Language for Communication: Language as Rational Inference

Edward Gibson
Massachusetts Institute of Technology
Brain and Cognitive Sciences Department
Cambridge, MA, USA
egibson@mit.edu

Invited Speaker Abstract

Perhaps the most obvious hypothesis for the evolutionary function of human language is for use in communication. Chomsky has famously argued that this is a flawed hypothesis, because of the existence of such phenomena as ambiguity. Furthermore, he argues that the kinds of things that people tend to say are not short and simple, as would be predicted by communication theory. Contrary to Chomsky, my group applies information theory and communication theory from Shannon (1948) in order to attempt to explain the typical usage of language in comprehension and production, together with the structure of languages themselves. First, we show that ambiguity out of context is not only not a problem for an information-theoretic approach to language, it is a feature. Second, we show that language comprehension appears to function as a noisy channel process, in line with communication theory. Given si, the intended sentence, and sp, the perceived sentence we propose that people maximize $P(s_i|s_p)$, which is equivalent to maximizing the product of the prior $P(s_i)$ and the likely noise processes $P(s_i \rightarrow s_p)$.

We show that several predictions of this way of thinking of language are true:

1. the more noise that is needed to edit from one alternative to another leads to lower likelihood that the alternative will be considered;
2. in the noise process, deletions are more likely than insertions;
3. increasing the noise increases the reliance on the prior (semantics); and
4. increasing the likelihood of implausible events decreases the reliance on the prior.

Third, we show that this way of thinking about language leads to a simple re-thinking of the P600 from the ERP literature. The P600 wave was originally proposed to be due to people's sensitivity to syntactic violations, but there have been many instances of problematic data in the literature for this interpretation. We show that the P600 can best be interpreted as sensitivity to an edit in the signal, in order to make it more easily interpretable.

Finally, we discuss how thinking of language as communication can explain aspects of the origin of word order. Some recent evidence suggests that subject-object-verb (SOV) may be the default word order for human language. For example, SOV is the preferred word order in a task where participants gesture event meanings (Goldin-Meadow et al. 2008). Critically, SOV gesture production occurs not only for speakers of SOV languages, but also for speakers of SVO languages, such as English, Chinese, Spanish (Goldin-Meadow et al. 2008) and Italian (Langus and Nespor, 2010). The gesture-production task therefore plausibly reflects default word order independent of native language. However, this leaves open the question of why there are so many SVO languages (41.2% of languages; Dryer, 2005). We propose that the high percentage of SVO languages cross-linguistically is due to communication pressures over a noisy channel. We provide several gesture experiments consistent with this hypothesis, and we speculate how a noisy channel approach might explain several typical word order patterns that occur in the world's languages.

Proceedings of COLING 2014, the 25th International Conference on Computational Linguistics: Technical Papers, pages 781–782, Dublin, Ireland, August 23-29 2014.

References

Matthew S. Dryer. 2005. The order of subject, object and verb. In *The World Atlas of Language Structures*, pages 330–333. Oxford University Press, Oxford, UK.

Susan Goldin-Meadow, Wing Chee So, Aslı Özyürek, and Carolyn Mylander. 2008. The natural order of events: How speakers of different languages represent events nonverbally. *Proceedings of the National Academy of Sciences of the United States of America*, 105(27):9163–9168.

Alan Langusa and Marina Nespor. 2010. Cognitive systems struggling for word order. *Cognitive Psychology*, 60(4):291–318.

C.E. Shannon. 1948. A mathematical theory of communication. *Bell System Technical Journal*, 27:623–656.