

MEANINGFUL CALL COMBINATIONS AND COMPOSITIONAL PROCESSING IN A SOCIAL BIRD

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A defining feature of language is its generative nature, but elucidating how this capacity evolved is a non-trivial task (Christiansen & Kirby, 2003). Language derives its expressive power from its combinatorial nature: meaningless acoustic elements are phonologically combined into meaningful words, which at a higher syntactic layer can be assembled into phrases, where the meaning of the whole is a product of its parts (Hockett, 1960). While recent work on birds has provided evidence for the phonological level (Engesser et al., 2015; Lachlan & Nowicki, 2015), evidence for basic compositional syntax outside of humans is less clear (Arnold & Zuberbühler, 2008; Hurford, 2011; Ouattara et al., 2009). In particular, experimental data demonstrating a compositional understanding of information are rare (Collier et al., 2014). Here we provide strong evidence for compositionality in the discrete vocal system of the cooperatively breeding pied babbler (*Turdoides bicolor*). Natural observations revealed pied babblers produce acoustically distinct alert-calls in response to close, low urgency threats, and recruitment-calls when recruiting group members during locomotion. Upon encountering terrestrial predators, both vocalizations are combined into a sequence (hereafter ‘mobbing-sequence’), potentially to recruit group members in a dangerous situation. To investigate whether babblers process these mobbing-sequences in a compositional way, we conducted systematic playback manipulations, playing back the individual calls in isolation, as well as naturally occurring and artificial sequences. Our results show babbler groups reacted most strongly to mobbing-sequence playbacks, showing a greater attentiveness and a quicker approach to the sound source, compared to individual calls or

control sequences. We conclude pied babbler mobbing-sequences communicate information on both the context and the requested action, with receivers computing the combination of the two, functionally distinct, calls in a compositional way. Given the babblers' constrained vocal repertoire, paired with the extensive number of social and ecological contexts that require communication (Ridley & Raihani, 2007), such compositional production and processing of vocalizations is likely adaptive for pied babblers, allowing them to coordinate key additional events than would otherwise be possible with a non-syntactic system (Arnold & Zuberbühler, 2008). Ultimately, our work indicates that the ability to combine and process meaningful vocal structures, a basic syntax, may be more widespread than previously thought.

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