Supplemental Information: Chimpanzee carrying behaviour and the origins of human bipedality

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Supplemental Data

Supplemental Figures

Figure S1. (related to Fig. 1A)
Transport of items by wild chimpanzees under three experimental conditions of resource availability.
Rates were calculated for each experimental session as bouts of transport of tools or nuts per hour of observation per individual present. Error bars are standard errors of the mean. Statistical tests are General Linear Models, controlling for individual where appropriate and transforming variables where necessary to meet assumptions of parametric tests (only the main effects and interactions of the comparisons depicted in the graphs are reported). (A) Overall transport rates ($F_{2,58} = 5.61$, $P = 0.006$); (B) Rates of bipedal transport ($F_{2,58} = 7.44$, $P = 0.001$); (C) Number of items carried per bout of transport, when moving quadru-, tri- or bipedally ($F_{2,726} = 21.73$, $P < 0.001$); (D) Proportion of transports involving more than one body-part (any combination of hands, feet, and mouth; $F_{2,174} = 6.45$, $P = 0.003$); (E) Overall transport rates; males vs. females (main effect of sex: $F_{1,25} = 25.47$, $P < 0.001$; interaction between sex and condition: $F_{2,25} = 2.06$, $P = 0.148$); (F) Rates of bipedal transport; males vs. females (main effect of sex: $F_{1,26} = 6.58$, $P < 0.001$; interaction between sex and condition: $F_{2,26} = 1.13$, $P = 0.339$); (G) Number of items carried per bout of transport, when moving quadru-, tri- or bipedally; males vs. females (main effect of sex: $F_{1,734} = 28.48$, $P < 0.001$; interaction between sex and mode of locomotion: $F_{2,26} = 6.27$, $P = 0.002$). In (E)-(G), dark grey bars indicate males, light grey bars indicate females. For all pair-wise comparisons shown in the graphs, * = p < 0.05, ** = p < 0.01, *** = p < 0.001, *ns* = p > 0.05.

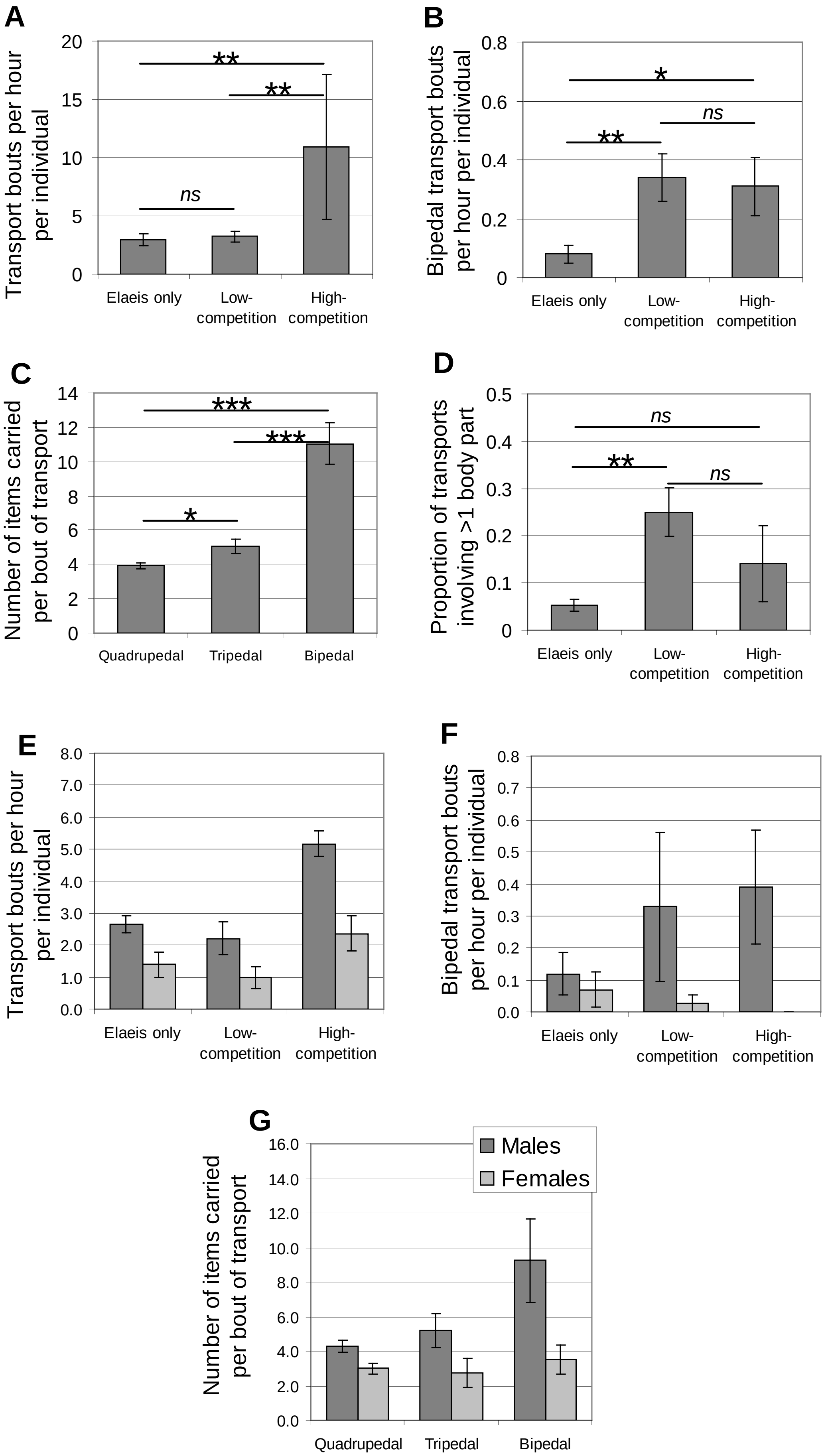
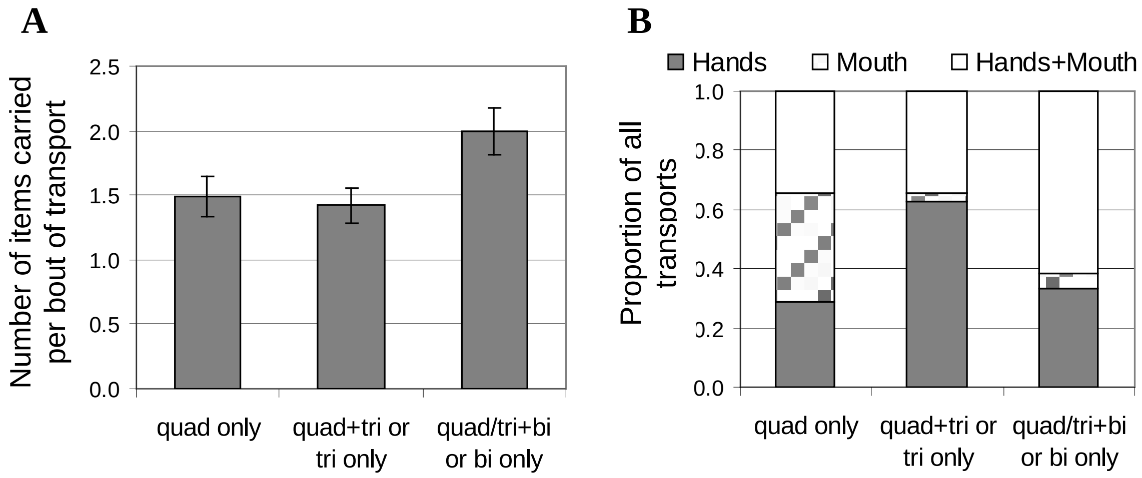

A
Transport bouts per hour per individual
20
15
10
5
0
**
**
ns
Elaeis only
Low-competition
High-competition
B
Bipedal transport bouts per hour per individual
0.8
0.6
0.4
0.2
0
*
**
ns
Elaeis only
Low-competition
High-competition
C
Number of items carried per bout of transport
14
12
10
8
6
4
2
0
***
***
*
Quadrupedal
Tripedal
Bipedal
D
Proportion of transports involving >1 body part
0.5
0.4
0.3
0.2
0.1
0
ns
**
ns
Elaeis only
Low-competition
High-competition
E
Transport bouts per hour per individual
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Elaeis only
Low-competition
High-competition
F
Bipedal transport bouts per hour per individual
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Elaeis only
Low-competition
High-competition
G
Number of items carried per bout of transport
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Males
Females
Quadrupedal
Tripedal
Bipedal

Figure S2. (related to Fig. 1B)
Transport of raided crops by wild chimpanzees at Bossou. “Quad only” refers to transport bouts with only quadrupedal steps; “quad+tri or tri only” to bouts with either combination of quadrupedal and tripedal locomotion, or tripedal steps only; and “quad/tri+bi or bi only” to bouts involving any combination of locomotory modes that included bipedal steps, or bipedal steps only. Error bars are SEM. (A) Mean number of items carried during transport in crop-raiding bouts as a function of locomotory mode ($F_{2,98}$ = 5.48, P = 0.006). (B) Proportion of crop-raiding transports with carrying of items in hands only, in mouth only, or in both hands and mouth simultaneously.



Supplemental Movies

Movie S1 (related to Fig. 1A)
Video clip shows bipedal transport of nuts and stone tools by adult male chimpanzee at Bossou’s outdoor laboratory. He first gathers up a whole pile of 20 *Coula edulis* nuts, using both hands and mouth, then walks bipedally to set of stone tools provided, where he first selects stone anvil (carried in left hand) then stone hammer (carried in left foot). He then continues to walk bipedally, moving to different spot, where he stops to process nuts and to consume their kernels. While walking bipedally during final stage of transport, he uses three limbs, as well as mouth, to carry nuts and stone tools.

Movie S2 (related to Fig. 1B)
Video clip shows transport of three papayas by adult male chimpanzee at Bossou. Fruits were collected from small orchard in village and transported back to forest. Items are carried in both hands and mouth. Transport includes quadrupedal, tripedal and bipedal locomotion, with 17 of 38 steps being bipedal.

Supplemental Experimental Procedures

We performed experiments at the long-term chimpanzee field site of Bossou, Republic of Guinea, over two field seasons (Jan 2005; Dec 2008 – Feb 2009). The forest of Bossou (5-7 km^2 core area) harbours one chimpanzee population (*Pan troglodytes verus*). Between 1976 and 2009, the size of the group ranged from 13-22 individuals.

Bossou chimpanzees customarily use pairs of stones as hammer and anvil to crack open oil-palm nuts. A natural clearing of about $200m^2$ ("outdoor laboratory" [7, S1]) in Bossou forest has been since 1988 the site of intensive study of chimpanzee stone tool technology and the ontogeny of nut-cracking. Here, experimenters provide raw materials for nut-cracking (piles of nuts and an assortment of ~50 stones suitable for use as hammer and anvil) and record chimpanzees' interactions with these objects at close range. Chimpanzee parties voluntarily visit the outdoor laboratory and use the objects provided once or twice daily during their regular ranging activities.

In experimental sessions, we provided both the locally available species of nut (the oil-palm nut, *Elaeis guineensis*) and a species unavailable at Bossou but cracked by chimpanzees at nearby sites (the coula nut, *Coula edulis*). *Coula* had been presented to Bossou chimpanzees intermittently since 1994, but never for more than two weeks per year. Therefore, individuals were familiar with the nuts, and most had learned to crack them [S1], but they represented a rare resource of unpredictable availability. In a session, resources were made available under one of three conditions: oil-palm only (7 piles of *Elaeis*), high-competition (7 piles of *Elaeis* and 2 piles of *Coula*) and low-competition (2 piles of *Elaeis* and 7 piles of *Coula*). Piles of nuts were about the same size but had different numbers of nuts, due to *Coula* being larger (one pile of *Elaeis* = ~70 nuts; one pile of *Coula* = ~20 nuts). The same set of ~50 stone tools was made available in all sessions. Sessions began when the first chimpanzee of a visiting party entered the outdoor laboratory and ended when the last of the party exited. All experimental sessions were filmed by at least two digital video cameras. Neither mean party size (total number of individuals in the outdoor laboratory during an experimental session) nor mean session duration differed across the three conditions (ANOVA, # individuals (square root transformed): $F_{2,67} = 0.21$, $P = 0.812$; session duration (log transformed): $F_{2,67} = 0.57$, $P = 0.568$).

From the video footage, we recorded each instance of chimpanzees transporting items (nuts, stone tools, or both simultaneously), noting the carrying individual, number and identity of the items transported, mode of locomotion (quadrupedal, tripedal, or bipedal), body parts used for carrying (hand, foot, or mouth), timing of the event since the start of the experimental session, and identities of other individuals present and engaged in nut-cracking.

Transport was defined as the movement of an object from its original position during a session, or, subsequently, the further movement of an object from the endpoint of a previous transport. A bout was classed as terrestrial bipedal locomotion when the individual took two or more steps using the legs without the arms touching the ground between the start of the first and the end of the second step. Tripedal and quadrupedal bouts followed the same criteria, but when one or both of the arms touched the ground, respectively.

Transport of food items during crop-raiding was observed on an ad-hoc basis, during daily nest-to-nest follows of chimpanzees, over a period of 14 months. A crop-raiding event was any successful foray by an individual to obtain guarded, cultivated food. Besides the type of locomotion performed during transport, we also recorded the number and species of the item carried and the body part used for carrying.

Supplemental References

S1. Biro, D., Carvalho, S., and Matsuzawa, T. (2010) Tools, traditions, and technologies: interdisciplinary approaches to chimpanzee nut cracking. In The mind of the chimpanzee: ecological and experimental perspectives, E. Lonsdorf, S. Ross, and T. Matsuzawa eds. (Chicago: University of Chicago Press), pp. 141-155.