Supplementary methods – "Rhythmic motor behaviour influences perception of visual time"
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Procedure

Familiarization phase

Before starting the main experiment, participants practiced the visual interval estimation task in a familiarization phase (one block composed by ~50 trials). At the beginning of the block participants were presented with 10 repetitions of the standard interval, which was delivered by the yellow LED while they maintained the fixation on the red LED. The standard interval was identical to that used in the main experiment (i.e., an empty interval of 150 ms marked by two brief visual flashes of 5 ms each). Each repetition of the standard interval was separated by a random pause drawn from a uniform distribution ranging from 1.1 to 2.7 s. Once the sequence of standard intervals was completed, the block of trials was run. Each trial started with the red fixation LED being lighted on. After a random delay between 0.6 and 1 s, a variable temporal interval – the probe interval – marked by a pair of visual flashes (5 ms each) was delivered by the yellow LED. The probe interval varied randomly on a trial-by-trial basis from 70 to 300 ms in steps of 10 ms. At the end of the trial, participants were asked to verbally report whether the probe interval was shorter or longer compared to the standard interval (presented at the beginning of the block). This familiarization phase provided an initial estimate of participants' precision in the duration judgments, which was subsequently used to set the width and grain of the range of probe stimuli presented in the main experiment (see below for details about the range of probe intervals used). Data collected during the familiarization phase were excluded from the analysis.

Stimuli

1. **Range of probe intervals**. To optimize data sampling, the exact range of stimulus variation and its grain was adjusted by the experimenter according to subjects' performance. The number of probe intervals used was 42±5 (MEAN±SE). Despite the subject-specific adaptive changes that were manually performed by the experimenter, the range of stimuli used was rather comparable across subjects, with the smallest interval varying from a minimum of 50 ms to a maximum of 75 ms, and the largest from a minimum of 245 ms to a maximum of 300 ms. Importantly, we ensured that performance for each subject reached asymptotic levels (0-100%) at both the inferior and superior bound of the range of intervals used.
2. **Presentation times**. Stimulus presentation times were randomly extracted from a uniform distribution with 1 s width and mean centred on the estimated half of the 4th inter-tap interval (corresponding to ~7.5 s after the fixation LED was lighted on at the beginning of the trial). To maximize stimulus sampling within the 4th inter-tap interval, an on-line automatic algorithm adjusted the mean of the distribution of stimulus presentation times according to subjects' performance. The time point (averaged across the past 10 trials) that was half-way between the 3rd and the 4th taps was subtracted from the mean of the distribution of stimulus presentation times that was currently used. If the difference exceeded ±100 ms, the distribution was updated by adding/subtracting the calculated difference, otherwise it remained unchanged. This resulted in a forward/backward shift of the distribution of stimulus presentation times towards the 'expected' central time point of the 4th inter-tap interval. Importantly, by this procedure we only modified the mean, not the width of the distribution (which was always 1000 ms), therefore keeping the predictability of the stimuli unchanged. Moreover, by repeating this procedure every 10 trials we strongly limited the impact of possible outliers in tapping behaviour on the data sampling procedure.

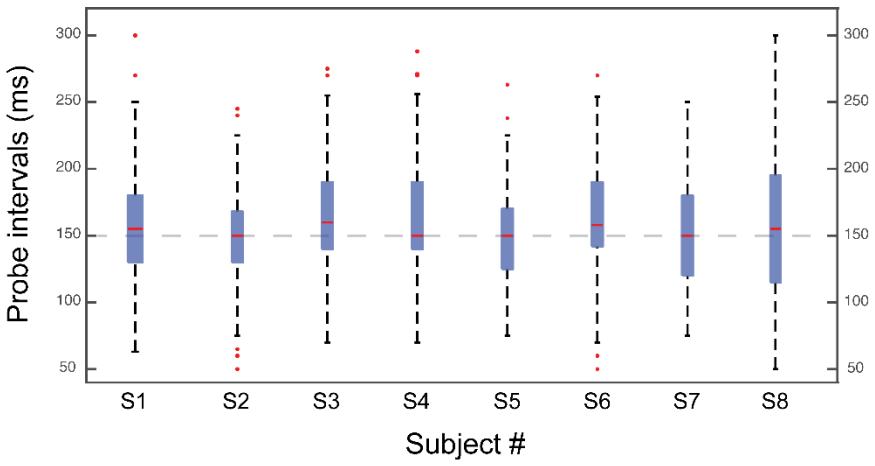

Figure S1. The box plots show the set of probe intervals presented to each subject (collapsed across latencies).

Data analysis

Permutation test

The difference in the latency of maximal time dilation between the short and the long inter-tap category was evaluated by using a non-parametric statistical approach based on permutations. This consists in randomly assigning the short and long inter-tap labels to each trial (belonging to the two relevant categories). Then, for each random permutation (1000 iterations), we first estimated the time courses of the PSE aligned to the 4th tap in the same way as described in the main text for the original data. We then extracted the latencies corresponding to the maximal time dilation as the mean of the Gaussian functions which best fitted the time courses of the PSEs (from -800 to -200 ms) and calculated their difference. This procedure allows us to generate an estimate of the distribution of the difference in the latencies of maximal time dilation under the null hypothesis that the data for the short and long inter-taps derive from the same probability distribution. The p-value of the statistical test is calculated as the proportion of random permutations that resulted in a larger difference in latency compared to the difference observed between the short and long inter-tap trial categories.

Control experiment (no-movement)

Subjects

Eight subjects (3 females; 22.5±1.2 year; MEAN±SD) took part in the control experiment. Subjects were all naïve with respect to the aims of the study and were all paid (€10/h) for their participation. All subjects had normal or corrected-to-normal vision and were right-handed by self-report. The study and experimental procedures were approved by the local ethics committee (Comitato Etico della Provincia di Ferrara). Participants provided written, informed consent after explanation of the task and experimental procedures, in accordance with the Declaration of Helsinki and the local ethics committee.

Apparatus

The experimental apparatus used for the control experiment was the same as described for the main experiment, except that the LEDs were operated via an Arduino (UNO R3) board controlled with custom-made Matlab code. The voltage signals deriving from the loudspeakers and the LEDs were acquired with a data acquisition device (NI-USB 6009, sampling rate 1000 Hz) for off-line computation of event timings.

Procedure

Trial structure and stimuli were the same as described for the main experiment with two exceptions: 1) participants were not required to continue the sequence of auditory tones by tapping with their finger (their hand was kept still on the table), and 2) the probe interval was presented at a random time (drawn from a uniform distribution with 1 s width) between the 3rd and 4th auditory tone (see Figure S2). Again, participants underwent a preliminary familiarization phase (as described above for the main experiment). Data were collected in separate blocks of 45 trials each and every participant completed a total of 14 blocks (630 trials).

Data analysis

Stimulus latencies were computed as the difference between the stimulus presentation time and the onset of the 4th auditory tone. Individual data were binned (bin size, 150 ms) according to stimulus latency. For each latency bin, the PSE and SD were estimated in the same way as described for the main experiment. Psychometric functions were never fitted to less than 30 data points.

To evaluate statistically the influence of stimulus latency on visual temporal judgments, both the PSEs and SDs were submitted to a repeated-measures ANOVA with latency (-950, -800, -650, -500, -350, -200, -50 ms) as within-subject factor.

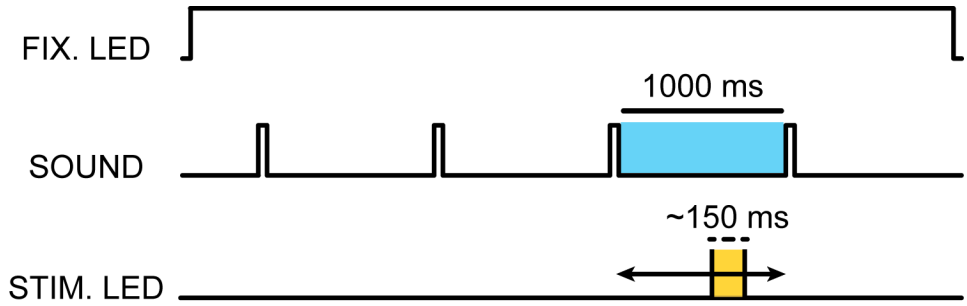

Figure S2. Schematic of trial structure for the control (no-movement) experiment. Each trial started with the FIX. LED being lighted. After a variable delay (~0.6 s), four auditory tones (800 Hz, 50 ms) were played at 1 Hz (i.e., with a fixed inter-onset interval of 1000 ms). At random times between the 3rd and the 4th auditory tone (i.e., the last inter-sound interval; marked in blue), two visual flashes (5 ms each) were presented separated by a variable temporal interval (probe; marked in yellow). Participants were required to report verbally at the end of the trial (FIX. LED turned off) whether the two visual flashes were separated by a shorter or a longer time interval compared to the standard interval (150 ms, presented at the beginning of each block of trials; not shown).