Stiffness of connection influences exchange of physical cues during coordinated movements

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When two people coordinate their movements, such as by holding hands or moving furniture, they exchange physical cues through the objects

that connect them. New research published in *PLOS Computational Biology* suggests that stiffer connections allow for better communication but require more effort to achieve coordination.

During physical contact, the brain attempts to infer a partner's goal from their actions. Previous research has shown that during stiff interactions, such as holding hands or moving a table, one partner follows the other's lead. However, leader-follower roles do not emerge during soft interaction, such as when moving a mattress.

Atsushi Takagi of Tokyo Institute of Technology and colleagues set out to better understand how interaction strategies change with stiffness. They asked 14 pairs of people to chase a common target on a screen with a cursor using coordinated wrist movements. A robotic interface was used to simulate a virtual elastic band connecting each pair's wrists.

The research team found that a more rigid connection between partners—i.e., a stronger virtual elastic band—resulted in better communication of physical cues, but required partners to expend more effort to chase the common target. Partners connected by a softer virtual band were still able to coordinate by inferring information about each other's intentions, but this process deteriorated as the connection became softer.

A computational simulation of the experiment allowed the researchers to test different models of potential underlying mechanisms to see which one best explained the data. The best-fitting model accounted for the stiffness of the elastic band and how it influenced each partner's performance and effort.

"Our findings have implications for physical training and rehabilitation, as human-like assistance based on our interaction model results in better learning than robotic guidance," Takagi says. "Shared driving could also

benefit from this study to adaptively change the interaction stiffness between an autonomous vehicle and the human driver for a smooth handover."

Next, the research team plans to use brain imaging to investigate how each partner's actions and goals are represented in the brain during physical interaction.

More information: Takagi A, Usai F, Ganesh G, Sanguineti V, Burdet E (2018) Haptic communication between humans is tuned by the hard or soft mechanics of interaction. *PLoS Comput Biol* 14(3): e1005971. doi.org/10.1371/journal.pcbi.1005971