The Epicycles of Collective Motion
A Public Experiment

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INTRODUCTION

When blindfolded participants are passively moved along a short curved trajectory, they can remember the shape of the trajectory reasonably well and render drawings of it afterwards, even though differences between participants can be substantial (Fig. 1A, Ivanenko et al. 1997). However, this is the case only as long as heading and movement directions coincide, as in normal walking. If both are dissociated, perceived trajectories strongly deviate from the real ones (see Fig 1).

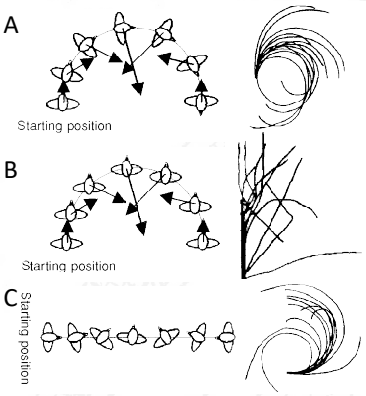


Fig. 1: Objective and subjective trajectories during passive transport (from Ivanenko et al. 1997)
(A) While moving on a half-circle trajectory, motion direction and heading coincide. Subjective drawings reflected the path, albeit with variability in turning angle. (B) When heading was kept constant as if moving in a along a line direction, most subjects reported perceiving a straight path. (C) When subjects were rotated while moving on a straight line, participants reported a curved trajectory similar to the half circle reported in condition A.

Here we adopted the methodology used in Ivanenko et al. (1997) and performed a similar experiment, but in a public space as collective naturalistic experience of several participants in the art-science framework of a Tate Exchange Event ("Moving Humans", Tate Modern, London, 2019). From the point of view of artistic research understanding subjective differences in drawing memorized trajectories is essential. Its rationale often builds on artefacts by individuals that allow the generation of new knowledge for many.
The title of the public performance, which refers to the historical epicycle theory that described apparent planetary motion from the point of view of the earth being stationary, emphasizes the importance of subjectivity in the present approach.

METHODS

Since it is currently unknown how more complex trajectories are perceived, we modified the condition shown in Fig. 1C by adding additional straight segments. Inspired by the "magic circle of play", a core thinking figure of the Ludic Method in artistic research (Jahrmann 2011), we used a pentagram as path (see Fig. 2 for explanation). Consequently, each participant moved on the same trajectory, but from different starting points (overall movement duration ≈50s, length of one leg ≈7m) while being turned through 2 full rotations. After informing them about the experiment, participants were asked to were blindfolds and earplugs. They were moved while sitting on office chairs by the experimenters. After stopping, participants were asked to draw the experienced path on an iPad or a paper sheet. The drawings were exhibited as collective art piece and rendered into a 3D shape evolving over time and shown as abstract film after the experiment. During debriefing participants compared their perceived trajectories and were informed about the real path taken. The experiment was approved by the ethics committee of the School of Advanced Study (University of London).

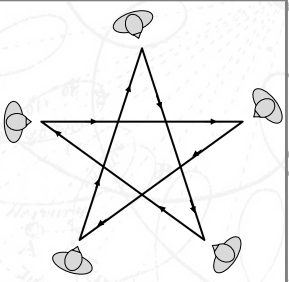


Fig. 2: Experimental setup. The experiment was performed by 5 participant/experimenter pairs in parallel forming a ludic dance performance of scientists and subjects. Each participant was moved along the segments of the pentagram and was rotated simultaneously so that participant p_i was constantly facing participant p_{i+2}.

SIMULATION

Assuming that participants perceive the movement as if their heading was always coinciding with motion direction, one can calculate the predicted perceived trajectory. For the simulation shown in Fig. 3 we assumed a parabolic speed profile and a path length equal to the actual one. The shape of the predicted trajectory does not depend on the speed profile.

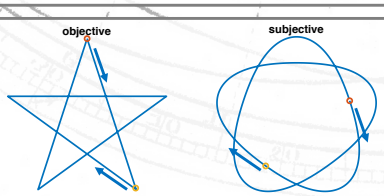


Fig. 3: Trajectories. Left: actual trajectory. Right: predicted perceived trajectory. Movement starts at the red corner and proceeds to the yellow corner.

RESULTS

None of the adult participants had a problem understanding the task and all of them could report the perceived trajectory by drawing. Most participants reported that the first two or three parts of the movement were easy to remember but that they lost track in the end. Several participants also reported that they felt transported much further than the size of the room. From over 100 drawings, only one came close to the expected shape (see Fig. 4). Interestingly, several participants drew a shape close to the objective one, but reported that they had not seen the performance before.

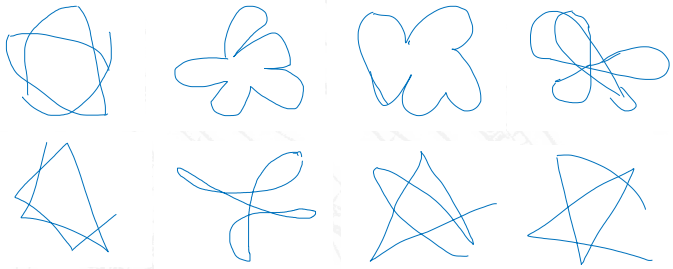
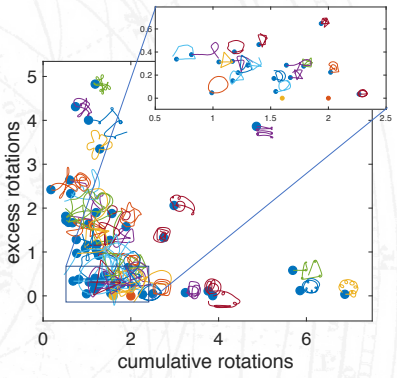


Fig. 4: Representative drawings. Only one drawing was close to the expected shape but with start and end points closer to the actual shape. Several participants drew shapes close to a pentagram.

Fig. 5: Quantification. Excess rotations plotted over cumulative rotations (e.g. three rotations right and two left would yield one cumulative rotation with four excess rotations) together with small versions of the respective drawings. Actual shapes indicated by red and yellow dots (2 or 1.6 cumulative rotations, no change in direction and therefore no excess rotations). Most subjects did not draw the correct number of rotations and felt rotated in changing directions.



DISCUSSION

Our results confirm previous findings (Ivanenko et al. 1997; Wertheim et al. 2001) that perception of passive transport is highly variable between participants and that decoupling of movement direction and angular rotation leads to perceptual illusions in the majority of subjects. This holds as well for the less controlled but naturalistic conditions of the present experiment (Fig. 6 top). As control we recorded the actual motion profiles using a mobile phone (100 Hz sampling rate). Fig. 6 (middle) shows that the executed profile closely follows the desired simulated one.
We further provided our participants with the social experience of perceptual variability by giving them feedback after the experiment and encouraging them to compare their subjective paths (Fig. 6 bottom), which together generated a collective 'object'. The performance aspect, the embedding of game mechanics beyond oversimplified gamification, and the visualization of collective perception as sculptural shape to convey a theoretical concept resulted in a novel contribution to the development of artistic research.

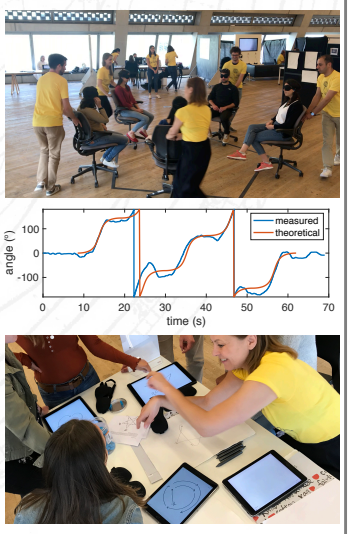


Fig. 6: Perfomance-experiment and debriefing. Top: experiment. Middle: motion profile recorded by mobile phone. Bottom: debriefing of participants and comparison of subjective experiences.

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