

# The amount of environmental noise in a listener's living environment affects how much a listener benefits from gestures in degraded speech

*The Communicative Brain Group:*  
Noor Seijdel<sup>1</sup>, Sara Mazzini<sup>1</sup>, Linda Drijvers<sup>1,2</sup>

<sup>1</sup>Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands

<sup>2</sup>Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, the Netherlands

[noor.seijdel@mpi.nl](mailto:noor.seijdel@mpi.nl), [sara.mazzini@mpi.nl](mailto:sara.mazzini@mpi.nl), [linda.drijvers@mpi.nl](mailto:linda.drijvers@mpi.nl)

Face-to-face communication involves speech and visual information (such as from visible speech, and gestures). The presence of gestures has been shown to facilitate speech. Iconic gestures can improve speech comprehension, especially in adverse listening conditions where the quality of auditory information may be degraded (Drijvers & Özyürek, 2017). However, individual differences exist in how much listeners benefit from gestures when understanding speech in adverse listening conditions. One factor that could impact the ability to process language and integrate audiovisual information is the presence of environmental noise. For example, growing up or going to school in high-noise environments (such as in the proximity of frequent heavy traffic or airports) has been shown to influence language abilities, reading comprehension, and speech perception (Evans & Maxwell, 1997; Hygge et al., 2002; Lercher et al., 2003; Seabi et al., 2012; Thompson 2022). In the current study, we investigated whether environmental noise affects how much a listener can benefit from gestures during degraded speech comprehension.

In an online experiment, 40 participants were presented with video clips of an actress uttering a highly-frequent action verb that could be accompanied by an iconic gesture or no gesture, and that could be presented in clear or degraded (6-band vocoded) speech. The task of the participants was to type the verb they thought the actress conveyed in the videos. Additionally, we asked participants to identify the environmental noise levels of their current and previous living environments, by using the atlas from the Dutch Institute for Public Health and the Environment for sound disturbance (Rijksinstituut voor Volksgezondheid en Milieu, 2020), as well as their subjective ratings about the environmental noise levels of their current and previous living environments. We hypothesized that individuals who grew up or lived in high-noise areas would perform worse on the task and benefit less from gestures, and that their subjective ratings would show a similar pattern.

Results showed that the amount of environmental noise in both current and previous living environments, as well as the subjective experience of those environmental noise levels, affected the degree to which individuals benefit from gestures in degraded speech comprehension. Specifically, individuals who experienced lower levels of environmental noise in both their current and previous living environment benefitted more from gestures during degraded speech comprehension. Moreover, individuals who were living in or lived in high-noise environments found it easier to identify the verbs in the videos when speech was degraded than individuals who were living in or lived in low-noise environments. Finally, the subjective experience of the environmental noise levels predicted how much a listener benefitted from gestures during degraded speech: individuals who experienced a high-noise environment benefitted less from gestures.

These results are valuable for understanding individual differences in gestural enhancement of degraded speech comprehension. By showing how previous auditory experiences can affect audiovisual speech-in-noise comprehension and auditory processing, these results may inform the design of interventions to enhance communication in noisy environments. Future studies could investigate the underlying neural mechanisms of these effects and explore potential interventions that can facilitate audiovisual integration in individuals with neurodiverse traits.

**Index Terms:** gestural enhancement, speech comprehension, individual differences, environmental noise

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