Effects of Syntactic Complexity and Prosody on Sentence Processing and Comprehension in Noise

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REBECCA CARROLL

geboren am 04.07.1980 in Witten

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Referentin: Prof. Dr. Esther Ruigendijk
Korreferenten: Prof. Dr. Kai Alter
Prof. Dr. Jörg Peters

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LIST OF ABBREVIATIONS

ACC	Accusative case
ADJ	Adjective
AI	Articulation Index
CPS	Closure Positive Shift
DAT	Dative case
D.O.	Direct Object
EEG	Electroencephalogram
ELU	Ease of Language Understanding
ERP	Event-Related Potential
FEM	Feminine gender
GÖSA	Göttingen Sentence Tests
GP	Garden-Path sentence
HINT	Hearing In Noise Test
HL	Hearing Level
I.O.	Indirect Object
IPh	Intonational Phrase
LAN	Left Anterior Negativity
MASC	Masculine gender
N1/P2	The combination of a negative-going peak after 100 ms followed by a positive deflection at 200 ms post stimulus onset
N400	(Centro-parietal) negativity with a maximum at 400 ms post stimulus onset
NEUTR	Neuter gender
NOM	Nominative case
NP	Nominal Phrase
OLACS	Oldenburg Audiologically and Linguistically Controlled Sentence Corpus
OLSA	Oldenburg Sentence Test
OVS	Object-Verb-Subject (non-canonical word order for German main clauses)
OR	Object Relative Clause
ORamb	Ambiguous Object Relative Clause
O-S	Object before subject word order
P600	Centro-parietal positivity with a maximum at 600 ms post stimulus onset
PL	Plural

RC	Relative Clause
RMS	Root Mean Square
ROI	Region Of Interest
RT	Reaction Times
SG	Singular
SII	Speech Intelligibility Index
SNR	Signal-to-Noise Ratio
S-O	Subject before object word order
SOV	Subject-Object-Verb (canonical word order for German subordinate clauses)
SPL	Sound Pressure Level (≈ amplitude)
SR	Subject Relative Clause
SRamb	Ambiguous Subject Relative Clause
SRT	Speech Reception Threshold
SVO	Subject-Verb-Object (canonical word order for German main clauses)
V2	Verb-second word order (main clauses)
VP	Verb Phrase
VWM	Verbal Working Memory
WM	Working Memory

OVERVIEW OF SENTENCE STRUCTURES

STRUCTURE	**EXAMPLE SENTENCE**
SVO	Der kleine Junge umarmt den dicken Nikolaus.
OVS	Den dicken Nikolaus umarmt der kleine Junge.
OVSamb	Die dicke Köchin umarmt der fiese Metzger.
SR	Der Bauer, der die Ärztinnen grüßt, lächelt.
OR	Der Bauer, den die Ärztinnen grüßen, lächelt.
SRamb	Die Ärztinnen, die die Bäuerin grüßen, lachen.
ORamb	Die Ärztinnen, die die Bäuerin grüßt, lachen.
Early IPh	[Der Mann verspricht]$_{IPh1}$ [Anna zu entlasten] [und das Büro zu putzen.]
Late IPh	[Der Mann verspricht Anna]$_{IPh2}$ [zu arbeiten] [und das Büro zu putzen.]

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ABSTRACT

This dissertation systematically investigates the interaction of speech perception in noise, syntactic complexity, as well as the influence of morpho-syntactic and prosodic cues from a psycholinguistic perspective. In German, at least four aspects contribute to this interaction, which mainly rely on results from several reaction time studies. The basic assumption is that segmental morpho-syntactic cues such as case, number, and gender marking do not provide reliable information in noise, as they typically occur in prosodically weak and thus perceptionally unfavorable positions. Suprasegmental prosodic information by contrast may be more reliable in (stationary) noise, as they are available over a longer period of time, and thus easier to extract from the noise masker.

Firstly, syntactic complexity is demonstrated to interact with sentence processing in noise. Difficult sentence parts of complex structures are affected more strongly by noise than easier parts. This finding is related to an additional cognitive strain. If complex sentences increase the cognitive load, and if the filtering of the speech signal from a noisy background also requires cognitive load, then the cognitive capacity of the individual listeners becomes increasingly important, as resources have to be reallocated. This is in line with accounts by Pichora-Fuller (2008), Rönnberg et al. (2008, 2010), and comparable empirical findings by Tun et al. (2010) and Kilborn (1991).

Secondly, complex sentences that heavily rely on prosodic information for correct interpretation do not seem to be affected by stationary noise as much as sentences relying on segmental morpho-syntactic cues such as case or number markings. Although noise slows down processing, I observe no interaction with structure. It is argued that the reason for this is a prosodic benefit in the sense that both the fundamental frequency and the rhythmic structure are still reliable cues in stationary noise. Intonational phrase boundaries may facilitate chunking, which relieve the cognitive load. Electrophysiological evidence supports the observations obtained in the reaction time study.

Thirdly, sentence processing in fluctuating noise requires different processing strategies than those observed for stationary noise. Whereas SVO and OVS structures profit from a dip-listening advantage (Festen & Plomp, 1990; Wagener et al., 2006), the prosodic benefit observed for center-embedded relative clauses does not seem to hold. Instead, comparatively higher processing times are interpreted to reflect a rhythmic clash, which

increases the difficulty to segregate and extract relevant speech cues from the noise masker.

Taken together, these aspects provide a clearer view on the mechanisms and strategies used when processing complex (German) sentences in acoustically difficult listening situations. Generally, listeners tend to use whatever cues are available for correct interpretation. If bottom-up processes become unreliable, top-down processes kick in. If the latter are misleading (e.g., in case of improbable non-canonical word orders), then comprehension is seriously reduced. Moreover, redundant information may be neglected in adverse listening situations, which can also be attributed to a tendency to reduce the cognitive load.