

Modeling participants' compliance in a large-scale sociometric study in low- and middle-income environments

Keywords: participant compliance, proximity networks, wearable sensors, human behavior, field studies

Extended Abstract

Studies on social networks and child development have been carried out for a long time [1], but the research potential afforded by high frequency, high-resolution data sources is still largely untapped [2]. Proximity sensors have been deployed with promising results in a different range of settings, including low- and middle-income countries [3]. Child-care within the same household may be affected by inequalities in the interaction with the parents: wearable sensors provide an opportunity to monitor some quantifiable aspects of parental behavior and relate them to the outcomes of interest.

Here, we study a large-scale dataset collected with wearable proximity sensors in rural villages in Malawi, part of a large study on childhood development [*anonymous citation*]. The data comprise close-range proximity information on 682 individuals, spanning 252 households and a temporal interval of 29 days. Each household comprises a *guardian* (parent) and one or two children, aged 2 to 6 years and enrolled in a community-based childcare center.

Each participant was provided with one wearable sensor recording time-resolved close-range interactions (using low-power radio-frequency) as well as movement patterns (via an onboard accelerometer). Compliance - i.e., the adherence to the protocol for wearing the proximity sensor during the study - critically impacts the quality of the collected data. Here we investigate compliance behavior and in the household environment described above. More precisely, we define as *non-compliance* an incorrect use of the proximity sensor (e.g. when it is not worn or when it is switched off). By design, when a *non-compliant* individual has an interaction, it will not be recorded and low sociability (lack of contacts) cannot be disentangled from low compliance since they both result in missing interactions. Our goal is to run a systematic study of compliance and its relation to available context variables.

For each participant, we use the sensor's accelerometer to detect whether the sensor was moving on a given day of the study (i.e., whether it was switched on and worn) or not. Figure 1 reports our main result, showing that compliance behavior is mainly household-dependent. We introduce a *compliance similarity* score, obtained by averaging the cosine similarity of the compliance time series of all household member pairs. Its value ranges between 0 (all household members were compliant in different days) and 1 (all household members were

compliant in the exact same days). The histogram of this score is shown in blue in Figure 1. The pink plot, instead, corresponds to a null model obtained by randomizing the household association and yields significantly lower scores, with a the Kolmogorv Smirnov (KS) statistics of 0.43 with $p < 10^{-2}$.

In Figure 2 we further analyze the impact of the household's guardian gender. The left plot shows that larger similarity scores are obtained for household with a female guardian (the KS statistics is 0.40 with $p < 10^{-2}$). This group also achieves a larger number of total days of compliance (the KS statistics is 0.22 with $p < 10^{-2}$).

We further investigate on the role played by mirroring, i.e. following the behavior of close contacts, as well as on the role of socio-economic factors. Our contribution aims at both improving the interpretation of sociometric data, as well as better accounting for partial compliance in designing future field studies..

References

1. Homel, R., Burns, A., & Goodnow, J. (1987). Parental social networks and child development. *Journal of Social and Personal Relationships*, 4(2), 159–177.
<https://doi.org/10.1177/0265407587042004>
2. Kleyn, L. M., Hewstone, M., Ward, C. L., & Wölfer, R. (2021). Using Longitudinal Social Network Analysis to Evaluate a Community-Wide Parenting Intervention. *Prevention science : the official journal of the Society for Prevention Research*, 22(1), 130–143.
<https://doi.org/10.1007/s11121-020-01184-6>
3. Ozella, L., Paolotti, D., Lichand, G., Rodríguez, J. P., Haenni, S., Phuka, J., Leal-Neto, O. B., & Cattuto, C. (2021). Using wearable proximity sensors to characterize social contact patterns in a village of rural Malawi. *EPJ Data Science*, 10(1).
<https://doi.org/10.1140/epjds/s13688-021-00302->

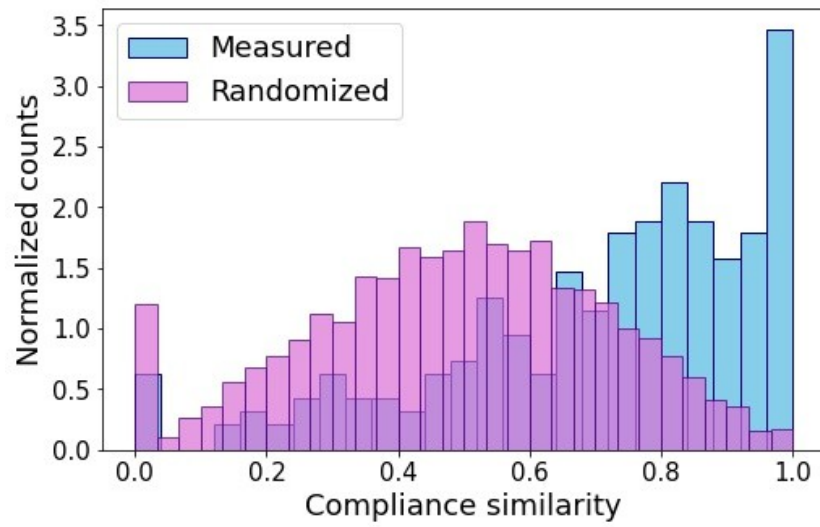


Figure 1. Histogram of the compliance similarity score between people in the same household (cyan) and for the null model (purple).

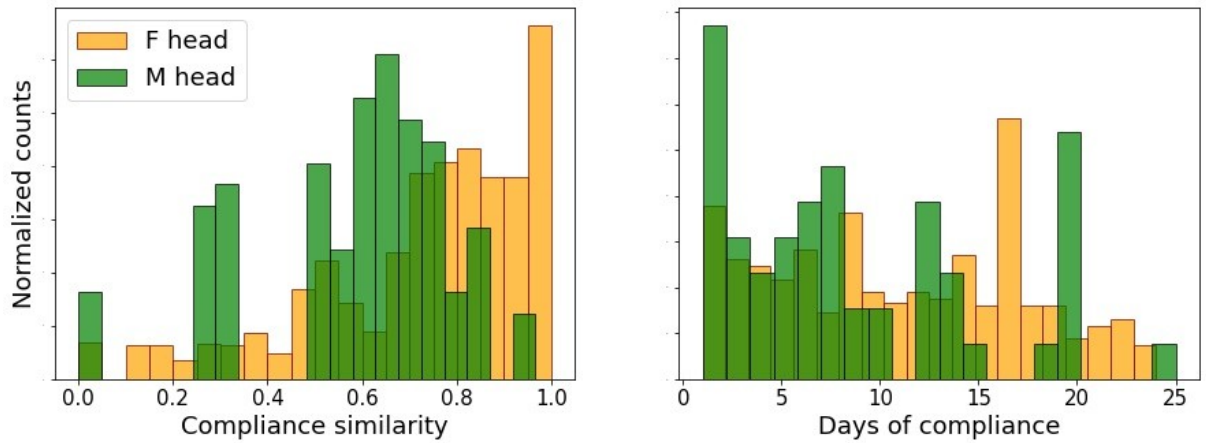


Figure 2. Compliance similarity score (left) and number of days of compliance (right) in households with female guardian (orange) vs those with male guardian (green).