Everyone knows what attention is.

1 Experiment 1: Predictability effect of degraded speech are reduced as a function of attention

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1.1 Introduction

In this chapter we examine how attention modulates the facilitatory effect of predictability in an adverse listening condition. When listening condition is adverse, for example, due to speech degradation, listeners utilize context information. It can be information about a topic of conversation, semantic and syntactic information of a sentence structure, world knowledge, visual information, etc. [1–4, **Stilp2020**]. To utilize the context information, listeners must attend to it and build up a meaning representation of what has been said. Listeners attend to the context information in clear speech with minimal effort, but processing and comprehending degraded speech is more effortful and requires more attentional resources [**Peelle2018**, **Wild2012**, 5]. However, it is less clear how listeners distribute attentional resources: On the one hand, listeners can attend throughout the whole stream of speech and may thereby profit from the context information to predict sentence endings. On the other hand,

listeners can focus their attention on linguistic material at a particular time point in the speech stream and, as a result, miss critical parts of the sentence context. If the goal is to understand a specific word in an utterance, there is a trade-off between allocating attentional resources to the perception of that word vs. allocating resources also to the understanding of the linguistic context and generating predictions.

The aim of the study in this chapter was to investigate how the allocation of attentional resources induced by different task instructions influence language comprehension and, in particular, the use of context information under adverse listening conditions. To examine the role of attention on predictive processing under degraded speech, we conducted two experiments in which we manipulated task instructions. In Experiment 1, participants were instructed to only repeat the final word of the sentence they have heard, while in Experiment 2, they were instructed to repeat the whole sentence, and by this drawing attention to the entire sentence including the context. In both experiments we varied the degree of predictability of sentence endings as well as the degree of speech degradation.

1.1.1 Predictive processing and language comprehension under degraded speech

It is broadly agreed that human comprehenders generate expectations about upcoming linguistic material based on context information [**Kuperberg2016**, **Nieuwland2019**, for reviews, see 6, 7]. These expectations are formed while sentence unfolds. The claims about the predictive nature of language comprehension are based on a variety of behavioral and electrophysiological experimental measures including eye-tracking and electroencephalography (EEG). For instance, in the well-known visual world paradigm, listeners fixate at a picture of an object (e.g., the cake) that is predictable based on the prior sentence context (e.g., 'The boy will eat the ...') even before hearing the final target word [**Ankener2018**, e.g., 3, 8]. Moreover, highly predictable words are read faster and are skipped more often compared to less predictable words [9, 10].

In EEG studies, the N400, a negative going EEG component, that usually peaks around 400 ms post-stimulus is considered as a neural marker of semantic unexpectedness [11]. For instance, in the highly predictable sentence context 'The day was breezy so the boy went outside to fly ...,' DeLong, Urbach, and Kutas [12] found that the amplitude of the N400 component for the expected continuation 'a kite' was much smaller than for the unexpected continuation 'an airplane'. Although these studies demonstrated that as the sentence context builds up, listeners form predictions about upcoming words in the sentence, the universality and ubiquity of predictive language processing has been questioned [**Huettig2016**]. Also, the use of context for top-down prediction can be limited by factors like literacy [**Mishra2012**], age, and working memory [**Federmeier2010**, **Federmeier2002**], as well as by the experimental setup [**Huettig2019**]. While these language comprehension studies investigating predictive processing have used clean speech and sentence reading, the present study focuses on examining how attention influences the use of context to form top-down prediction under adverse listening conditions

There is already some evidence that when the bottom-up speech signal is less reliable due to degradation, listeners tend to rely more on the context information to support language comprehension [13–15]. For example, Sheldon, Pichora-Fuller, and Schneider [15] (Figure 2) estimated that for both younger and older adults, the number of noise-vocoding channels required to achieve 50% accuracy varied as a function of sentence context. Compared to highly predictable sentences, a greater number of channels (i.e., more bottom-up information) was required in lowly predictable sentences to achieve the same level of accuracy. Therefore, they concluded that when speech is degraded, predictable sentence context facilitates word recognition. Obleser et al. [16] found that at a moderate level of spectral degradation, listeners' word recognition accuracy was higher for highly predictable sentence contexts than for less predictable ones. However, while listening to the least degraded speech, there was no such beneficial effect of sentence context [see also 14]. Hence, especially when the bottom-up speech signal is less reliable due to moderate degradation, information available from the sentence context is used to enhance

language comprehension, suggesting that there is a dynamic interaction between top-down predictive and bottom-up sensory processes in language comprehension [17].

1.1.2 Attention, predictability and processing of degraded speech

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1.1.3 Current study

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1.2 Experiment 1A *[Attending only to the target word]*

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1.3 Materials and methods

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1.3.1 Participants

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1.3.2 Stimuli

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1.3.3 Task and procedure

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1.4 Analyses

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1.5 Results

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1.6 Experiment 1B *[Attending to the entire sentence]*

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1.7 Materials and methods

1.7.1 Participants

1.7.2 Stimuli

1.7.3 Task and procedure

1.8 Analyses

1.9 Results

1.10 Discussion

1.11 Conclusions

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