REPLY TO MARTENS:

Various factors may enable large populations to enhance cumulative cultural evolution, but more evidence is needed

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Martens (1) suggests that including model-based bias (e.g., prestige) in our experiment would have enhanced cumulative cultural evolution (CCE) in the larger populations reported in our paper (2). This is a plausible hypothesis, but not one our experiment was designed to test. Given the controversy around the relationship between population size and CCE (3), our experiment was designed to isolate the basic effect of population size on CCE by excluding extraneous factors, including model-based bias. In our experiment increasing population size did not enhance CCE. We do not conclude that larger populations do not enhance CCE but that other factors may be necessary to see this benefit.

As Martens (1) points out, the larger populations in our experiment generated greater artifact variation, and this gave participants access to higher-quality artifacts. This highlights the potential of larger populations. (Although not reported in our paper, this greater variation also gave participants access to lower-quality artifacts; the variation was a doubled-edged sword.) Despite this, increasing population size did not enhance CCE. In fact, there was an inverse relationship between population size and CCE, such that an improvement in artifact performance was not observed in the larger (2- or 4-model) populations but was observed in the smaller (1-model) populations. Further analysis indicated that the greater variation participants had access to in the larger populations may have overwhelmed their working memory (4) and weakened their ability to selectively copy the best-adapted artifact(s). To avoid cognitive overload it may be necessary for members of larger populations to find a way to avoid encountering undesirable artifacts in order to focus their limited cognitive resources on the best-adapted artifact(s). Such a filtering mechanism may allow larger populations to enhance CCE. Consistent with this, when participants can choose to view a single artifact based on its reported performance, larger populations are found to enhance CCE (5, 6).

Cultural learning biases (7) might offer a solution to this filtering problem. Specifically, Martens (1) proposes that model-based bias, selectively attending to particular models (e.g., those high on prestige), allows people to prefilter the artifacts they encounter. Network dynamics offer another solution. Filtering can be distributed across a social network, and by interacting in dyads people can reduce the rate of exposure to variation, preventing cognitive overload (8). Technology offers yet another solution. Writing systems allow people to offload cognitive complexity to external representations, freeing up cognitive resources. So, the hypothesis proposed by Martens is one of several plausible hypotheses, all of which should be subjected to empirical test.

To conclude, our experiment set out not to simulate reality but to test the basic effect of population size on CCE. We found no evidence that larger populations enhanced CCE, suggesting that additional factors may be required. Several candidates are listed above, all of which merit empirical test. However, we must remain open to the possibility, consistent with some reports from the archeological and ethnographic record (3, 9), that larger populations do not enhance CCE.

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