A computer simulation of the reducing effect

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The reducing effect (Bybee, 2003) is a common mechanism of phonetic change in language, causing frequent constructions to become phonetically reduced over time (e.g. *I don't know* becomes *dunno*). High-frequency constructions especially are said to reduce faster and more strongly due to "neuromotor automation" (Bybee, 2006, p. 5). Corpus studies show reduction empirically, but cannot explain how communication remains successful despite the phenomenon. We do not know, for example, what requirements keep language users from reducing "too far", avoiding communicative chaos.

To find these requirements, we built a computer simulation with virtual speakers ('agents'). Each agent has a memory of constructions represented as vectors (cfr. Baevski et al., 2020). During communication, these are compared on the basis of phonetic distance to determine what construction was 'heard'. To simulate acoustic reduction, speakers can reduce an exemplar's vector, leading to sparser representations over time.
We show that two requirements are necessary for successful reduction (i.e. reduction that is strongest, but never overly strong, in high-frequency constructions). First, the frequency distribution of constructions must be Zipfian, else the acoustic space will fail to be distributed efficiently among constructions. Second, when applying reduction, speakers should check if they are able to understand their reduced utterance themselves ("re-entrance," Steels, 2003). Without this check, speakers reduce too far, with mass confusion as a consequence.

Our simulation shows that there might be more to the reduction principle than just a link between usage and sparsity, as certain properties inherent to language (Zipfian distribution, inner voice) are indispensable in our model world. An experimental spin-off could help confirm this.

References

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