

8-2005

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Brenda Wristen

University of Nebraska--Lincoln, bwristen2@unl.edu


Nick Stergiou

University of Nebraska at Omaha, nstergiou@unomaha.edu

Sharon Evans

University of Nebraska-Lincoln, sevans1@unl.edu

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Recommended Citation

Wristen, Brenda; Stergiou, Nick; and Evans, Sharon, "Using Three Dimensional Motion Capture Technology to Describe and Assess Piano Technique: A Case Study" (2005). *Health and Kinesiology Faculty Proceedings & Presentations*. 1.
<https://digitalcommons.unomaha.edu/hperfacproc/1>

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Brenda Wristen

University of Nebraska-Lincoln, bwristen2@unl.edu

Nicholas Stergiou

HPER Biomechanics Laboratory, University of Nebraska at Omaha, nstergiou@mail.unomaha.edu

Sharon Evans

University of Nebraska-Lincoln and Institute for Rehabilitation Science and Engineering, Madonna Rehabilitation Hospital, sevens1@unl.edu

Wristen, Brenda; Stergiou, Nicholas ; and Evans, Sharon , "Using Three Dimensional Motion Capture Technology to Describe and Assess Piano Technique: A Case Study" (2005). *Conference Presentations -- Music Faculty*. Paper 2.
<http://digitalcommons.unl.edu/musicpresentations/2>

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Using Three Dimensional Motion Capture Technology to Describe and Assess Piano Technique: A Case Study ¹

Brenda Wristen, Ph.D., N.C.T.M.²

Nicholas Stergiou, Ph.D.³

Sharon Evans, Ph.D.⁴

The purpose of the study was to examine any differences that exist in the quality of motions employed by pianists when they are sight-reading versus performing repertoire. A secondary question of interest was whether or not an improvement in the efficiency of motion could be

¹ Abstract of a paper presented at the National Conference on Keyboard Pedagogy, Oak Brook, IL, August 2005

² School of Music, University of Nebraska–Lincoln, 343 Westbrook Music Building, Lincoln, NE 68588-0100

³ Director, HPER Biomechanics Laboratory, University of Nebraska at Omaha

⁴ Department of Educational Psychology, University of Nebraska–Lincoln and Institute for Rehabilitation Science and Engineering, Madonna Rehabilitation Hospital, Lincoln, NE

observed between two sight-reading trials of the same musical excerpt. While data analysis for the full study is ongoing, the following results from a case study are illustrative.

In order to determine sight-reading level, a pretest was administered prior to data collection. The subject was presented with excerpts of different levels of difficulty and a ten point Likert scale was used to measure sight-reading level according to predetermined criteria. The level was defined once the values the criteria all fell within a range between six and nine. During data collection, reflective markers, applied on body segments on both sides of the body, were used to measure movement activity. Specifically, reflective markers were placed on both shoulders, between the shoulder blades on the back, on the upper arms, the elbows, the forearms, the wrists, and on all three joints of the index fingers. The movements of the markers were recorded via a six-camera digital motion capture system. The marker coordinates in space were then analyzed by an integrated software package from Motion Analysis, Inc. that identifies three-dimensional movements in space (frontal, sagittal, and transverse planes). The subject performed two separate trials of two tasks for approximately two minutes apiece: These tasks were (1) a sight-reading excerpt (equivalent to, but different than the excerpt used in the pretest), and (2) a “performance-ready” repertoire piece.

The subject in this case study was a 23 year old female who reported taking piano lessons for 19 years, and was still taking lessons at the time of data collection. The repertoire piece she played for both repertoire tasks was the Chopin Scherzo in B-flat Minor Op. 31. The sight-reading excerpt

she engaged in was the “Jazz Waltz” movement from Judith Lang Zaimont’s *Suite Impressions*. For the purposes of this initial case study we examined only two of the data sets collected: angular velocity (speed) and displacement (distance of motion).

With regard to the distance of motions, the subject used a *greater* range of motion in both her repertoire and sight-reading examples from the first trial to the second trial. This observation may be related to the instrumentation used in the study and may reflect the subject’s increased comfort level wearing the markers by the second trial. Secondly, the test subject used less movement overall for the sight-reading in comparison with her repertoire piece. This finding is related to the specific task demands of the two different musical excerpts. A third observation is that, in this particular case, the pianist’s movements on the right side of her body were higher. This finding may demonstrate right hand dominance. Significantly, in *both* trials of sight-reading, the finger used almost double the motion of the other three joints. While sight-reading, the subject played using more independent finger motion than she did in her repertoire piece.

Several significant observations were also made in this case study regarding angular velocity, or the speed at which the marked body segments were moving. Unlike the findings regarding range of motion, right-hand dominance was not demonstrated by this data set. In both the sight-reading and the repertoire tasks, the velocity of the body segments increased as it moved from the top of the arm to the tip of the finger. The most interesting finding in relation to velocity is that while velocity from the first repertoire task to the second repertoire task did not change significantly,

there *was* a significant increase in speed from the first sight-reading task to the second sight-reading task. This finding was not a function of tempo, which remained roughly the same from the first sight-reading task to the second, but rather indicates the subject’s adaptation to task demands. The greater velocity used in the second trial indicates that the test subject gained some level of neuromuscular familiarity with the sight-reading excerpt after a single reading. Results from this case study validate the use of motion capture technology to describe and assess piano technique using this protocol.