

SOCIAL TOLERANCE AND INTERACTIONAL OPPORTUNITIES AS DRIVERS OF GESTURAL REDOINGS IN ORANG-UTANS

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Communicative repair is a fundamental and universal element of interactive language use. It has been suggested that the persistence and elaboration after communicative breakdown, as frequently observed in non-human primates, constitute evolutionary building blocks of this capacity [1], but the conditions favouring it are poorly understood. Social tolerance and interaction opportunities beyond the mother-offspring dyad may be central drivers of gestural redoings (i.e. repetition and/or modification of an initial signal after communicative failure) as a crucial element of social action coordination. Because zoo-housed individuals of some species are more sociable and terrestrial than in the wild, they should be more likely to produce and respond to gestural redoings during the coordination of joint activities.

We here examine this question by comparing the same species living in the wild and in artificial, man-made habitats in captivity. The wild-captive contrast allows us to directly test the prediction that captive individuals more readily exhibit persistence and elaboration during face-to-face interactions, because captivity's more social and terrestrial settings may foster the extensive use of redoings in the coordination of joint activities. We tested this prediction in orang-utans, a great ape genus which is in our view ideal for this avenue of research. First, the orang-utan populations of Borneo (*Pongo pygmaeus wurmbii*) and Northwest-Sumatra (i.e. Suaq and Ketambe, *Pongo abelii*) differ considerably in sociability [2] and social tolerance (Bornean orang-utans become more stressed in group settings than Sumatrans [3]). Second, in contrast to natural environments, captive orang-utans are always in close proximity and more on the ground, clearing sight and freeing hands for visual and tactile communication. Third, in addition to these setting and taxonomic contrasts, the pairing of social partners (i.e. the interaction dyad) also affects features of social interactions, e.g. due to differences in social tolerance and familiarity. Our recent work demonstrated remarkable behavioural plasticity in orang-utans, with regard to communicative repertoires [4] and multimodal use of communicative acts contingent on social context and partner [5]. There are no systematic wild-captive comparisons of apes' communicative behaviour to date, but we assume that contrasts must be larger for orang-utans

than any other great ape taxon in light of the profound contrasts in sociality and arboreality between captivity and the wild.

We studied a large comparative sample ($N = 3869$ signal instances) of wild and zoo-housed orang-utans of two different species (*Pongo abelii*, *P. pygmaeus*), focusing on the gestural solicitation of three distinct joint activities: social play, allo-grooming and joint travel. Specifically, we tested how research setting, species and interaction dyad affected the probability of repetition and elaboration in signal use after communicative failure, as well as the success in obtaining the original goal (the “apparently satisfactory outcome”; [6]), while controlling for critical individual variables and context. Our predictions were confirmed only for elaboration, the more flexible form of redoings. Specifically, results showed that gestural redoings in general were best predicted by the specific social context (i.e. social play) and interaction dyad (i.e. beyond mother-offspring), although were least frequent in captive Bornean orang-utans. For gestural elaboration, we found the expected differences between captive and wild research settings in Borneans, but not in Sumatrans (the more socially tolerant species). Moreover, we found that the effectiveness of elaboration in eliciting responses was higher in Sumatrans, especially the captive ones, whereas effectiveness of mere repetition was influenced by neither species nor setting.

In sum, this study demonstrated that Bornean and Sumatran orang-utans living in different socio-ecological environments (i.e. wild versus captive settings) frequently deploy gestural redoings in the face of communicative failure within and beyond mother-offspring dyads. Both repetition and elaboration have been interpreted as simple forms of repair [1], a fundamental layer of the human interaction engine [7]. Our findings also showed that social tolerance, as a foundation for extended social interactions (both higher in Sumatrans and in captivity), plays a central role in the emergence of complex exchanges in great apes. These findings support the notion that the human version of the interaction engine evolved when contexts with limited conflicts of interests and involving coordination for joint action became more widespread [8]. The Interdependence Hypothesis further posits that as individuals in hominin societies became more cohesive and interdependent, pressure for shared intentionality, and thus effective coordination via communication increased [8]. As parts of the interactional base for joint action coordination, this includes the repair of communicative “glitches” in case of misunderstandings as well as negotiation in case of diverging interests [7]. For future empirical research on nonhuman primates, it would be important to distinguish communicative sequences resulting from prior communicative failure alone (and thus primarily driven by the signaller) from more interactional communicative exchanges involving signalling by both parties, as common in human conversation.

References

1. Heesen R., Fröhlich M., Sievers C., Woensdregt M., Dingemanse M. (in press) Coordinating social action: A primer for the cross-species investigation of communicative repair. *Philosophical Transactions of the Royal Society B: Biological Sciences*.
2. van Schaik C.P. (1999) The socioecology of fission-fusion sociality in orangutans. *Primates* **40**(1), 69-86.
3. Weingrill T., Willems E.P., Zimmermann N., Steinmetz H., Heistermann M. (2011) Species-specific patterns in fecal glucocorticoid and androgen levels in zoo-living orangutans (*Pongo* spp.). *General and Comparative Endocrinology* **172**(3), 446-457.
4. Fröhlich M., Bartolotta N., Fryns C., Wagner C., Momon L., Jaffrezic M., Mitra Setia T., Schuppli C., Noordwijk M.A., van Schaik Carel P. (2021) Orangutans have larger gestural repertoires in captivity than in the wild – a case of weak innovation? *iScience* **24**(11), 103304.
5. Fröhlich M., Bartolotta N., Fryns C., Wagner C., Momon L., Jaffrezic M., Noordwijk M.A., van Schaik C.P. (2021) Multicomponent and multisensory communicative acts in orang-utans may serve different functions. *Communications Biology* **4**, 917.
6. Hobaiter C., Byrne R. (2014) The meanings of chimpanzee gestures. *Current Biology* **24**(14), 1596-1600.
7. Levinson S.C. 2019 Interactional foundations of language: the interaction engine hypothesis. In *Human language: From genes and brain to behavior* (ed. Hagoort P.), pp. 189-200. Cambridge, US, MIT Press.
8. Tomasello M., Melis A.P., Tennie C., Wyman E., Herrmann E. (2012) Two Key Steps in the Evolution of Human Cooperation: The Interdependence Hypothesis. *Current Anthropology* **53**(6), 673-692.