

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

Von der Carl von Ossietzky Universität Oldenburg  
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REBECCA CARROLL

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Referentin: Prof. Dr. Esther Ruigendijk

Korreferenten: Prof. Dr. Kai Alter

Prof. Dr. Jörg Peters

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**Rebecca Carroll**

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Internet: [www.shaker.de](http://www.shaker.de) • e-mail: [info@shaker.de](mailto:info@shaker.de)

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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 ( $\approx$ 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       | <u>Den</u> dicken Nikolaus umarmt der kleine Junge.                                         |
| OVSamb    | Die dicke Köchin umarmt <u>der</u> fiese Metzger.                                           |
| SR        | Der Bauer, <u>der</u> die Ärztinnen grüßt, lächelt.                                         |
| OR        | Der Bauer, <u>den</u> die Ärztinnen grüßen, lächelt.                                        |
| SRamb     | Die Ärztinnen, die die Bäuerin <u>grüßen</u> , lachen.                                      |
| ORamb     | Die Ärztinnen, die die Bäuerin <u>grüßt</u> , lachen.                                       |
| Early IPh | [Der Mann <u>verspricht</u> ] <sub>IPh1</sub> [Anna zu entlasten] [und das Büro zu putzen.] |
| Late IPh  | [Der Mann <u>verspricht</u> Anna] <sub>IPh2</sub> [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 perceptually 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.