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Chimpanzee gestural exchanges share temporal structure with human language

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Humans regularly engage in efficient communicative conversations, which serve to socially align individuals[1]. In conversations, we take fast-paced turns using a human-universal structure of deploying and receiving signals which shows consistent timing across cultures[2]. We report here that chimpanzees also engage in rapid signal-to-signal turn-taking during face-to-face gestural exchanges with a similar average latency between turns to that of human conversation. This correspondence between human and chimpanzee face-to-face communication points to shared underlying rules in communication. These structures could be derived from shared ancestral mechanisms or convergent strategies that enhance coordinated interactions or manage competition for communicative 'space'.

Many animal species engage in communicative turn-taking[3]; however, in most well-studied systems interlocutors exchange signals outside of face-to-face interaction, including long-distance vocal exchanges and short-distance contact calls[3,4]. One exception is ape gestural communication, in which signals are used in a face-to-face setting to make a range of imperative requests[5]. Sequences of events in which ape signallers produce a gesture and the recipient responds by changing their behaviour have been equated to human conversational turn-taking with the latency between signal and behavioural response at times approaching the ~200 ms between human conversational turns (up to 2000 ms in apes[6,7]). However, in human conversation both participants exchange communicative signals (words or signs) and the exchange typically represents more than a simple signal–response paradigm: they include clarification, persuasion, and negotiation between interactants[8].

We conducted an analysis of ape gesture-to-gesture exchanges, focusing on the timing between participant turns and the consistency in timing across five wild East African chimpanzee (*Pan troglodytes schweinfurthii*) communities. With this large corpus (N gesture instances = 8559; N individuals = 252 individuals) of gestural interactions, we provide a direct comparison of the turn-taking patterns of chimpanzee gesture-to-gesture exchanges with conversational patterns observed across human languages. We analysed latencies between signal turns in gesture-to-gesture exchanges and gesture-to-response interactions in which the response was a change in the recipient's behaviour that appeared to represent the outcome of the interaction[7,8]. Detailed methodology and model results are provided in the Supplemental information.

We found that 14% (N = 592/4223) of communicative interactions included an exchange of gestures between interactants. The majority (83%, N = 460/557 with known number of gesture-to-gesture transitions) of gestural exchanges included a two-part exchange (one signalling turn per interactant) but could extend up to seven parts. After excluding outliers, latencies between a gesture and a gestural response (Figure 1) were similar to latencies reported for turn-taking in human conversations (~200 ms), and significantly shorter than latencies between a gesture and a behavioural response (GLMM: $X^2 = 128.465$, $df = 1$, $p < 0.001$; N = 1491 exchanges; N dyads = 819). We found no difference in the results when subsetting the data to exclude exchanges between immature

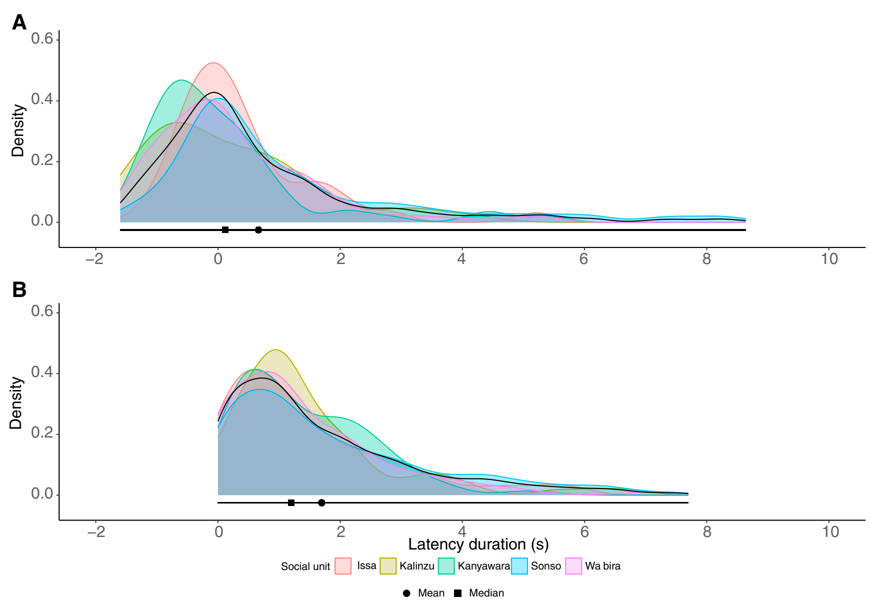

Figure 1. Distribution of the latency to gesture response and behavioural response in gestural interactions across communities.
(A) The distribution of latency between gesture turns in gesture-to-gesture exchanges. (B) The distribution of latency between a gesture and behavioural response in gesture-to-behaviour exchanges. Data include 95% interquartile range of latencies (N gesture response = 595; N behavioural response = 1435). Black distribution lines represent the overall latency distribution across communities. The range (black horizontal lines) and the mean (circles) and median (squares) of latencies are shown at the bottom of each plot. Latency to gesture response (median = 120 ms, mean = 663 ms, 95% inter-quartile range = -1600–8640 ms) was shorter on average than latency to behavioural response (median = 1200 ms, mean =1697 ms, 95% inter-quartile range = 0–7699 ms). Negative latencies in gestural response indicate that the response gesture (second turn) began before the end of the Minimum Action Unit of the first gesture (turn) in the interaction, before the full information from the first gesture was transmitted (see Supplemental information).

individuals. The similarities to human conversations reinforce the description of these interactions as true gestural exchanges, in which the gestures produced in response are contingent on those in the previous turn. Across a wide range of goals, latencies between exchanged gestures overlapped but showed some variation between communities (GLMM: $X^2 = 13.945$, $df = 4$, $p = 0.007$; N = 431 gesture-to-gesture exchanges; N dyads = 330). The Sonso community exchanged gestures with longer latencies between turns than the Kanyawara and Waibira communities; the timing showed no difference in the eight other community comparisons (see Supplemental information). While the range of latencies to response was greater in the chimpanzee interactions (Figure 1) than those reported in human interactions (between -500 ms and 1500 ms[9]), our data came from a much wider range of behavioural contexts, as compared to the controlled laboratory studies of human conversation[9].

Across chimpanzee communities timing was largely consistent and overlapping but showed some group differences, akin to the cultural variation shown in response timing across human languages[9]. The similarity in the timing structure of chimpanzee gestural exchanges suggests shared mechanisms with human conversation. Species-level consistency in such rapid timing (and even occasional signal overlaps) indicates that chimpanzee interactants may be responding before fully processing the entire signal as observed in the interruptions common to human conversation[9].

The ability to engage in fast-paced, conversational turn-taking is a core feature of human language. The evolution of a communicative structure that promotes rapid alignment between interactants could provide a mechanism to increase communicative efficiency by decreasing the time and energy required to reach individual and shared goals. This type of communication is more likely to evolve in face-to-face communicative interaction with immediate outcomes, and where these outcomes may strengthen social bonds and/or lead to mutual benefits. Research to date suggests chimpanzee gestural interactions are largely limited to imperative requests for behavioural change[5] (Supplemental information), which may explain the relatively low frequency (14%) of gesture exchanges we observed across communities.

Outside of negotiations, imperative requests typically lead to a behavioural response. In contrast, human conversations encompass a much broader range of meaning that could promote and extend conversational exchanges. Future studies may benefit from investigating how the relationship between interactants, and between their respective goals, influences the likelihood and dynamics of signal exchanges. The frequency of use of communicative exchanges varies across species more broadly[4], and it remains to be established if the frequency we observed in East African chimpanzees generalises to other apes.

Irrespective of their specific function, the shared timing structure of chimpanzee gestural exchanges and human conversations suggests either convergent or homologous origins. Analogous communicative structures could exist in other social species that communicate over short distances to mediate social interactions (for example, cetaceans, bats, hyenas), which can include coordination of prosocial behaviour (for example, grooming, food sharing) or conflict management to avoid escalation into aggression (for example, requesting that conspecifics stop behaviour). Extending this research to other non-human species would clarify whether these similarities between chimpanzee and human communicative timings arise from homology or other shared mechanisms. Our findings demonstrate that the temporal structure of short-distance communicative exchanges is largely consistent across groups in (at least two) species of great apes and may have represented an important structural feature that scaffolded human language evolution.

SUPPLEMENTAL INFORMATION

Supplemental information including one figure, one table, experimental procedures, detailed acknowledgements, author contributions, and data availability can be found with this article online at https://doi.org/10.1016/j.cub.2024.06.009.

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DECLARATION OF INTERESTS

The authors declare no competing interests.

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