Micro-movement as physical signature of movement intention in work of choreographer Myriam Gourfink

Rebecca Warzer, Elizabeth Torres, Asaf Bachrach

► To cite this version:

Rebecca Warzer, Elizabeth Torres, Asaf Bachrach. Micro-movement as physical signature of movement intention in work of choreographer Myriam Gourfink. International Workshop on Movement and Computing, IRCAM, Jun 2014, paris, France. pp.156 - 157, 2014, 10.1145/2617995.2618024 . hal-01100680

HAL Id: hal-01100680

<https://hal.science/hal-01100680>

Submitted on 6 Jan 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Micro-movement as physical signature of movement intention in work of choreographer Myriam Gourfink

Rebecca Warzer
Bennington College
Bennington, VT, USA

Elizabeth B. Torres
Cognitive Psychology & Computational Neuroscience
Rutgers University
New Brunswick, NJ, USA

Asaf Bachrach
Centre National de la
Recherché Scientifique
Paris, France

Abstract

A micro-movement paradigm that distinguishes goal-directed from goal-less movement in Autistic children was adapted to study intentionality of movement in dancers. Dancers were trained in Myriam Gourfink’s technique, whose work is characterized by constant and heightened awareness of the body and its movement. In past studies using the forward-and-retracting structure of pointing motions [2], the instructed motor segment deliberately intended toward the target had a statistical signature of intentionality, measured with inertial measurement units, that differed from that of the uninstructed motions. The latter tend to occur largely below the threshold of awareness. We hypothesize that the dancers’ uninstructed, goal-less movements will have signatures closely resembling those of the instructed goal-directed movement. We expect this to be particularly true after training.

Introduction

Torres et al. use the term micro-movement to describe the statistical microstructure of body movement inherent in the variability of velocity- or acceleration-dependent parameters in the continuous flow of motion trajectories. These can be measured with wearable sensing technology such as accelerometers, and analyzed with a newly developed technique [4] that enables real time tracking of the signatures of motor-output variability. In previous studies, Torres et al. used a basic pointing task to examine the statistical signatures of goal-directed and goal-less motor segments [4]. In comparing the micro-movements of the pointing task across many different repetitions of the task, Torres et al. found that the trajectory of the goal-directed motor segment (arm extension) exhibited much more stability across trials than the goal-less retraction. Additionally, the trajectory of the goal-directed motor segment was less sensitive to experimentally induced speed variations [2, 3, 4].

Adapting this paradigm, the present study examines the extent to which a given movement resembles goal-directed, deliberate, and intentional movement by comparing the stability of its trajectory across trials differing in speed. In this way, collecting trajectory data from dancers before and after training sessions in Gourfink’s technique enables us to study any effect that the training may have had on the unintended components of the dancers’ movements.

Materials & Methods

In the pointing experiment, dancers were instructed to point at a target on the wall (a black “X” 4 inches across) in response to a tone. Each tone that was played was one of four different pitches, and dancers were instructed to point faster in response to a higher pitch, and slower in response to a lower pitch. Varying pointing speed allows the pointing trajectory to be studied across different contexts, and using different pitches to accomplish this was the method that was least invasive to our study. Each pitch was played 25 times in a randomized order, yielding 100 trials per experiment. Each tone was 750ms long, and tones were separated by a randomly chosen interval of time between 4 and 8 seconds to hamper dancers’ ability to predict the regular occurrence of a tone. Movement trajectory was measured with an inertial measurement unit (IMU) consisting of an accelerometer and a gyroscope at a sampling rate of 200 Hz. Data from the IMUs were recorded using a Max/MSP patch developed in-house. We used 10 IMUs that were paired in units of two for each subject. One IMU was worn on the pointing hand of the subject and the other worn on the subject’s head.

Figure 1. Methods Summary: (A) Obtain the hand tri-axial linear acceleration (x,y,z) vector time series. (B) Obtain the time series of the norm (scalar quantity) of the acceleration vector and locate the acceleration peaks. (C) Automatically parse out the forward peaks for the ballistic phase of the pointing motions (red), the uninstructed retractions (blue) and the resting phase between trials (green). (D) Gather the data in a frequency histogram for density estimation and probability distribution fitting (red morning and blue afternoon for the forward motion in this example).

Results & Analysis

In Figure 1A, the top graph plots data from the accelerometer mounted on one sample subject’s head, and the bottom graph plots the same for the accelerometer on the subject’s pointing hand. Data is automatically parsed between forward pointing segment (blue), retraction (red), and rest (green). All three segments of the gesture were performed faster in the afternoon session compared to the morning (Figure 1D). Further analysis and control experiments will be required to determine whether this acceleration was due to the dance training. We used a Gamma function family to estimate the distribution of the values of the acceleration peaks by segment and session (Figure 1C). Peak acceleration fluctuations across trials for each individual have distinct stochastic signatures. The empirical frequency distributions of such parameters can be used to estimate the two Gamma parameters that uniquely label that individual’s somato-sensation [5]. A log map of the two parameter values (Figure 2A) provides a visualization of the relative predictive-ness (growing from left to right) and noise (decreasing from top to bottom) of each segment regarding the next trial (by individual and by session). The three segments are clearly distinguishable by their Gamma parameters, the pointing motion being the most variable (least predictive), and the resting segment the most predictive. The low predictability of the pointing segment is most probably due to the randomly instructed speed, which, surprisingly, had a smaller effect on the retraction segment. The high predictive-ness of the resting segment is most surprising and could be due to dance training. In the afternoon session, the retraction and rest segments appear to be more predictive than the corresponding segments in the morning session. We hypothesize that this increase is the result of Myriam Gourfink’s specific training, enhancing continuous conscious awareness of body and movement state. We are currently conducting additional analyses to verify this conclusion.

References

[1] Gourfink, M. 2003. Contact Quarterly interview. (Winter-Spring 2003). Retrieved February 18, 2014, from <http://www.myriam-gourfink.com/interviews.html>.
[2] Torres, E.B. 2013. Signatures of movement variability anticipate hand speed according to levels of intent. Behavioral and Brain Functions. 9, 10. DOI= 10.1186/1744-9081-9-10
[3] Torres, E.B. 2011. Two classes of movements in motor control. Exp Brain Res 215:269–283. (Oct 2011). DOI= 10.1007/s00221-011-2892-8
[4] Torres, E.B., Brincker, M., et al. 2013. Autism: the micro-movement perspective. Front. Integr. Neurosci. 7, 32. (July 2013). DOI= 10.3389/fnint.2013.
[5] Torres E.B., Jose J.V. 2012. Novel Diagnostic Tool to Quantify Signatures of Movement in Subjects with Neurobiological Disorders, Autism and Autism Spectrum Disorders. Rutgers University Patent US Pending 2012-051, 2012-085

Figure 2. Distributional Analyses. (A) For each of the 5 subjects obtain the estimated parameters of the continuous Gamma family of probability distributions best fitting the forward, backward and resting acceleration peaks using maximum likelihood estimation with 95% confidence. Plot for each subject and movement class plot the estimated (shape, scale) parameters on the Gamma plane with confidence intervals. (B) Plot the mean and standard deviation of the Gamma estimated probability distributions for each subject, movement class and session.