Linguistic diversity and individual variation: A comment of "Rethinking foundations of language from a multidisciplinary perspective" by T. Gong et al.

Pablo Contreras Kallens[1], Rick Dale[2], and Morten H. Christiansen[*1]

[1]Department of Psychology, Cornell University, Ithaca, NY
[2]Department of Communication, UCLA, Los Angeles, CA

July 2, 2018

In their comprehensive review article, Gong, Shuai and Wu argue that theorizing about the foundations of language requires taking evolution into account—in particular, the cultural evolution of linguistic structure. We wholeheartedly concur with this point (Beckner et al., 2009; Christiansen and Chater, 2017). In this commentary, we give further emphasis to two features of language that support this account: linguistic diversity and individual variation. These are critical to bringing theories of language in line with evolutionary considerations.

Variation fuels evolution—without it, no *adaptive* changes are possible (though other types of change may occur due to non-adaptive processes such as random drift). Fortunately, as noted by Evans and Levinson (2009), human language is perhaps unique among animal communication systems in its sheer diversity. There are currently between 6,000 and 8,000 different languages spoken in the world (Evans and Levinson, 2009; Hammarström, 2016; Nettle, 1998), and these vary substantially along every imaginable linguistic feature.

However, this diversity is not randomly distributed. On the contrary, there are statistical trends that govern these patterns (Christiansen and Chater, 2016a; Evans and Levinson, 2009; Lupyan and Dale, 2016), be it geographical (Gavin et al., 2013), morphological (Bentz et al., 2015), lexical (Regier et al., 2016; Lewis and Frank, 2016), phonological (Dediu et al., 2017; Everett, 2017), among others. As the target article shows, there has been substantial progress towards

[*]Corresponding author at: Department of Psychology, Cornell University, Ithaca, New York 14853.
E-mail address: christiansen@cornell.edu.

understanding the mechanisms that allow for language to emerge. However, there has been significantly less progress in determining both the general processes that allow language to be diverse, and the specific processes that produce the patterns detectable in that diversity.

One of the better-studied processes that could drive diversity is the adaptation of language to the cultural community that speaks it. On a timescale of generations, a language culturally evolves to be learnable and usable (Christiansen and Chater, 2008, 2016b). However, different communities of language users are not necessarily homogeneous. They may have systematic differences in their processing and production mechanisms. Some of the relationships between these differences and language diversity have been explored. For example, Dediu et al. (2017) hypothesize that slight but systematic differences in the vocal tract could underlie some of the phonological patterns such as the appearance and maintenance of click consonants.

Moreover, communities may also vary in their social and demographic features. For example, population size has been linked to linguistic patterns (Lupyan and Dale, 2010; Reali et al., 2018; Lewis and Frank, 2016; Lupyan and Dale, 2015; Nettle, 2012; Winter and Bentz, 2014). In general, these studies have shown that population size is inversely correlated with morphological complexity and positively correlated to lexical diversity. The proposed mechanism driving this particular pattern is the *Linguistic Niche Hypothesis* (Lupyan and Dale, 2010; Dale and Lupyan, 2012): language adapts to the particular social structure of language learners. Thus, languages spoken in relatively isolated communities can remain morphologically complex because first-language learners (infants) have no difficulties learning them. In contrast, communities that span more territory, have a bigger population, or come into contact with communities where different languages are spoken more frequently, have a higher probability of being learned and taught by adults. This creates a pressure for simpler structures that are easier to learn by adults. A clear historical example of this is provided by Bentz and Christiansen (2013) with the gradual simplification of the case system of Proto Indo-European in both its Germanic- and Latin-derived descendants.

Although not as well-explored, relationships between linguistic patterns and the structure of the environment have been documented. Iterated learning experiments have shown that varying environments in communication tasks produces differently structured linguistic systems after an evolutionary process of several generations (Perfors and Navarro, 2014; Winters et al., 2015). All of these languages allow the participants to communicate efficiently, but they take on distinct forms in a manner adapted to their environments. Christensen et al. 2016 specifically test the syntactic structure of languages resulting from iterated learning. They found that different environmental and social-interaction pressures shape the word order (either SVO or SOV) of the gestural languages that emerge out of the interaction of their participants. These experiments are consistent with the large scale analysis carried out by Regier et al. (Regier et al., 2016) showing, after very rigorous statistical control, that higher temperatures are correlated with the tendency to use the same term for ice and snow.

These studies of linguistic diversity all presuppose another kind of variation: differences in linguistic abilities within a particular population. This kind of individual variability is rarely, if ever, explored directly—but without it linguistic divergence may not be possible. Indeed, computational simulations by Baronchelli et al. (2012) have demonstrated that only a learning-based foundation for language acquisition (allowing for individual variation) is compatible with linguistic diversity. Fortunately, again, psycholinguistic studies of both children and adults have demonstrated that language users within a given speech community vary substantially in their language skills, from phonology and morphology to syntax and pragmatics (Kidd et al., 2018), thus providing the needed within-population variance to fuel the cultural evolution of language.

We agree with the evolutionary emphasis of Gong and co-authors. We emphasize that mapping these two sources of variation—across and within language communities—offers continuing challenges to getting specific about the cultural evolutionary forces guiding the languages that we observe today.

References

Baronchelli, A., Chater, N., Pastor-Satorras, R., and Christiansen, M. H. (2012). The biological origin of linguistic diversity. *PloS ONE*, 7(10):e48029.

Beckner, C., Blythe, R., Bybee, J., Christiansen, M. H., Croft, W., Ellis, N. C., Holland, J., Ke, J., Larsen-Freeman, D., and Schoenemann, T. (2009). Language is a complex adaptive system: Position paper. *Language learning*, 59(s1):1–26.

Bentz, C. and Christiansen, M. H. (2013). Linguistic adaptation: The trade-off between case marking and fixed word orders in germanic and romance languages. In Peng, G. and Shi, F., editors, *Eastward flows the great river: Festschrift in honor of Prof. William SY. Wang on his 80th birthday*, pages 48–56. City University of Hong Kong Press, Hong Kong.

Bentz, C., Verkerk, A., Kiela, D., Hill, F., and Buttery, P. (2015). Adaptive communication: Languages with more non-native speakers tend to have fewer word forms. *PLoS One*, 10(6):e0128254.

Christensen, P., Fusaroli, R., and Tylén, K. (2016). Environmental constraints shaping constituent order in emerging communication systems: Structural iconicity, interactive alignment and conventionalization. *Cognition*, 146:67–80.

Christiansen, M. H. and Chater, N. (2008). Language as shaped by the brain. *Behavioral and Brain Sciences*, 31(05):489–509.

Christiansen, M. H. and Chater, N. (2016a). *Creating language: Integrating evolution, acquisition, and processing*. The MIT Press, Cambridge, MA.

Christiansen, M. H. and Chater, N. (2016b). The now-or-never bottleneck: A fundamental constraint on language. *Behavioral and Brain Sciences*, 39:e62.

Christiansen, M. H. and Chater, N. (2017). Towards an integrated science of language. *Nature Human Behaviour*, 1(0163):10–1038.

Dale, R. and Lupyan, G. (2012). Understanding the origins of morphological diversity: The linguistic niche hypothesis. *Advances in Complex Systems*, 15(03n04):1150017.

Dediu, D., Janssen, R., and Moisik, S. R. (2017). Language is not isolated from its wider environment: Vocal tract influences on the evolution of speech and language. *Language & Communication*, 54:9–20.

Evans, N. and Levinson, S. C. (2009). The myth of language universals: Language diversity and its importance for cognitive science. *Behavioral and Brain Sciences*, 32(05):429.

Everett, C. (2017). Languages in drier climates use fewer vowels. *Frontiers in Psychology*, 8:1285.

Gavin, M. C., Botero, C. A., Bowern, C., Colwell, R. K., Dunn, M., Dunn, R. R., Gray, R. D., Kirby, K. R., McCarter, J., Powell, A., Rangel, T. F., Stepp, J. R., Trautwein, M., Verdolin, J. L., and Yanega, G. (2013). Toward a mechanistic understanding of linguistic diversity. *BioScience*, 63(7):524–535.

Hammarström, H. (2016). Linguistic diversity and language evolution. *Journal of Language Evolution*, 1(1):19–29.

Kidd, E., Donnelly, S., and Christiansen, M. H. (2018). Individual differences in language acquisition and processing. *Trends in Cognitive Sciences*, 22(2):154–169.

Lewis, M. L. and Frank, M. C. (2016). Linguistic structure emerges through the interaction of memory constraints and communicative pressures. *Behavioral and Brain Sciences*, 39:e82.

Lupyan, G. and Dale, R. (2010). Language structure is partly determined by social structure. *PLoS ONE*, 5(1):e8559.

Lupyan, G. and Dale, R. (2015). The role of adaptation in understanding linguistic diversity. In De Busser, R. and LaPolla, R. J., editors, *Language Structure and Environment: Social, cultural, and natural factors*, volume 6, pages 289–316. John Benjamins Publishing Company, Amsterdam, Netherlands.

Lupyan, G. and Dale, R. (2016). Why are there different languages? the role of adaptation in linguistic diversity. *Trends in Cognitive Sciences*, 20(9):649–660.

Nettle, D. (1998). Explaining global patterns of language diversity. *Journal of Anthropological Archaeology*, 17(4):354–374.

Nettle, D. (2012). Social scale and structural complexity in human languages. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 367(1597):1829–1836.

Perfors, A. and Navarro, D. J. (2014). Language evolution can be shaped by the structure of the world. *Cognitive Science*, 38(4):775–793.

Reali, F., Chater, N., and Christiansen, M. H. (2018). Simpler grammar, larger vocabulary: How population size affects language. *Proceedings of the Royal Society B: Biological Sciences*, 285(1871):20172586.

Regier, T., Carstensen, A., and Kemp, C. (2016). Languages support efficient communication about the environment: Words for snow revisited. *PLOS ONE*, 11(4):e0151138.

Winter, B. and Bentz, C. (2014). Languages with more second language learners tend to lose nominal case. In Wichmann, S. and Good, J., editors, *Quantifying Language Dynamics*, pages 96–124. Brill.

Winters, J., Kirby, S., and Smith, K. (2015). Languages adapt to their contextual niche. *Language and Cognition*, 7(03):415–449.