Measuring social networks in primates: wearable sensors vs. direct observations
Supplementary Material

Valeria Gelardi[1,2], Jeanne Godard[2], Dany Paleressompoulle[3], Nicolas Claidière[2,3], Alain Barrat[1,4,5*],

1 Aix Marseille Univ, Université de Toulon, CNRS, CPT, Turing Center for Living Systems, Marseille, France
2 Aix Marseille Univ, CNRS, LPC, FED3C, Marseille, France
3 Aix-Marseille Univ, Fédération de Recherche 3C, Marseille, France
4 ISI Foundation, Turin, Italy
5 Tokyo Tech World Research Hub Initiative (WRHI), Institute of Innovative Research, Tokyo Institute of Technology, Japan

S1 Description of behaviors.

Behavior	Meaning
Social resting	Staying at the same place without performing other behaviour (e.g. locomotion, social, object-directed) and at less than 1 m from at least one other individual
Carrying	Carrying another individual, often a baby.
Touching	Gentle contact from one individual to another
Presenting (Greeting)	Approaching another individual gently with/without lipsmacks and grunts and presenting the rear.
Embracing	Grasping another individual (with one or two arms)
Grooming	Fur cleaning
Playing with	Playing with another individual
Grunting-Lipsmacking	Affiliative mimic and vocalization from one individual to another
Threatening	Eyebrow raising and / or slapping the ground with or without vocalization
Attacking	Agonistic physical contact (biting, grasping, slapping)
Chasing	Threatening by running after another individual
Mounting	Social mount
Submission/Yak	Teeth bared, body lowered with production of typical yak vocalisation
Avoiding	Moving away from an approaching individual
Supplanting	Taking the place of another individual
Copulating	Sexual mount (generally with copulation call)

Table 1. Description of the social behaviours recorded during observation.

S2 Networks aggregated on the whole observation period.

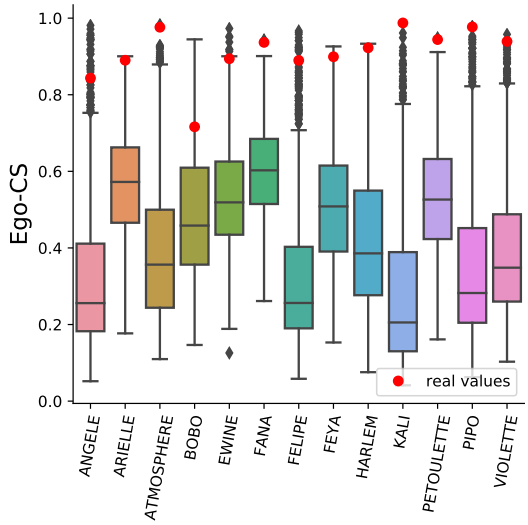

Fig S1. Cosine similarities between ego-networks obtained from the sensor data and from the observations. Values of the cosine similarity between the ego-networks of each individual in the contact network and the interaction network (red dots) and distributions of the cosine similarity values obtained with the null model (boxplots, with the box going from the 25^{th} to the 75^{th} percentiles of the distributions, whiskers at the 5^{th} and 95^{th} percentiles, and outliers shown as dots).

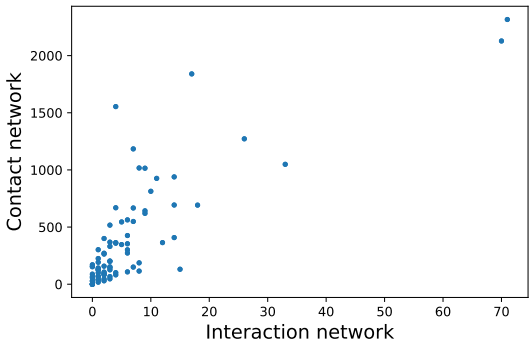

Fig S2. Scatter-plot of the link weights in the contact network (y-axis) vs. interaction network (x-axis). Each blue dot corresponds to one link.

S3 Networks aggregated on different timescales.

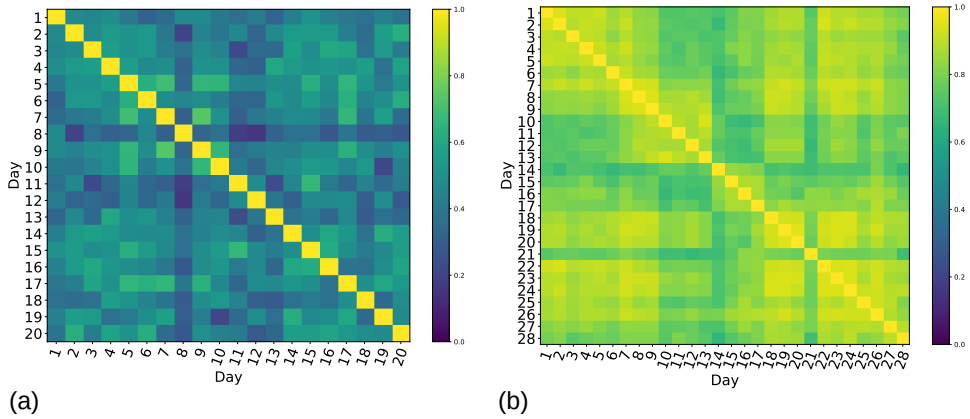

Fig S3. Cosine similarities between daily contact and interaction networks. The figure represent colour-coded matrices of the average local cosine similarity values between every pair of (a) daily interaction networks (min = 0.16; mean = 0.45) and (b) daily contact networks (min = 0.66; mean = 0.83).

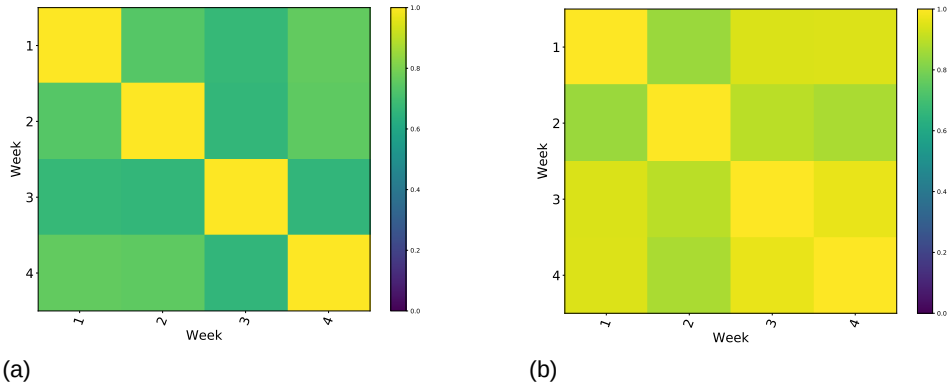

Fig S4. Cosine similarities between weekly contact and interaction networks. The figure represent colour-coded matrices of average local cosine similarity values between every pair of (a) weekly interaction networks (min = 0.66; mean = 0.71) and (b) weekly contact networks (min = 0.85; mean = 0.91).

S4 Robustness of the system against data loss due to the failure of a reader

In order to test the robustness of the results obtained from the wearable sensor data with respect to sampling issues, we have simulated the failure of a reader. This corresponds to removing from the data set the contacts that were registered only by that reader. Note that a number of contacts are registered by more than one reader, so that these contacts would still be present in the resampled data set after the simulation of the failure. As we have three readers (called f2, f3 and f4), we simulate successively the failure of one of these readers.

Figure 5 shows the effect of the failure of a single reader in terms of the amount of "lost" contacts, i.e., of contacts present in the whole data set but not in the data set with a reader failure simulated. The average amounts of lost contacts over all the period of study are 44%, 7% and 10% for the failure of readers f2,f3, and f4 respectively.

Despite these potentially large data losses, Fig. 6 and Fig. 7 show that both the distributions of the durations of contacts and of link weights for the incomplete data sets are extremely robust with respect to the absence of a reader. Most importantly, Fig.8 shows that the link weights of the networks built from the incomplete data are extremely correlated with those of the network obtained from the whole dataset. The networks remain full connected (no link is missing in the incomplete data) and the Pearson correlation coefficient between the lists of weights (sampled vs. whole data set for each reader failure) is ~ 0.99 in all cases. Finally, the cosine similarity values between the networks built from the sampled data and from the complete data are almost 1 (> 0.99 for all the sampling cases and both cosine similarity measures).

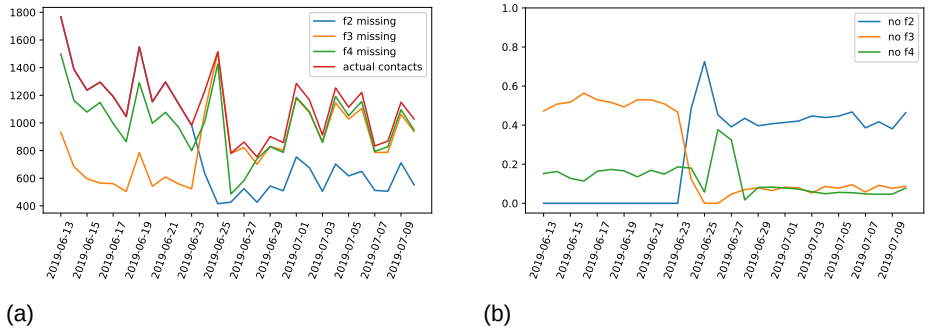

Fig S5. Amount of lost contacts in case of reader failure. (a): Number of contacts registered each day in total, and in case of failure of one single reader. For the first ten days the curve relative to the reader f2 overlaps with the total amount of contacts because the reader had not yet been installed. (b): Fraction of lost contacts in the three cases for each day of data collection.

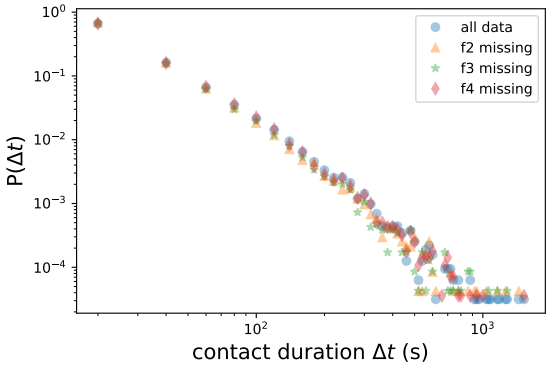

Fig S6. Durations of contacts. Distributions of contact durations for sampled data sets in which a single reader failure is simulated, compared with the distributions obtained from the whole data set.

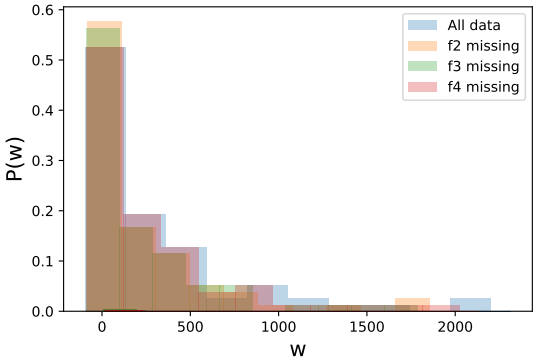

Fig S7. Distributions of weights for sampled data sets. Distribution of network weights for sampled data sets in which data from one reader has been removed, compared with the distributions obtained from the whole data set.

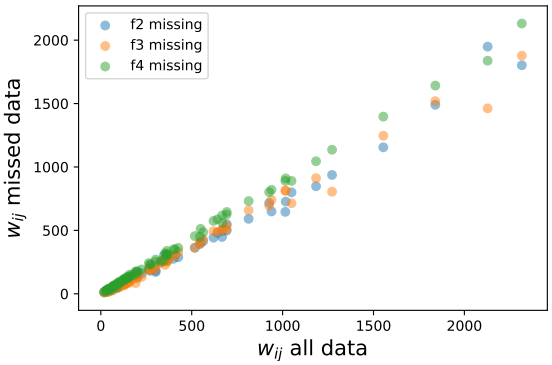

Fig S8. Weights of the contact network aggregated on the whole observation period, for the whole data set vs. for a data set with simulated missing data.