

THE EFFECT OF COMMUNICATION ON CATEGORY STRUCTURE

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Words divide the world into labeled categories. Researchers in language evolution have debated whether the categories labeled by words are a prior product of non-linguistic cognition, or whether they are shaped at least partly by negotiation on communicative conventions (Hurford, 2007). We investigated the effects of individual cognition versus communication on categorisation of a novel, continuous stimulus space (Silvey, Kirby, & Smith, 2013). Participants divided this space into labeled categories in three conditions: IC1) an individual condition, where participants divided the set of images into categories on the basis of similarity; IC2) a second individual condition, where participants did the same task but in an incremental, serial fashion; Comm) a communicative condition, where participants created categories in the same incremental, serial fashion as condition IC2, but in a partnered communication game, where they took turns to produce a label for a target image with the aim of helping their partner to pick the target from the set. Comm participants divided the space into more categories than either IC1 or IC2 participants. While both IC1 and IC2 participants converged on around 6 categories, Comm participants varied significantly between pairs in the number of categories created. Comm participants had fewer contiguous categories, despite contiguous categories being better, in principle, for the communicative task. Communicative pairs who shared prototypes, i.e. agreed on 'default' image(s) for a given word, tended to be most successful.

To illuminate these differences further, we fit a statistical model of categorisation behaviour to participants' responses. Following e.g. Griffiths et al. (2008), we make use of the Dirichlet process mixture model (DPMM). We fit a DPMM to each labelled category. With respect to a single parameter α , the DPMM interpolates between traditional prototype ($\alpha \rightarrow 0$) and exemplar ($\alpha \rightarrow \infty$) style representations. Fig.1. shows that communicators' category structures appear most prototype-like, while IC1 categories appear most exemplar-like. We can likewise treat each participant's *set* of categories as an overarching DPMM with its own equivalent parameter β , which can be interpreted as quantifying how will-

ing a participant is to create a new category. This hierarchical model can be fit to the sequences of decisions made by participants in conditions IC2 & Comm. A grid search over $\alpha \times \beta$ finds that, for the IC2 condition, the best fit parameters are $\alpha = 1.54$ and $\beta = 7.7$, which assign the data a log likelihood of -2472.46 (predicting roughly 30% of decisions), whereas for the Comm condition, best fit parameters are $\alpha = 1.03$ and $\beta = 12.82$, with a log likelihood of -1732.6 (roughly 18%), further suggesting that communicators were less willing to accept novel stimuli into existing categories, leading to more categories with stricter membership requirements. This can be explained as a response to the pressure for greater specificity imposed by the communication game, which may have been well served by localised category structures.

Taken together, these results show that communication and individual cognition produce qualitatively different category structures. This suggests that rather than language simply labeling pre-linguistic categories, the pressure of coordinating on communicative conventions actively works to shape the structure of word meaning categories.

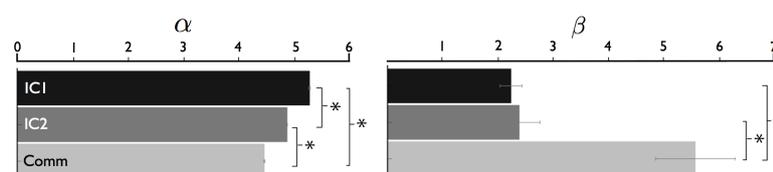


Figure 1. Parameter fits for final categories by condition. Bars show mean and SEM for: samples (1000 per labelled category) from the posteriors for α (left) and maximum likelihood values for β (right). α samples collected under a Gamma(2,1) prior.

References

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