 81-102). Amsterdam/New York: John Benjamins.
Maienborn, C. (2003). *Die logische Form von Kopula-Sätzen*. Berlin: Akademie Verlag.
Schwarz, M. (2000). *Indirekte Anaphern in Texten*. Tübingen: Niemeyer.
van Berkum, J. J. A., Zwisterlood, P., Hagoort, P., & Brown, C. M. (2003). When and how do listeners relate a sentence to the wider discourse? Evidence from the N400 effect. *Cognitive Brain Res*, *17*(3), 701-718.

Acknowledgements

This research was supported by German Research Foundation grants to PBS (BU 1853/2-1) and MC/MK (SCHW 509/6).