Adapting to individual differences: An experimental study of variation in language evolution

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While language variation has been typically studied as a marker of social groups (Labov, 1972, 1990), it is also omnipresent at the individual level (Yu & Zellou, 2019). Randomly pick two individuals in any population, and it is highly likely that they will exhibit some degree of variability in their language, for example by pronouncing the same word slightly differently. Language variation may arise from various causes, such as individual differences in the physiological ability to produce sounds. But could these individual differences shape the trajectory of language evolution?

Studies on language evolution traditionally disregard individual differences, and instead focus on group-level patterns and universal biases (despite a long tradition of studying variation in sociolinguistics, e.g. Tamminga, 2021, with which our work is connected, but different in the types of individual differences, processes and phenomena of interest). However, treating groups as homogeneous entities can result in a loss of valuable information when it comes to understanding language evolution. Indeed, languages could adapt to the biases of only a subset of their speakers (Butcher, 2018), as well as to the anatomical and physiological traits of their speakers (Blasi et al., 2019; Dediu et al., 2017, 2019). Individuals may unconsciously adapt their language to align with the unique characteristics of their conversational partners (i.e., accommodation), which can contribute to patterns of language evolution (Fehér et al., 2016, 2019). While some agent-based models have attempted to investigate language evolution dynamics in heterogeneous populations (Jameson & Komarova, 2009a, 2009b; Josserand et al., 2021; Navarro et al., 2018; Rita et al., 2022), no experimental work to date

has tested the role of individual differences in shaping the live formation of languages in the lab.

In this study, we use an experimental approach based on a group communication game (Raviv et al., 2019a, 2019b), where micro-societies of four interacting participants need to communicate with each other using a miniature artificial language. Following exposure to a set of initial labels, participants interacted face-to-face in alternating dyads over multiple rounds using a computer interface. In each round, one participant produced a label to describe an image to their partner, and their partner needed to select the correct item from a set of distractors. We introduced individual differences by preventing one participant (the *biased participant*) from using two (out of eight) letters on the keyboard, simulating a speech variation or impairment that individuals may experience in their real lives. We ask whether the collective language of the group will adapt to the biased participant (i.e., by avoiding the use of these 'unavailable' letters), or, conversely, whether the unbiased majority will prevail (i.e., resulting in a language that encompasses all letters).

We tested 7 groups containing one biased participant (*heterogeneous* groups) and 7 groups containing no biased participants (*control* groups). Using mixed-effect models with the group as a random factor, we assessed participants' communicative success, their convergence on a shared language, and the specific usage frequency of the letters unavailable to the biased participants in the other participants' production in different models. Our results show that languages evolved differently in groups with a biased participant. After the nine rounds of communication, *heterogeneous* groups showed less communicative success (β=-27±7.3, $p<0.01$) and convergence (β=-0.33±0.04, $p<0.001$), which fostered the use of more linguistic variants. Additionally, we noticed partner-specific alignment, with participants typically adjusting their language to accommodate the idiosyncrasies of the biased participant during one-on-one interactions (i.e., avoiding the use of unavailable letters when interacting with the biased participant). Interestingly, this alignment extended to the group level, with five out of seven heterogeneous groups exhibiting group-level adaptation whereby the use of the biased letters significantly decreased over time in participants' languages (even when interacting with unbiased participants) (β=0.46±0.12, $p<0.001$) . Notably, the extent of this group-level adaptation was linked to the participants' initial learning accuracy, suggesting that stronger attachment to conventionalized forms can result in less accommodation to minorities. Together, our results show that individual differences in language use can spread to the wider community, and also accumulate over time, ultimately contributing to language changes.

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