

Four-way mirror game

Introduction

Mirror game is an improvisation exercise for two people, where one person moves and the other acts as their mirror. In the game, the roles of leader and follower can be switched, and eventually the roles can be abolished, and the pair shares leadership, both mutually mirroring each other. The mirror game has been adapted to scientific research, where the game has been simplified to a 1D version with buttons on sliders [3], and a 2D version where participants move their hands as if drawing in the air [1]. In these studies, the condition of joint leadership has been found to produce movements that are better synchronised and smoother than those in the leader-follower conditions.

We extended this game to four people, and are investigating it as a) a method for studying group dynamics in movement coordination, and b) a measure of intersubjective attunement.

Methods

We used a 20-camera optical motion capture system to record four-player games. For the capture, each participant had 12 reflective markers attached to their upper limb joints, chest, head, and index fingers. In the pilot stage, we had four participants (2 female), all experienced in dance and improvisation. They played two games, and in between, engaged in another type of group improvisation. During the games, participants stood in a circle, with their right arm and index finger extended towards the centre. Participants were instructed to mirror each others' hand movements, without an assigned leader.

For this initial analysis, we calculated the average velocity of all the markers (quantity of motion, QoM) for each player. The QoM's of the players were then correlated with those of the other players, to evaluate the overall synchronicity in the game. A more detailed analysis was conducted on the finger tip movements. The Euclidean norm of the acceleration of the extended fingers was calculated, to obtain their accelerations along the trajectories. This method allows us to analyse the relationships between the players in more detail.

Task videos

Your browser does not support the HTML5 video element

This video shows the first four-way game from different perspectives.

Your browser does not support the HTML5 video element

For this video, all four players' bodies have been rotated so that the first game can be observed from the players' perspective.

Results

Comparing the QoM's of the two games, the first game produced a less correlated performance (Figure 1), and the cross-correlations indicate that overall, no pairs emerge as very well coordinated (Figure 2). Looking at the QoM's, there is clearly coordination, but it is quite noisy. There are times when people are not sure how to follow everyone else, and there are some cases where one participant moves but others don't seem to respond (e.g. A, (blue trace) at 1200–1400 samples). The four-player game poses difficulties, as there are many options for how to mirror others' movements: whether to do the same as others, mirror the player in front, or for example minimise the distance between the fingers? The rules left this ambiguous and for the players to figure out.

The second game has higher QoM peaks than the first, indicating that participants were conducting larger sudden movements (Figure 3).

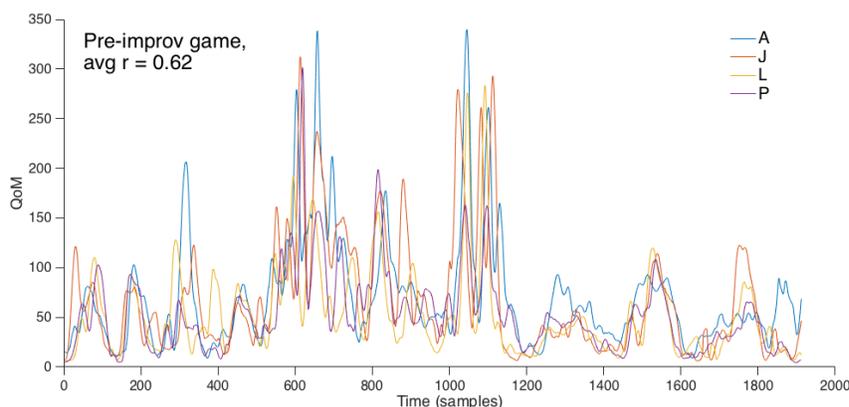


Figure 1. First game, quantity of motion in each player, calculated from all markers.

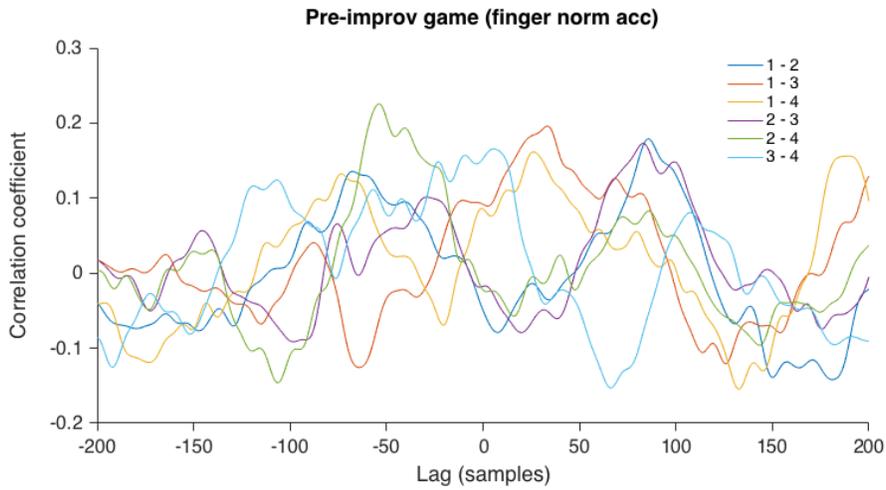


Figure 2. First game, cross-correlations of finger norm accelerations for each pair.

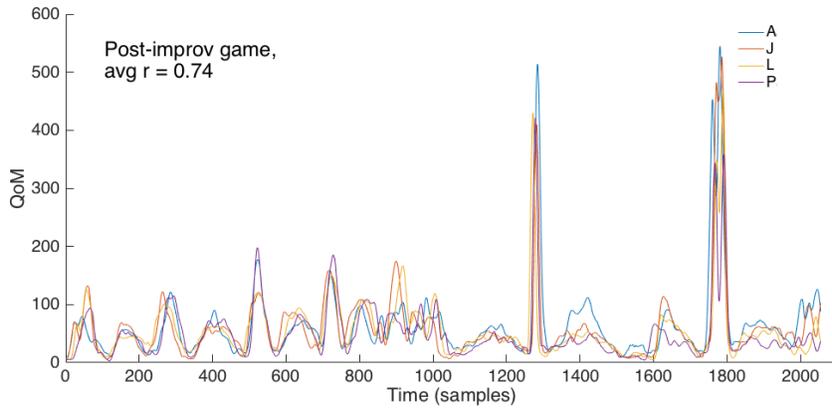


Figure 3. Second game, quantity of motion in each player, calculated from all markers.

In the second game, we also see a more coherent cross-correlation structure (Figure 4). Participants are numbered in clock-wise direction, so the adjacent numbered players are standing next to each other in the game. Looking at the peaks that are closest to the lag 0, we can see that they all are from dyads of adjacent players. us players seem to follow the players next to them more closely than players they are facing.

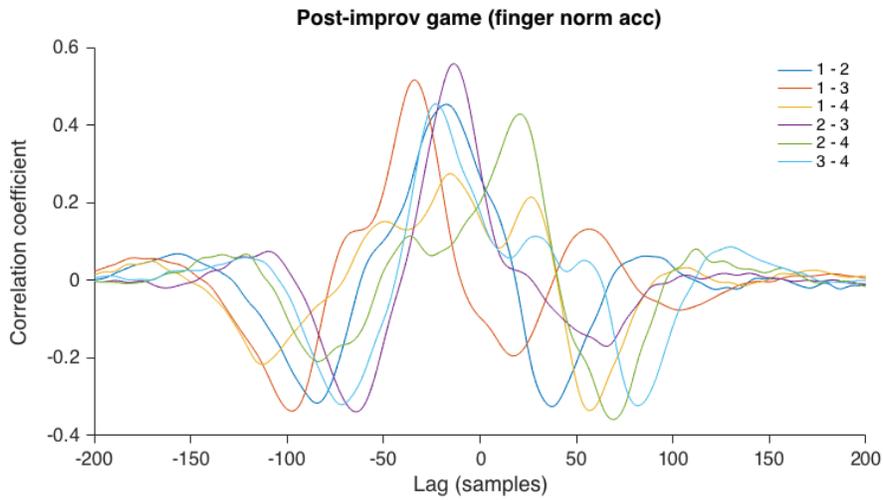


Figure 4. Second game, cross-correlations of finger norm accelerations for each pair.

If we zoom in to some of the peaks in the QoM graph, we can see the anatomy of these larger movements: who initiated them, who followed and at how large were the lags. Figures three and four show two of these peaks.

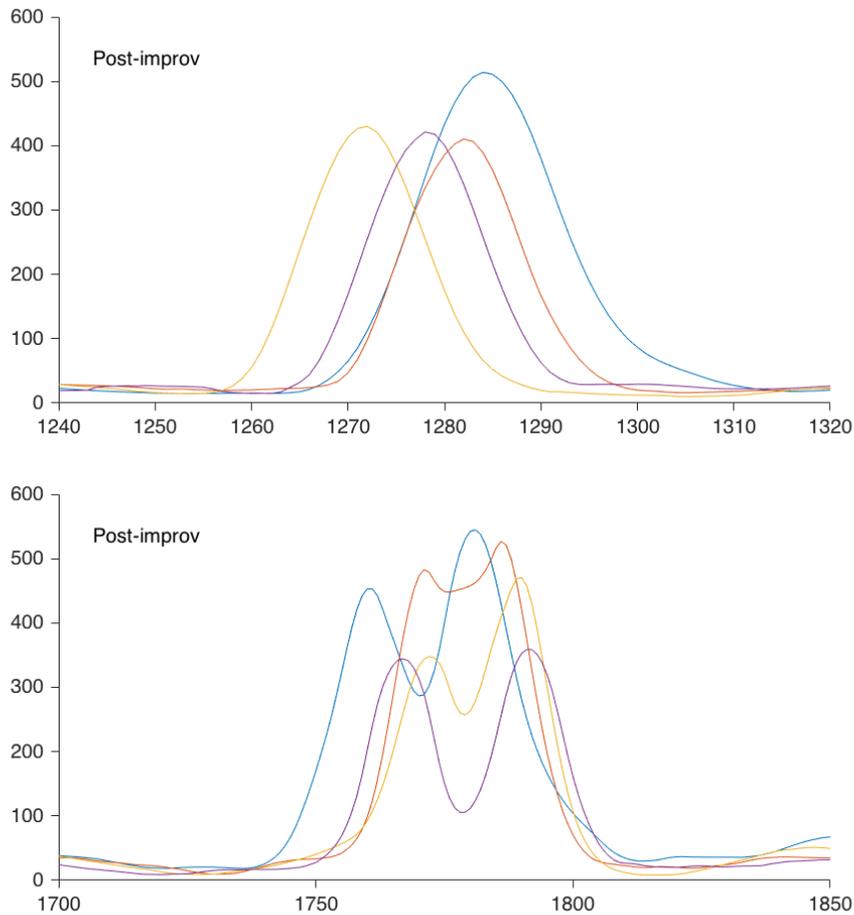


Figure 5. Details of QoM peaks. Top: first game; Bottom: second game.

Conclusions

Our pilot study suggests that the four-person game produces phenomena that are interesting from group dynamics point of view, for example the emergence of subgroups [4]. The task gives rise to "conflicts" where a performer must quickly decide which of the three other players to match, which leads to a mis-match with the other players. Prior research indicates that synchronisation and coordination lead to positive affective and social outcomes [2, 5], the four-way game offers a potential to study these effects and mechanisms in more detail.

In the pilot, the latter game produced more group synchrony, and facilitated the introduction of larger movements. This is probably due to the group improvisation in between, where participants were all holding on to a piece of paper and were "following its movement". is provided them with a potential solution to the arising conflicts: if all four aim to minimise the distance between their hands, they maintain a coordinated state, even though they are no longer, strictly speaking, mirroring movements. In the experiments to be conducted in the spring 2017, a musical group improvisation task will be used instead, to avoid such direct effects.

References

- [1] Tommi Himberg, Maija Niinisalo, and Riitta Hari. 2015. Coordination of Fluent Hand-Movements in Dyads. RPPW15, Amsterdam, Netherlands.
- [2] Michael J. Hove and Jane L. Risen. 2009. It's All in the Timing: Interpersonal Synchrony Increases Affiliation. *Social Cognition* 27, 6 (2009), 949–960. DOI:[10.1521/soco.2009.27.6.949](https://doi.org/10.1521/soco.2009.27.6.949)
- [3] Lior Noy, Erez Dekel, and Uri Alon. 2011. The mirror game as a paradigm for studying the dynamics of two people improvising motion together. *Proceedings of the National Academy of Sciences* 108, 52 (2011), 20947–20952. DOI:[10.1073/pnas.1108155108](https://doi.org/10.1073/pnas.1108155108)
- [4] Henri Tajfel. 1982. Social psychology of intergroup relations. *Annual review of psychology* 33, 1 (1982), 1–39.
- [5] Piercarlo Valdesolo, Jennifer Ouyang, and David DeSteno. 2010. The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Social Psychology* 46, 4 (2010), 693–695.