

Finger motion in piano performance: Touch and tempo

Werner Goebel¹ and Caroline Palmer²

¹ Department of Computational Perception, Johannes Kepler University Linz, Austria

² Department of Psychology, McGill University, Canada

This study investigated movement properties of pianists' fingers with three-dimensional motion capture technology while pianists performed melodic passages at a range of tempi. The main question was whether finger motion differs across tempi. Individual

performance speed led to specific claims about desirable
successful piano playing.

capture; piano performance; finger dynamics; pro-

Piano pedagogues disagree on how performers should develop the ability to perform scale passages evenly and dexterously at very fast rates. One side points out the importance of practicing fast sequences at very slow tempi, while others hold that practicing at the intended fast tempo is more appropriate. The main argument of the latter is that movement strategies change considerably across different tempi—for example, as human gait changes from walking to running—and movements that are learned while practicing slowly are not useful at fast tempi. We address here whether kinematic properties of finger movements scale proportionately with performance tempo.

We investigated the movements of pianists' fingers and hands as they performed melodies at a wide range of tempi to test the proportionality hypothesis. Furthermore, we examined how pianists' touch—the way pianists' fingers approach the piano keys—is affected by tempo by measuring key-strokes containing a finger-key landmark, a marker for a pianist's touch. This

work aims to generate potential recommendations for piano pedagogy, based on observations of skilled pianists performing at different tempi.

METHOD

Participants

Twelve highly-trained pianists participated in the study. They were 20 to 33 years old (mean=27.0 years; NB. one participant was 61 years old with 40 years of experience in playing the piano) and had 10-25 years of piano lessons (mean=18.7 years); most were piano performance students in Montreal.

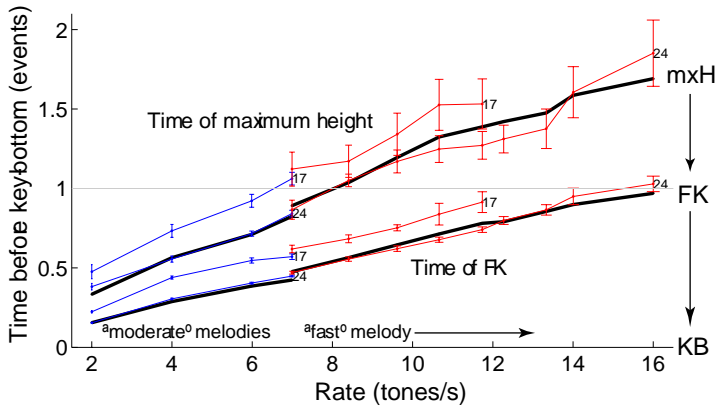
Stimuli and design

One isochronous melody (the “fast” melody) was created that was easy to perform with the right hand and could be continuously repeated (see notation in Figure 2); it was designed to be performed at very fast tempi (tempo conditions were 7, 8.4, 9.6, 10.7, 11, 7, 12.3, 14 and 16 tones/s, presented on different trials); the pianists decided at what tempo they stopped performing (open-ended design). The tempo was indicated by a metronome in a synchronization-continuation paradigm. For comparison, we include data from two “moderate” melodies that contained 16 tones and were performed at moderate to medium fast tempi (2, 4, 6, and 7 tones/s), as reported earlier (Goebel and Palmer 2008).

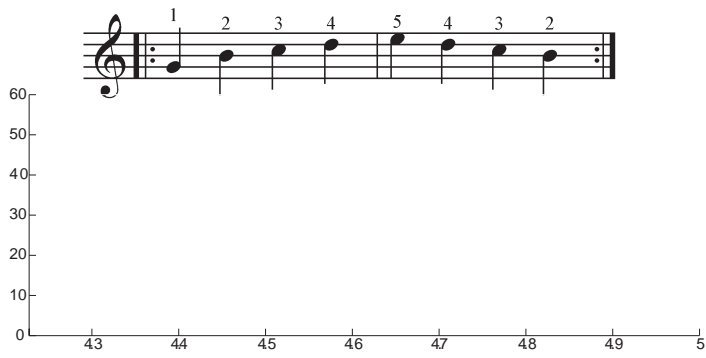
Procedure

A passive motion capture system (Vicon 460) equipped with six infrared cameras tracked the movements of 4 mm reflective markers glued on pianists' finger joints, hand, and wrist at a sampling rate of 250 frames/s. The motion trajectories of the five finger-tip markers were smoothed with functional data analysis techniques (Ramsay and Silverman 2005) and analyzed in the vertical dimension (height above piano key surface).

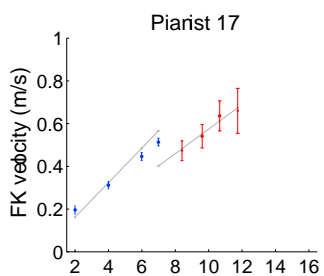
Kinematic landmarks were extracted prior to each keystroke (see also Figure 2): the key-bottom landmark (KB, the finger is stopped by the keybed) and the maximum finger height (mxH, to be interpreted as the beginning of the finger movement) for all [LJLLJ.wULz1gLz1tg] TY zU.JULqBUBT d [1egGJ.wULz.UJGN



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