Are all control conditions in rhythm experiments equivalent?

Humans extract regularity from 'random' sequences

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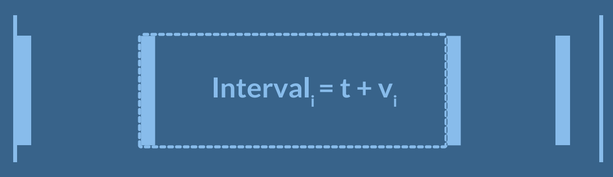
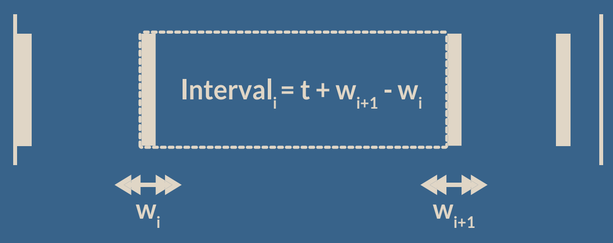
How unpredictable are 'random' control sequences used in rhythm experiments?

Two ways of creating 'random' timing:

1. (Interval) sampling



2. (Onset) jittering



t = tempo
v = variance for interval
w = amount of jitter

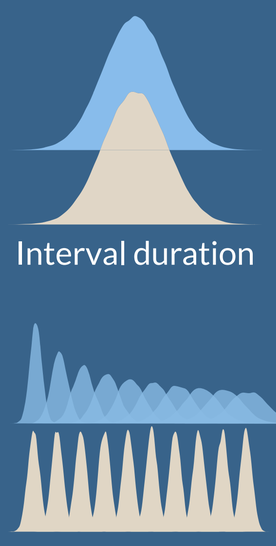
Humans are keen pattern-seekers, also in audition.

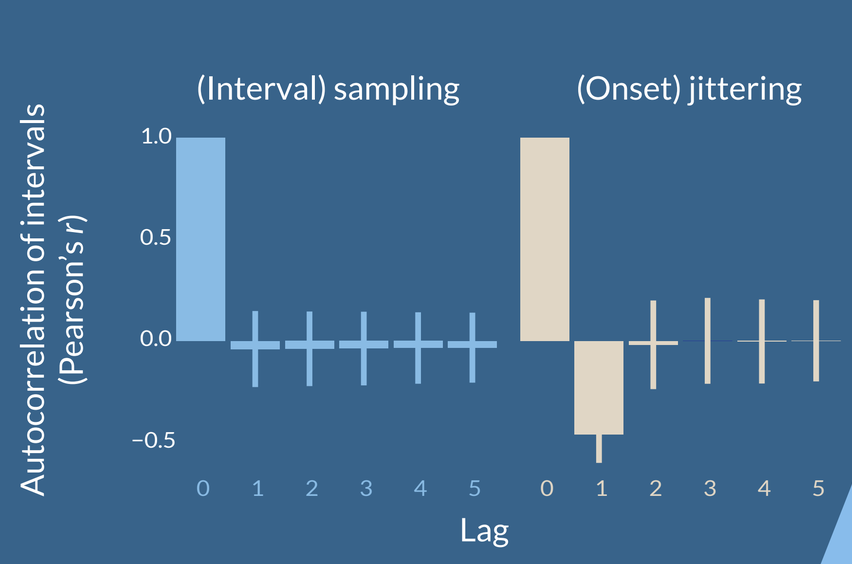
It is common in experiments to use **'randomly timed'** sequences of stimuli as a control condition, often to provide a contrast with temporal regularity (e.g. a rhythm or a metronome).

There are two ways of creating randomly timed sequences:

1. Interval sampling: We randomly sample the intervals between events (e.g. sounds) from a normal/uniform distribution
2. Onset jittering: We start with a regular sequence and we randomly jitter (displace/perturb) the events a little to the left or to the right. The amount of displacement is sampled from a normal/uniform distribution

What mathematical differences are there between 'sampling' and 'jittering'?



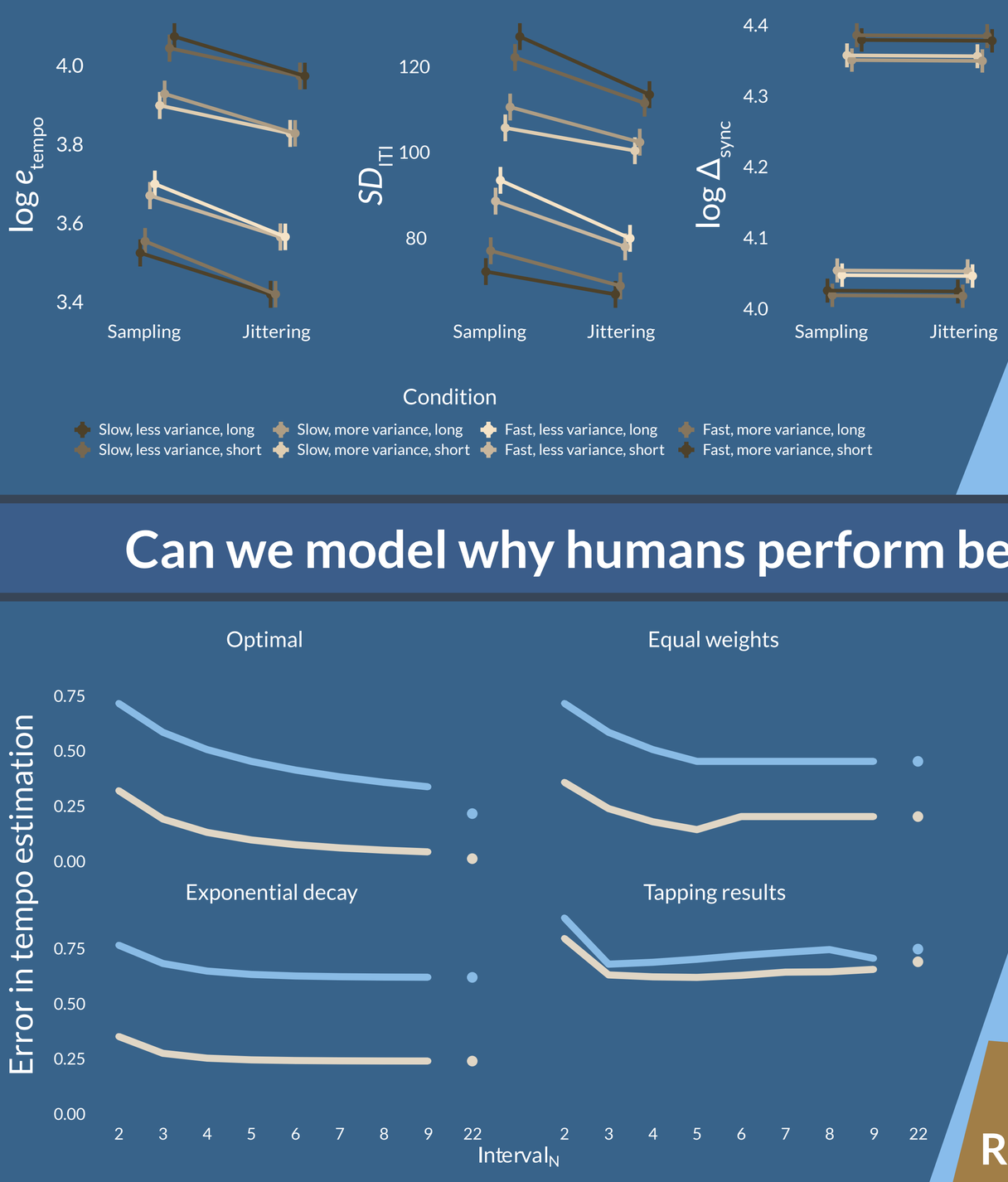


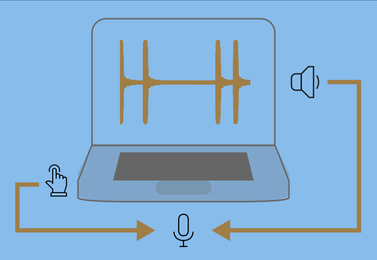
The intervals between sounds show the exact **same distribution** for both methods: no difference there.

Sequences created using the **interval sampling** method have more variable duration in total. For **onset jittering**, the total duration of the sequence is more predictable (probably why people like this method).

Importantly, onset jittering results in correlated intervals
(negative lag-one autocorrelation).

Are humans sensitive to the autocorrelated intervals in jittered sequences?





*Participants (n = 135) tried to tap their finger, as best as they could, together with randomly timed sounds. Random timing was created with the **interval sampling or onset jittering** method.*

- Onset jittering: participants tap closer to the sequence tempo (e_{tempo})
- Onset jittering: participants tap more regularly (lower SD_{ITI})
- Participants did not tap more accurately (i.e. closer to the stimulus onsets, Δsync)

Participants are indeed sensitive to the autocorrelated intervals.
They regularize the random sequences, and can do so better for jittered sequences.

We should stop using onset jittering,
interval sampling is more random to the human ear.

Can we model why humans perform better for jittering? And why should we care?

We modelled how, based on the durations of the intervals between sounds, participants might estimate the tempo of a whole sequence. The tempo is the average duration of the intervals.

Three potential strategies:

- Mathematically '**optimal**', with infinite memory
- '**Equal weights**' for experienced interval, memory = 5 intervals
- '**Exponential decay**', i.e. a recency effect for newly experienced intervals. Here, memory has a half-life of one second

In all scenarios, the amount of error in estimating the tempo is lower for jittering, same as in our tapping results. The difference appears after only 2/3 intervals!

Even from very irregular sequences, people can extract regularity.

Rhythm is in everything, humans entrain to anything