Influence of Body Proportions on Dance Movements in Pre-Professional Dancers

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DANCE BIOMETRICS RESEARCH LAB
We Move and Measure Above the Rest

Introduction

Body proportions are the basis for one's ability to execute movements given range of motion and center of gravity determined by specific key structures. One such structure, the pelvis, is the core of all movement, it is the main pivot point of stability and movement and the primary pivot point between the upper and lower body. While the spine is another main source of movement, it contrasts from the pelvis with its mixture of flexibility and rigidity. The movement of the body creates angles and positions that are aesthetically pleasing, this is known as dancing (Daprati, 2009).

Our research objective is to investigate the influence of body proportions on the execution of dance movements in pre-professional dancers. This research will facilitate a quantitative understanding of form and function in dancers who typically have a wider distribution of body proportions than their professional counterparts. This research will also facilitate the dancers' understanding of movement specific to their bodies, injury prevention, and use of training techniques to enhance performance.

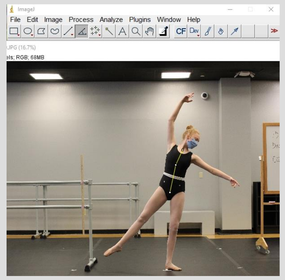

Figure 1: Example of how the program ImageJ appears to those analyzing photos on a computer.
Dance position #10: dégagé à la second, with épaument.

Timeline

- **Fall 2020**: Dance Biometrics lab formed, and our research lab's main focus was developing the methodologies and protocols based upon our research objective. We were also placing some focus on building our theoretical knowledge in both dance anatomy and form and function. Much of our effort was focused on literature searches and developing an annotated bibliography. We also researched extensively low-cost, and thus low-technology protocols to collect data. We were also introduced to ImageJ, a software program to measure photographs. We took our first set of photographs and measurements that would later be used to develop our protocol guide for data collection and received approval for our IRB permit application.
- **Spring 2021**: We continued to refine our methodologies and measurements using ImageJ. We also scheduled our first set of participants (subjects) in April. With data from these subjects, we will have enough data points to begin preliminary statistical analyses.
- **Future/Ongoing**: As analyzing the photos taken of each subject can take days, we will begin preliminary data analyses in fall and will continue to recruit subjects on a rolling basis. This is a long-term research study and as we analyze the data, we expect to develop more specific and refined research hypotheses.

Abstract

While most dancers are pre-professionals and have a wide range in body proportions, research investigating the influence on body proportions in the ability of pre-professional dancers to execute movements is lacking. Much of this variation in movement originates from the proportions associated with the pelvic and vertebral bones, given their primary role in both stabilizing and facilitating balance during a broad spectrum of movements. Our objective is to determine the influence of various body proportions on the ability of pre-professional dancers to execute various dance positions. We are using a low-cost approach that measures relative body positions using photographic data. This research will support an understanding of how body proportion influence dance movements in pre-professional dancers as well as aid in skill development and injury prevention.

Methods

In the last seven months since our research lab was formed, we have been focused primarily on developing the research methods. Modifications to our protocol have been ongoing as we find more effective strategies to improve accuracy and precision in data collection.

Protocol Development

Our research requires the use of an IRB permit, which was recently approved. Our pool of potential subjects includes any students at TMCC and UNR who have at least an introductory-level dance background. We developed an intake questionnaire to capture demographic data that will be used as covariates during analysis (i.e. age, years of dancing, and previous injuries). Stickers (N=26) are placed are key joint and bony landmark features in the axial and appendicular regions. The stickers act as landmarks for important body regions that are the basis for data collection. Specific dance positions (N= 19) and measurements analyzed in this study are based upon capturing a range in difficulty that provide a sense of the subjects' capabilities(Figure 3 & 4).

Photos are divided into two groups: baseline and dance. Baseline photos are used to standardize within-dancer measurements to allow for cross-subject comparisons, as well as the starting position and maximum range of movement for various joint regions. Examples: lateral bend, wing span, and anterior flexion. Dance photos are used to capture the placement of the subject's body for each position.

For each dance photo, a range of 4-8 measurements are taken that represent linear distance and angles of joint positions. These measurements are compared to the subject's baseline photos to capture a proportional value (ratio) that allows us to compare across-subject movements. This comparison will be made using linear regressions (to investigate body-region specific trends in proportions and execution of respective movements) and multivariate analyses (to investigate the influence of covariates and provide a holistic perspective of the entire body position for each dance position) using SAS. Our data will also be made into a composite for each subject that shows relatively position of body regions as compared to the ideal execution of the position. Subjects can use this information to improve their dance skills but also aid in injury prevention.

Room Setup

For each position, photographs are taken from two cameras positioned 90° from each other to provide an anterior and lateral view for each dance position. Two cameras is a low technology approach used to capture the 3-D movements associated with dance (Dela, 1999). Both cameras are positioned at 20m from each subject to reduce error associated with distortion from the 35mm wide angle lens. A grid is placed behind the subject to calibrate and provide reference lines used during analysis in ImageJ (Figure 2).

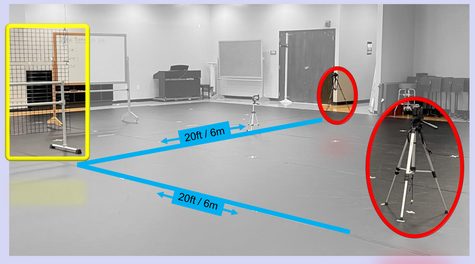

Figure 2: Photo of the research lab studio setup with measurements (blue lines) indicating the 6m/20ft distance of both cameras (red circles) set 90° apart. A grid (yellow rectangle) is located behind each dancer (not shown) to facilitate measurements of photographs in ImageJ

Trial Data

As pre-professional dancers, we (Joslyn and Hannah) were used as the trial subjects to conduct preliminary analyses in ImageJ (Figure 1). ImageJ is an open-source measuring program designed for scientific research (Schneider, 2012). We both separately measured the linear distances and angles for each photograph to determine the accuracy of our protocol and to determine the effect of human error for each measurement. We revisited measurements where the % difference between measurements was ≥5%, and adjusted the photograph, sticker location, or measurement protocol (Figure 3). Few measurements were inconsistent and were mostly associated with small angles less than 3°.

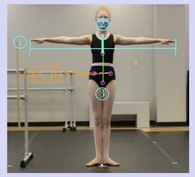

Figure 3: Example of a baseline position (#P1) from which the dancers' body proportions and range of motion are determined.

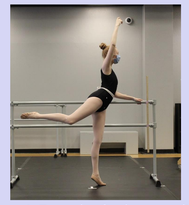

Figure 4: Example of a dance position #D35, Attitude Derrier en Releve, at barre which is the most advanced dance position we are analyzing.

Preliminary Data

As of May 2021 our recruitment efforts include ~10 subjects, each with a wide range of dance experience (Figure 5). We are currently prioritizing the collection of photographic data to include students in our research who are graduating this semester. We will recruit volunteers for this research on an ongoing basis and measurements of photographic data will begin in the fall semester.

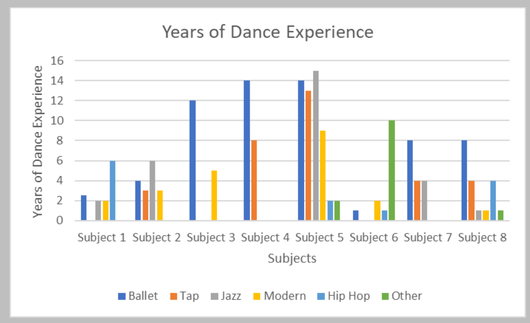

Figure 5: As is common in pre-professional dancers, our subjects have a broad range in dance experience across all major disciplines. However, ballet is a fundamental dance style upon which the other dance disciplines draw from. This information, along with other demographic data, will be used as covariates during analyses.

Figure 6: Dayna, Joslyn, and Hannah collecting angle measurements for later comparison to photographic data measurement. The use of a laser level allows us a direct comparison of measurements captured in 3-D space with our 2-D measurements captured using photography. This will ensure accuracy and precision in our data collection and analyses.

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Acknowledgments

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