MULTIVARIATE KINEMATIC ANALYSIS OF PIANO PERFORMANCE: A CASE STUDY OF A PROFESSIONAL PIANIST

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INTRODUCTION

The music performance by professional pianists is remarkable from the perspectives of aesthetics, i.e., beautiful sounds, and human movement science as well. In particular, the complex and dexterous actions by the hands and fingers during a piano performance are feasible due to the structural advantage of the hands and fingers, such as high mechanical degrees of freedom. In other words, high-quality piano performance may be associated with the ability to coordinate high-dimensional elements, including hands, fingers, and trunk. By general consensus from the current control theories, the strategy of the central nervous system (CNS) toward the high dimensionality of the elements is to reduce the degrees of freedom in such a way that the elements are classified into a limited number of groups (i.e., dimension reduction) that are latent variables as to the performance skills or coordination [1]. The purpose of this study was to examine the patterns of coordinative patterns and dimension reduction of a piano performance by a professional pianist.

METHODS

One professional pianist who has worked performer and instructor for at least 20 years participated in this study. The participant played a Computer Controlled Piano (Disklavier C7, Yamaha Inc., Hamamatsu, Japan) for 30 repertories which were composed of four techniques. (1) pulling arm legato: up, down, pronation and supination motion of wrist with released in the shoulder, (2) upper-arm gravity drops: a portion of the pulling arm cycle with a low- and high-wrist form, (3) forward gravity drops-rebounds: control of lower arm to maintain wrist height, and (4) hand bounce: produce faster and lighter repetitions of hands [2]. Spherical reflective markers were attached to the hand and each finger joint. Kinematics of upper body segments were captured using eight infrared cameras at 100Hz (OptiTrack, Natural Point Inc., Corvallis, OR). The geometric model consisting of 24 segmental angles was used for the quantification of mechanical properties of body kinematics. Principal component analysis (PCA) was performed to investigate the strategy of dimension reduction during the piano performance.

RESULTS AND DISCUSSION

(1) In pulling arm legato technique showed that the wrist, thumb, and little fingers were performed in one mode.

ACOUDNCLUSIONS

The current results showed the existence of a common mode (i.e., latent variable) across different piano techniques. Further, the kinematics of the thumb, little finger, and wrist joint played a significant role in the overall frame. To sum up, the control ability of wrist position and independent motions of fingers may be a contributor to the professional piano performance, albeit these should not be all about the “beauty” of the piano performance.

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REFERENCES