

MULTIMODAL AND MULTIPLEX COMMUNICATION IN WILD AND CAPTIVE ORANG-UTANS (*PONGO* *ABELII/PYGMAEUS*)

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The ecological niche of language is face-to-face interaction, hence human communication is inherently multimodal (Holler & Levinson, 2019). Non-human primates and many other species also have a natural predisposition for multimodal social interactions. With regard to the function(s) of multimodality in the animal kingdom, hypotheses have invoked redundancy, refinement, or complementarity. However, very few studies addressed this issue in great apes, our closest living relatives. Similar to humans, great apes display striking behavioural plasticity in the communicative domain, and we might gain critical insights about learning effects by studying the flexible combination of modalities (i.e. sensory channels) and articulators (i.e. communication organs) in different socio-ecological environments.

Compared to the African great apes, orang-utans' (*Pongo* spp.) non-vocal communication has to date been little studied in natural environments (but see Fröhlich et al., 2019; Knox et al., 2019; MacKinnon, 1974; Rijksen, 1978). However, studies over the past decades have shown that populations of the two orang-utan species on Borneo (*Pongo pygmaeus*) and Sumatra (*Pongo abelii*) differ considerably in sociability and behavioural variants such as call types and tool-use techniques, which has been interpreted as evidence for culture (van Schaik et al., 2003; Wich et al., 2012). In contrast, in captive settings orang-utans are often exposed to a social and semi-terrestrial lifestyle similar to that of wild chimpanzees and bonobos. Specifically, they encounter more opportunities for social interactions with conspecifics other than the mother, resulting in a large

proportion of well-established interaction dyads and a lower risk of misunderstanding, as well as better visibility and a more terrestrial lifestyle. Orang-utans in captivity show substantially higher levels of social interactions than observed in the wild, including social play and grooming sessions among adults and socio-sexual behaviours among immature individuals (Poole, 1987). These population and setting (wild-captive) contrasts make orang-utans eminently suitable to test hypotheses about the function of multimodality in apes and the effects of learning on its incidence.

In the present study, we examined the communicative behaviour of Bornean and Sumatran orang-utans living in the wild (*Tuanan, Suaq*) and in European zoos (*Apenheul, Cologne, Munster, Munich, Zurich*), to explicitly test to what extent socio-ecology—particularly, visibility and availability of social partners— influenced communicative behaviour. During ca. 1,600 hours of focal observations, we video-recorded more than 6,300 communicative interactions, resulting in the coding of around 10,000 communicative acts. Here, we focused specifically on the use of multimodal (i.e. involving multiple sensory modalities) as well as multiplex (i.e. involving multiple articulators, such as mouth and limbs) communication. Our 2x2 comparative design allowed us to disentangle effects of species and research setting while controlling for age and sex as well as contextual and recipient-related factors. Our first analyses of this extensive dataset revealed that purely visual (non-contact) communicative acts were significantly less, but tactile and multimodal acts more common in *P. pygmaeus* in the least sociable wild population (Tuanan) compared to the other species-setting combinations. Moreover, both multimodal and multiplex communication was more pervasive in wild than captive settings. Irrespective of these effects of setting and species, we found differences in use between age classes and contexts.

These preliminary findings indicate that the main function of multi-component communication in orang-utans is to facilitate detection and disambiguation of a specific message rather than to carry multiple messages, supporting a redundancy function. As previously shown for wild chimpanzees, predictable outcomes and high visibility may foster the use of unimodal signals when unimpeded face-to-face communication is possible. Communicative efforts are thus reduced like in humans, when interactions between partners occur repeatedly (Clark & Brennan, 1991), or when partners share an extensive interactional history (Brown & Levinson, 1987). Moreover, this also suggests that humans evolved a novel function of multimodality to support more complex messages.

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