Can An Overly Slow Initial Tempo Counteract the Deceleration Caused by Auditory Delay?

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Objective

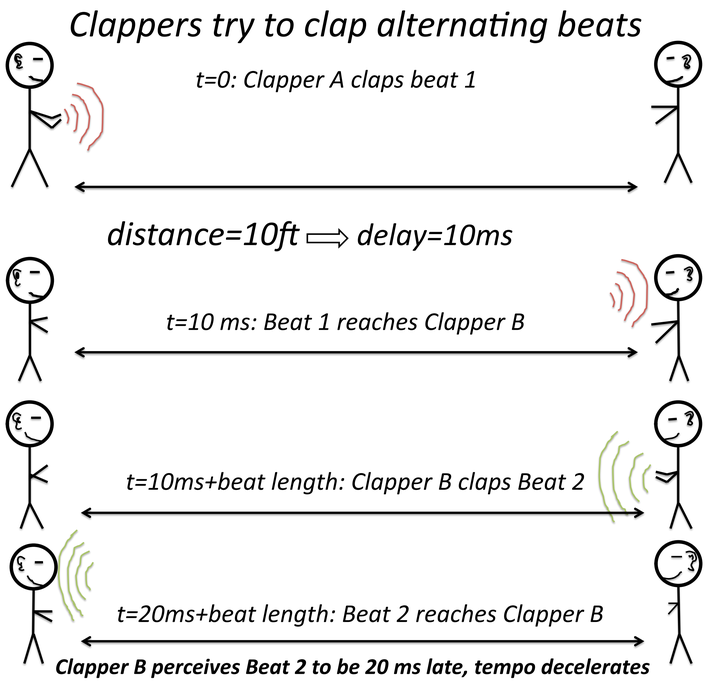
The demands of rhythmic coordination in ensemble performance make it an ideal platform through which to study and gain insight into human interaction over the Internet, specifically in the presence of network delay.

Researchers such as Chafe et al. [1] and Farner et al. [2] have conducted clapping experiments to show that below a certain delay threshold, tempo of clapping patterns tends to accelerate, and above that threshold, tempo tends to decelerate.

Intuitively, initial tempo has an influence on tempo change over the course of a performance: when the initial tempo is extremely slow, performers may tend to speed up, and when the initial tempo is too fast, performers may tend to slow down.

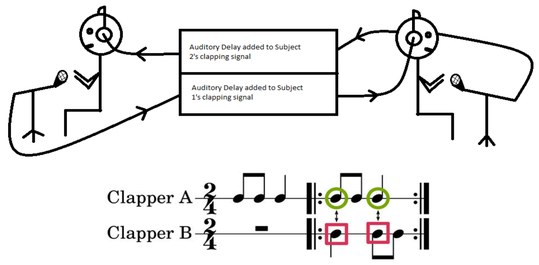
This research studies the interaction between auditory delay and initial tempo, and their combined influence on tempo change.

The Effect of Auditory Delay



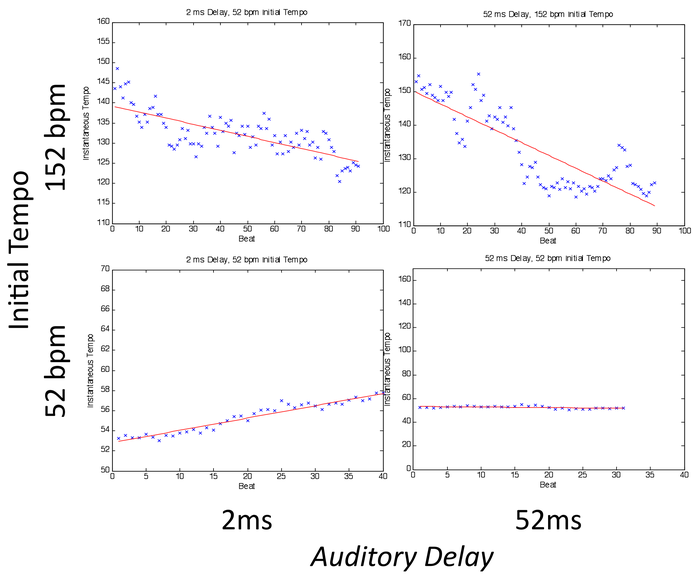
Experimental Design

- Non-Reverberant Conditions (delay introduced with software)
- Initial Tempi of {52, 72, 92, 112, 132, 152} bpm
- Auditory Delays of {2, 12, 22, 32, 42, 52} ms
- 6 subjects (3 pairs) each completed 36 trials at all level combinations

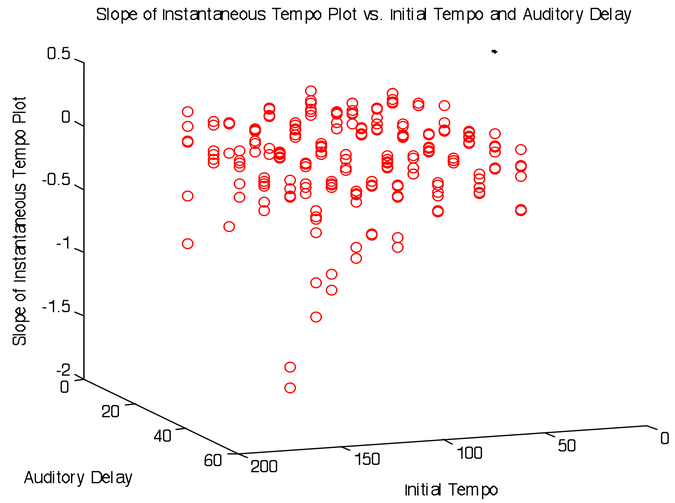


- Clappers performed the interlocking rhythm for 30 seconds, and each onset was recorded.
- Onset data was filtered and analyzed to create tempo plots for each trial.

Tempo Plots for Extreme Cases



Results



- Tempo change over the course of a rhythmic performance was found to depend on initial tempo as well as auditory delay.
- Moreover, it seems that the value of the initial tempo can be set deliberately in order to minimize tempo change. For each amount of delay, there was an optimum initial tempo that led to a stable performance with little to no tempo change.

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[2] S. Farner, A. Solvang, A. Sæbø, and P. Svensson: "Ensemble Hand-clapping Experiments Under the Influence of Delay and Various Acoustic Environments," *Journal of the Audio Engineering Society*, Vol. 57, No. 12, pp. 1028–1041, 2009.