# Quantifying Movement Coordination in Human-Robot Interaction

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**Abstract**

Human-robot collaboration necessitates effective coordination strategies to optimize joint task performance. This study investigates how robot morphology and collaboration structure influence coordination dynamics during a shared assembly task within a virtual reality environment. Employing analytical methods from dynamical systems theory—specifically, Recurrence Quantification Analysis (RQA) and Cross-Recurrence Quantification Analysis (cRQA)—we examine temporal patterns of interaction between human participants and robotic partners. Participants engaged in two modes of collaboration: sequential, where actions alternate between partners, and simultaneous, where actions occur concurrently. Findings indicate that sequential collaboration fosters more predictable coordination patterns, whereas simultaneous collaboration, despite initial instability, leads to enhanced efficiency as participants adapt over time. Furthermore, robots with anthropomorphic features, such as Baxter, facilitate smoother and more stable coordination but do not consistently improve task completion speed. Conversely, less human-like robots enable faster task execution, albeit with reduced initial coordination quality. These results underscore the trade-offs between coordination stability and task efficiency, offering valuable insights for the design of adaptive and effective human-robot teaming strategies.


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