

DOMINANCE STYLE AND VOCAL COMMUNICATION IN NON-HUMAN PRIMATES

KATIE SLOCOMBE^{*1}, EITHNE KAVANAGH¹, SALLY STREET², FELIX O. ANGWELA³, THORE J. BERGMAN⁴, MARYJKA B. BLASZCZYK⁵, LAURA M. BOLT⁶, MARGARITA BRISEÑO-JARAMILLO⁷, MICHELLE BROWN⁸, CHLOE CHEN-KRAUS⁹, ZANNA CLAY², CAMILLE COYE¹⁰, MELISSA EMERY THOMPSON¹¹, ALEJANDRO ESTRADA⁷, BARBARA FRUTH¹², CLAUDIA FICHTEL¹³, MARCO GAMBA¹⁴, CRISTINA GIACOMA¹⁴, KIRSTY E. GRAHAM¹, SAMANTHA GREEN¹⁵, CYRIL GRUETER¹⁵, SHREEJATA GUPTA¹, MORGAN L. GUSTISON¹⁶, LINDSEY HAGBERG¹⁷, DANIELA HEDWIG¹⁸, KATHARINE M. JACK¹⁹, PETER M. KAPPELER¹³, GILLIAN KING-BAILEY¹⁹, BARBORA KUBÉNOVÁ²⁰, ALBAN LEMASSON¹⁰, DAVID MACGREGOR INGLIS²¹, ZARIN MACHANDA²², ANDREW MACINTOSH²⁰, BONAVENTURA MAJOLO²³, SOPHIE MARSHALL¹, STEPHANIE MERCIER²⁴, JÉRÔME MICHELETTA²⁵, MARTIN MULLER¹¹, HUGH NOTMAN²⁶, KARIM OUATTARA²⁷, JULIA OSTNERA¹³, MARY SM PAVELKA²⁸, LOUISE R. PECKRE¹³, MEGAN PETERSDORF²⁹, FREDY QUINTERO²⁴, GABRIEL RAMOS- FERNÁNDEZ³⁰, MARTHA M. ROBBINS³¹, ROBERTA SALMI³², ISAAC SCHAMBERG¹⁷, OLIVER SCHÜLKE¹³, STUART SEMPLE²¹, JOAN B. SILK³³, J. ROBERTO SOSA-LOPÉZ³⁴, VALERIA TORTI¹⁴, DARIA VALENTE¹⁴, RAFFAELLA VENTURA³⁵, ERICA VAN DE WAAL³⁶, ANNA H. WEYHER³⁷, CLAUDIA WILKE¹, RICHARD WRANGHAM¹⁷, CHRISTOPHER YOUNG³⁸, ANNA ZANOLI¹⁴, KLAUS ZUBERBÜHLER²⁴, ADRIANO LAMEIRA³⁹

^{*}Corresponding Author: ks553@york.ac.uk

¹Department of Psychology, University of York, York, UK

²Department of Anthropology, Durham University, Durham, UK

³School of Agricultural and Environmental Sciences, Mountains of the Moon University, Fort Portal, Uganda

⁴Department of Psychology, University of Michigan, Ann Arbor, USA

⁵Department of Anthropology, University of Texas, Austin, USA

⁶Department of Anthropology, University of Waterloo, Canada,

⁷Instituto de Biología, Universidad Nacional Autónoma de México, Mexico

⁸Department of Anthropology, University of California, Santa Barbara, USA

⁹Department of Anthropology, Yale University, New Haven, USA

¹⁰Human and Animal Ethology (EthoS), University of Rennes, Rennes, France

¹¹Department of Anthropology, University of New Mexico, Albuquerque, USA

¹²School of Biological and Environmental Science, Liverpool John Moores University, UK,

¹³German Primate Center, Leibniz Institute for Primate Research, Göttingen, Germany

- ¹⁴Department of Life Sciences and Systems Biology, University of Turin, Turin, Italy
- ¹⁵ School of Human Sciences, University of Western Australia, Australia
- ¹⁶Department of Integrative Biology, University of Texas, Austin, USA
- ¹⁷Department of Human Evolutionary Biology, Harvard University, Cambridge, USA
- ¹⁸Center for Conservation Bioacoustics, Cornell University, Ithaca, USA
- ¹⁹Department of Anthropology, Tulane University, New Orleans, USA
- ²⁰Primate Research Institute, Kyoto University, Japan
- ²¹Department of Life Sciences, University of Roehampton, London, UK
- ²²Department of Anthropology, Tufts University, Medford, USA
- ²³School of Psychology, University of Lincoln, Lincoln, UK
- ²⁴Department of Comparative Cognition, University of Neuchâtel, Switzerland
- ²⁵Department of Psychology, University of Portsmouth, Portsmouth, UK
- ²⁶Department of Anthropology, Athabasca University, Canada
- ²⁷Centre Suisse de Recherches Scientifiques en Côte d'Ivoire, Côte d'Ivoire
- ²⁸Department of Anthropology and Archaeology, University of Calgary, Canada
- ²⁹Department of Anthropology, New York University, New York, USA
- ³⁰Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas, Universidad Nacional Autónoma de México, Mexico City, Mexico
- ³¹Department of Primatology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany
- ³²Department of Anthropology, University of Georgia, Athens, USA
- ³³School of Human Evolution and Social Change, Arizona State University, Tempe, USA
- ³⁴Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional Unidad Oaxaca, Instituto Politécnico Nacional, Oaxaca, Mexico
- ³⁵School of Social and Health Sciences, University of Abertay, Dundee, UK
- ³⁶Department of Ecology and Evolution, University of Lausanne, Switzerland
- ³⁷Department of Anthropology, University of Massachusetts, Amherst, USA
- ³⁸Mammal Research Institute, University of Pretoria, Republic of South Africa
- ³⁹Department of Psychology, University of Warwick, Coventry, UK

Understanding the variables that shape the use and evolution of vocal communication in non-human primates can inform understanding of how language evolved. Social complexity might drive communicative complexity (Freeberg et al. 2012). Dominance style (the strictness with which the dominance hierarchy is enforced; ranging from ‘despotic’ to ‘tolerant’; de Waal and Luttrell, 1989) is an important, but often overlooked, measure of social complexity and its relationship with vocal communication is largely unknown. As the outcomes of social interactions in more tolerant societies are more uncertain (Dobson, 2012), we predicted that more tolerant individuals and species would have a greater need for more frequent and more diverse vocal signals to negotiate their social interactions. Here, we provide evidence that dominance style is associated with vocal usage and repertoires at both individual and phylogenetic levels in primates.

At the inter-individual level, we considered given tolerance and received tolerance separately as there are different reasons for expecting dominant and subordinate individuals within tolerant relationships to communicate more frequently than those in despotic relationships. Considering these two measures separately should also allow us to infer whether tolerance puts pressure on dominant individuals to communicate more, or whether a more tolerant social environment relaxes constraints on subordinate individuals' communication. For our four behavioural dominance style variables (aggression symmetry, counter aggression, aggression intensity and grooming symmetry) we were able to obtain given and received tolerance measures for individuals by including only interactions with lower-ranking partners, or higher-ranking partners, respectively, in their calculations. We predicted that both i) given and ii) received tolerance versions of each variable would be associated with a higher rate of vocalising. At the interspecific level, we calculated the four dominance style variables per species, and combined them into a 'dominance style index'. We predicted that this index would be associated with three aspects of vocal repertoires, all of which were obtained from previous literature. Using Bayesian analyses on these observational data from 111 wild groups of 26 species, we show that more tolerant individuals vocalise at a higher rate, but more despotic species have a wider range of hierarchy-related vocalisations in their repertoires. We found little evidence that tolerance received from higher-ranking partners is related to vocal rate, or that more tolerant species have larger vocal repertoires in terms of overall repertoire size or number of social vocalisations. Our findings indicate that tolerance is related to vocal usage more strongly as a result of increased pressure for more tolerant individuals to communicate more, than alleviation of constraints on communication for lower-ranking individuals. Taken together, our findings indicate that dominance style is a valuable social variable for understanding vocal usage and evolution in primates.

References

- De Waal, F. B., & Luttrell, L. M. (1989). Toward a comparative socioecology of the genus *Macaca*: different dominance styles in rhesus and stump-tail monkeys. *American Journal of Primatology*, 19(2), 83-109.
- Freeberg, T. M., Dunbar, R. L., & Ord, T. J. (2012). Social complexity as a proximate and ultimate factor in communicative complexity. *Phil. Trans. R. Soc. B*, 367, 1785–1801.
- Dobson, S. D. (2012). Coevolution of facial expression and social tolerance in macaques. *American Journal of Primatology*, 74(3), 229-235.