

## THE CREATION OF THE BRAZIL-UNITED KINGDOM DANCE MEDICINE & SCIENCE NETWORK AS A POTENTIAL PLACE OF PROFESSIONAL AFFAIRS AND RESEARCH

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### Summary

Dance Medicine and Science (DMC) is a field that has been developing globally for more than 20 years through collaborations that involve different professionals in areas such as medicine, education, psychology, nutrition, science and dance, among others. The aim of DMS is to maintain the general well-being and good quality of the health, training and performance of the dancers. This is normally achieved by the promotion of discussions, research and services that cultivate educational, medical and scientific excellence. In the United Kingdom, the UNIVERSITY OF WOLVERHAMPTON, a renowned institution in DMS, initiated, in March 2016, with the support of the NATIONAL INSTITUTE OF DANCE MEDICINE AND SCIENCE (NIDMS), formed by this university and the TRINITY LABAN CONSERVATOIRE OF MUSIC AND DANCE, ONE DANCE UK, UNIVERSITY OF BIRMINGHAM, BIRMINGHAM ROYAL BALLET and ROYAL ORTHOPEDICS NATIONAL HOSPITAL, a dialogue with the STATE UNIVERSITY OF GOIÁS to promote the cooperation of this university and others, such as the FEDERAL UNIVERSITIES OF GOIÁS and RIO GRANDE DO SUL, FEDERAL INSTITUTES OF GOIÁS and BRASÍLIA, UNIVERSO, UNIVERSITY OF THE STATE OF SÃO PAULO, and STATE UNIVERSITY OF CAMPINAS, as well as other stakeholders from the private sector and individuals, for the creation of the BRAZIL-UNITED KINGDOM DMS NETWORK. It has the objective of developing research and collaborative services during the next 15-year period. One of the focuses of the Network is the investigate different aspects related to dance and invest on the exchange of technology between the mentioned regions. This expanded summary presents and diffuses the initial structure of the BR-UK Network and the dialogues generated by the first gatherings and discussions of the artists-researchers and institutions that participate of it, so that parameters of action can be pointed out, and future theoretical-practical pieces of research and services can be developed, contributing to the dilution and hybridization of the boundaries between dance and other areas of knowledge.

**Keywords:** Network; Medicine; Science; Dance.

### Introduction

The Brazil-United Kingdom Dance Medicine & Science Network<sup>1</sup> (Figure 01<sup>2</sup>) was created in 2016 with the aim of broadening the discussions, research and professional partnerships in DMS, through the exchange of information and technologies between these two world regions. The workshop *The*

<sup>1</sup> From this point onwards we will use the abbreviation BR-UK DMS Network throughout the text.

<sup>2</sup> For all the Figures, please refer to the summary in Portuguese.

*Potentials and Challenges of Research in Dance Medicine & Science: building innovation collaborations between the UK and Brazil*, which took place in August 2016, at the Cultural Center of the Federal University of Goiás, in Goiânia/Brazil, served as a first approaching action between those involved with the Network. This event was proposed and idealized by PhD Adriano Bittar, from the State University of Goiás/Goiás Higher School of Physical Education and Physiotherapy (UEG/ESEFFEGO)<sup>3</sup> and Professor Matthew Wyon, from the University of Wolverhampton/School of Performing Arts.

This workshop was co-funded by the British Council, through the Newton Fund, and by the Foundation for the Support of Research of the State of Goiás (FAPEG)<sup>4</sup>, and carried out by UEG/ESEFFEGO/Pro-rectory of Extension (PRE), University of Wolverhampton and NIDMS<sup>5</sup>. As partners, the workshop had the Dance Course of the Federal University of Goiás/Faculty of Physical Education and Dance (UFG/FEFD)<sup>6</sup>, and the Dance Course of the Federal Institute of Goiás/Campus Aparecida de Goiânia (IFG)<sup>7</sup>. As an institutional partnership, the support was provided by the Cultural Center of UFG/Pro-Rectory of Extension and Culture (PROEC). There were also cultural presentations, delivered by the partners Quasar Cia de Dança, Dança Basileu França, Quadrilha Arraiá Chapéu do Vovô and Popular Brazilian Music singer Grace Carvalho.

The objectives of the workshop were to present an overview of the current state of the DMC field, addressing issues such as: what is it? how has it dealt with the health of dancers in Brazil/UK? and what are the challenges of DMC in both regions? In addition to these, we can still list: introduce the field of DMC to dance and health researchers in Brazil; describe how it is growing worldwide, its potentials and challenges; exchange knowledge, experience and ideas on DMC research and existing services in the United Kingdom and in Brazil; become aware of funding and career development opportunities and how to form international collaborations in the field of DMC; create strategies and a plan of action related to the development of a BR-UK international collaboration on the future evolution of the DCM field of study for economic growth and the social welfare of the poor.

Initially, a group of different leading researchers from this field of study in Brazil and the United Kingdom, formed by Prof. Wyon, PhD Bittar, PhD Valéria Figueiredo (UFG/FEFD), PhD Luciana Ribeiro (IFG), PhD Aline Haas (UFRGS/FEFID)<sup>8</sup>, Prof. Márcia Strazzacappa (UNICAMP/Faculty of Education)<sup>9</sup>, PhD Alexandre Ferreira (UFG/FEFD), PhD Andreja Picon (USP/FM)<sup>10</sup> and Prof. Isabel Sacco (USP/FM),

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<sup>3</sup> UEG/ESEFFEGO in Portuguese stands for Universidade Estadual de Goiás/Escola Superior de Educação Física e Fisioterapia.

<sup>4</sup> FAPEG in Portuguese stands for Fundação de Amparo à Pesquisa do Estado de Goiás.

<sup>5</sup> NIDMS stands for National Institute of Dance Medicine and Science.

<sup>6</sup> UFG/FEFD in Portuguese stands for Universidade Federal de Goiás/Faculdade de Educação Física e Dança.

<sup>7</sup> IFG in Portuguese stands for Instituto Federal de Goiás.

<sup>8</sup> UFRGS/FEFID in Portuguese stands for Universidade Federal do Rio Grande do Sul/Faculdade de Educação Física, Fisioterapia e Dança.

<sup>9</sup> UNICAMP in Portuguese stands for Universidade Estadual de Campinas.

<sup>10</sup> USP/FM in Portuguese stands for Universidade de São Paulo/Faculdade de Medicina.

## INTERNATIONAL WORKSHOP BR-UK DANCE MEDICINE & SCIENCE NETWORK A

started thinking about the dynamics of the workshop. This group of researchers with different experiences in DMC and with the same desire to develop innovative collaborations exchanged several ideas about how the event would be formatted, and how collaborations could be refined in the face of the enormous potential available and the many challenges. Such an initiative was unheard of for the DMS field in Brazil, which had never come together around a common goal or event. It was also unheard of for the UK, which had never set up bridges with Brazil in the form of a DMS Network.

Concurrently, and two months before the event began, colleague MS Clara Fischer, promoter of DMC in Brazil, creator of the page *Dance Science Brasil* on Facebook and a private initiative worker in this area, began to write a series of articles<sup>11</sup> for the blog of the International Association of Dance Medicine and Science (IADMS), the organizing body of DMC in the world, about this field in Brazil. She contacted the members of IADMS in Brazil, namely Adriano Bittar, Aline Haas, Bárbara Marques, Cláudia Daronch, Daisy Machado, Flora Pitta, Izabela Gavioli, Kaanda Gontijo, Márcia Leite and Mariana Bahlis, and interviewed some of them so that articles were made. This resulted in closer ties between some of the researchers of DMC in Brazil, which made the event start to be planned having these members' works and themes of research in mind.

At the beginning, Prof. Wyon also invited PhD Bittar to join him and his staff in Walsall, at the *DMS Research Workshop* which took place at the University of Wolverhampton, in June 2016. Other colleagues such as MS Clara Fischer, MS Bárbara Pessali Marques (who was taking her doctorate at Manchester Metropolitan University/UK) and PhD Aline Haas, also joined PhD Bittar, and travelled to the UK to launch the workshop idea and share their researches with the European colleagues. Through the invitation of MS Fischer and MS Edel Quin, from the Trinity Laban Conservatoire of Music and Dance, PhD Bittar, MS Fischer and MS Marques also participated of the event *The Fourth Dance Science Student and Graduate Networking and Careers Day*, held in London, at the Trinity Laban, in June 2016.

Then, efforts were focused on publicizing a public call in Brazil and the United Kingdom so that those interested in the workshop could sign up. In order to do so, it was necessary that the colleagues had finished their doctorates no more than 10 years ago, and they needed to be fluent in English. However, realizing that this was not the reality of the area in the two regions involved, we ended up opening the call to all interested parties. We selected those who for many years presented in contact with DMS, named by us "seniors", those with the highest degrees and scientific productions in the area, and the stakeholders from different parts of Brazil and the United Kingdom. There were 46 candidates from Brazil and 14 from the United Kingdom. Of these, 19 candidates from Brazil

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<sup>11</sup> Read the first article at: <<http://www.iadms.org/blogpost/1177934/237549/Bridging-Dance-and-Health-in-Brazil-Part-I-The-early-steps-of-an-emerging-field?hhSearchTerms=%22Brazil%22&terms=>>>.

(excluding the coordinator and the two mentors from the workshop) and 12 from the United Kingdom (also excluding the coordinator - Figure 02) were selected to participate in the workshop.

From the United Kingdom, the participants were: Matthew Wyon (coordinator), Liliana Araújo, Frances Clarke, Derrick Brown, Sarah Needham-Beck, Lucie Clements, Christine Bergeron, Ross Armstrong, Moira McCormack, Barbara Pessali-Marques, Erin Sanchez, Nefeli Tsiouti and Janine Bryant. The British group was formed by colleagues who represented 10 very important institutions in DMC, such as the Trinity Laban Conservatoire of Music and Dance, University of Wolverhampton, One Dance UK, NIDMS, Bern University/Amsterdam, Manchester Metropolitan University and Royal Ballet. These specialists were dedicated to different themes in DMC such as: psychology and physical excellence, training and improvement of performance, balance/neurology, cardiorespiratory demands, image and creativity, Pilates, physical evaluation, bone health, street dance, contemporary dance and ballet, among others.

The participants from Brazil were: Adriano Bittar (coordinator), Valeria Figueiredo (mentor), Luciana Ribeiro (mentor), Aline Haas, Isabel Sacco, Clara Fischer, Andreja Picon, Cláudia Daronch, Cibelle Formiga, Maria Eugênia Ghizellini, Debora Cantergi, Janete Hernandez, Tânia Hamu, Izabela Gavioli, Flora Pitta, Marcia Strazzacappa, Flavia Gervasio, Alexandre Ferreira, Julia Ziviani, Diego Pizarro, Fernanda Nora and Ana de Pellegrin. Still entered the Network, after the workshop, PhD Mário Hebling Campos who participated in the opening table of the workshop, PhD Maria Cristina Bonetti, who taught a workshop on Sacred Dances at the event, Assistant Prof. Rafaela Noleto dos Santos, who develops research in the area of DMS, having greatly assisted in the organization of this workshop, and PhD Mônica Dantas, who already had a solid partnership with an English Institution, and acted as a mentor of another participant in this same Network. These colleagues represented several Higher Education Institutions (HEIs), as well as some private institutions, which have also been contributing for the research and the creation of services in DMS. In the Brazilian group there were representatives of 8 HEIs, such as: UEG, UFG, IFG, UFRGS, USP, UNIVERSO, UNICAMP and IF/Brasília (Figure 03). They were involved with subjects such as: improved performance and injury reduction, physical conditioning, biomechanics, Pilates, manual therapies, aerobic capacity, Parkinson's, ballet shoes, neuroscience, adolescents, children, physical evaluations, belly dancing and quality of life, creative processes in contemporary dance, somatic education, postural control, gait and flamenco.

In order to come up with an initial profile of the stakeholders of DMC in Brazil, we drew a few conclusions out of some characteristics of the candidates and participants of the workshop. In terms of enrollment, we found out that of the Brazilian 46 candidates, the highest qualifications were: 8 PhDs - senior researchers (finished their PhDs more than 10 years ago, nominated by us as "inaugurators of the area in the country"); 7 PhDs (early career researchers, with up to 10 years of

experience); 5 PhD students; 7 Masters; 4 Master students, 7 Specialists; 1 Graduate; and 6 Graduate students. One candidate was a Professional Dancer and Performer (Figure 04).

This data clearly demonstrates the interest and involvement of Brazilian academics in this workshop. This result was expected, since most of the workshop's dissemination was done focusing on this audience, since the project also had goals that met the interests of these researchers. But the results also seem to point to the fact that the Brazilian DCM has been developed primarily in the academic environment. While the historical commencement of DMC around the world took place in companies and dance schools that were concerned with the health of students and professionals, this scenarios was changed since the development of dance courses in universities and the support of private and non-profit institutions to dance. But in Brazil, while services for dancers continued to develop timidly in isolated places, namely, some professional dance companies and certain private institutions such as Pilates or fitness studios, research in this area has happened mostly in Brazilian universities. Therefore, the larger public outside the university is still unaware of how to become involved with DMC, both as a work area, or even as beneficiaries of DMS-related services.

Thus, a dichotomy in Brazil seems to have been established between services that provide care for dancers and research in the area, where "laboratory" discoveries are slowly absorbed by dancers, dance teachers in the classroom, by physicians, and all health team that deals with dancers and dance practitioners. Furthermore, we think that DMS is still not well established in Brazil and that the chain of production related to it cannot find a suitable way to generate products and consume what it produces. This is due to the lack of knowledge of and interest/investment in this area.

Attention was drawn to the fact that of the 8 senior PhDs, who were mostly invited personally by the organization of the event, some did not consider themselves able to collaborate with the DMS area, since they were not professionals that could be considered as dealing with the medical area. Others, working with research in the medical field, felt little inclined to invest in the artistic area/DMS, even though they had primarily built a professional reputation out of dance. This demonstrated that DMS is still ignored in its broader scope of practice in Brazil, which encompasses the narrow concept of health available for most of the health professionals, in which artists and scientists, or artists-scientists and scientists-artists, forget to deal directly with the body that dances in a perspective of functional integration and the search for an expanded poetic potential, as long as the health and poetic parameters are taken into account. Moreover, this seems to point to the fact that the relationship between dance and medicine is still isolated and stiffened, that is to say, self-absorbed, non-hybrid and diluted with respect to considering one another as intertwined areas of knowledge.

Regarding the areas of research and themes in demand, it was noticed that biomechanics was dominant in the Brazilian DMS. Soon after, the processes of composition, training and education in

DMS were followed. Pilates and somatic education were other subjects quite present, as well as neuroscience. These results point, in an initial analysis, to the fact that the great development of the area of the mechanics of biological systems in Brazil, first in the courses of Physical Education and after Physiotherapy, affected Dance in full. In a way, it seems that the laboratories and know-how already developed can, more fluidly, be used with greater readiness and dexterity to unveil the motor and poetic phenomenon in dance.

### Conclusion

This article presents an overview of the dynamics of the workshop *The Potentials and Challenges of Research in Dance Medicine & Science: building innovation collaborations between the UK and Brazil* and the formation of the BR-UK DMS Network, showing data that give us an excellent notion of this area in Brazil, even though the information gathered has still been explored without the possible depth. In addition to a better understanding of the DMS area in Brazil, the results presented have led us to consider innovative initiatives and collaborations that can lead to the development of services, research and educational opportunities for both dancers and professionals involved in dance.

We hope that this expanded summary can generate even greater interest from professionals working with dance in Brazil and UK, so that they can become involved with the actions of the Network, in an attempt to make them less circumscribed to the academic environment.

In later articles we want to clarify why there is still a perception that services in DMS are inaccessible. We would still like to reflect on the existing perception of the distancing of what happens in the academy with society, making access to partnerships difficult; and why the Brazilian dance itself has not yet found great support from public and private initiatives that could take some responsibility for health and care of the dancers. We will also be able to reflect on the reasons why there are other public and private non-profit institutions in the UK that have already begun to invest in this area. It might be the case that they have been able to clearly demonstrate what is DMS, making it visible what benefits can be generated when it is in play. In the United Kingdom it is well known that the dancer who has access to DMS can improve his or her performance, extending it for a longer time, as well as use what he/she knows to teach and deal with issues related to well being, quality of life and the formation of new dance artists and other dancing citizens who can make all the difference in the society in which they live.

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## PROFILE OF INJURIES IN DANCE: AN EPIDEMIOLOGICAL ANALYSIS OF SIX STYLES

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### Summary

Dance is an artistic practice with high physical and psychological demand. The bodies differ according to the style, choreographer and school where the dancer was trained, and this heterogeneity makes it difficult to investigate the patterns of exposure to injury. A standardization of the studies on the etiology of dance lesion is necessary to standardize the variables that in fact influence its occurrence. The objective of this study was to trace the lesion profile in 6 dance styles, relating this lesion profile with age and type of injured tissue. 799 questionnaires were answered via the web, containing closed questions about the routine of the dancers. The preliminary results of this analysis showed that of the analyzed styles ballet, belly dance, flamenco, street dance, contemporary and jazz, the modality with the highest number of injuries was jazz, with 95.87%. Of these lesions, the articular tissue was the most cited, mainly cartilaginous, with 50.53%. The age group most affected was between 20-24 years, standing out the specific age group of 20 years, with the percentage of 93.33% of occurrence.

**Key-words:** Injuries; Dance; Epidemiology.

### Introduction

Dance is an artistic practice defined by the body in motion submitted to a context of time and space, expressing the habits of a society. It requires high physical and psychological demands<sup>1</sup>. The bodies differ greatly according to the style, choreographer and school where the dancer was trained. This heterogeneity makes it difficult to investigate the patterns of exposure to injuries<sup>2, 3, 4, 5, 6</sup>.

When the dancer's body becomes restricted or incapable of this expression, due to the pain resulting from injury, concomitantly the execution of the movements decreases in intensity, volume, technical quality, range of motion and impact<sup>7</sup>.

There are many definitions of injury in dance, however, for this study, it is understood as an impediment of the dancer in whom some adaptation of his gestures is necessary; a withdrawal from dance, as loss of activity (class, rehearsal or presentation) full time, of one or more days, according to the affected tissue; a limitation in their daily activity; or the dysfunction of any anatomical tissue

diagnosed by a health professional<sup>8, 9, 10, 11, 12</sup>. The risk factors found are innumerable and diverse in nature.

The objective of this study was to trace the injury profile in 6 dance styles, relating this injury profile to age and the injured tissue.

## Methodology

The construction of the questionnaire was done through the consensus of a committee of 10 specialists in the health area. The questionnaire was sent to experts, who opined about each questioned item. When all the experts agreed with the questionnaire, its final version was formulated for application.

The questionnaire has 16 closed questions about dance style and routine of the dancers, such as: practice time, frequency of classes, injury and injury location. 799 questionnaires were answered via the web. Participants reported their main style of dance, and the occurrences were: ballet, contemporary dance, belly dancing, flamenco, jazz and urban dances.

## Results and Discussion

It is a fact that injury can end a career in dance, and it is also a consensus among researchers that dance can injure. Studies point out risk factors that cause these injuries, such as fatigue, malnutrition, proprioception, footwear and flooring, among others, that will be further studied later. Many authors report the lack of standardization of data collected in research that addresses the issue of health/injury in dance. However, little is known about how to effectively prevent them and even how to detect them on an early stage.

The constant practice of a poor technique, with alterations of postural and joint alignments, can also be considered a high risk factor. Corrections should be made in the classroom, or by the choreographers responsible. These changes reproduce compensatory movements, reducing the economy of movement and also increasing the risk of injury. There is an effective difficulty in detecting these inadequacies<sup>13, 14, 15</sup>. The risk may increase further when the dancer forces the end range of the movement in order to improve its elasticity and the angle of the range of motion. They exaggerate to obtain the desired aesthetic<sup>16, 17, 18</sup>.

Mayers<sup>19</sup> stresses that improper physical preparation can lead to injury. Lack of warm-up or stretching before or during practice can be a cause of exponential injury<sup>20</sup>, as well as the intensity of training<sup>21, 22</sup>.

Preliminary results of the analysis of the questionnaires applied to dancers showed that jazz, with 96% of the participants (Fig. 1<sup>12</sup>), was the style with the highest number of injuries in the analyzed styles - ballet, belly dance, flamenco, street dance, contemporary and jazz.

Jazz is an Afro-American dance with the fusion of American ballet, and it was recognized in Broadway musicals, being very present in American cinema. It can be described as a body manifestation accompanied by several rhythmic, simultaneous and syncopated movements<sup>23</sup>. Jazz also bares similarities to classical ballet, but the speed of its movements may be greater, muscle contractions are more vigorous, and joint range of motion can also be worked at the extremes. The high incidence of injury observed here can be credited to these great physical demands and also to the fact that it is not a modality of codified dance and with systematized teaching standards.

Observing the literature, the risk factors for dance injuries already identified were innumerable, both of intrinsic and extrinsic natures. Lack of rest in the dancer's routine can be a potential injury risk. The need for rest in dancers can be interpreted as a lack of physical or mental compromise. Dancers are constantly encouraged to persist in their activities, despite being known that excessive use of the body, resulting from high intensity, duration and frequency of an activity, is an exposure factor that contributes to tissue fatigue and possible injury<sup>24</sup>. Discomforts, fatigue and pain are symptoms that are continually ignored by dancers who persist in maintaining their activities<sup>25</sup>.

The age group most affected in the studied sample was between 20-24 years, with a highlight for 20 year-olds, with a 93.33% incidence of injury (Fig. 2). This may be related to the intensity of exposure in which the dancers are submitted at that age. Studies report that from the age of 18, the period of ascension of the dancer's career, the dancer is in the ideal stage of realization of the dance career<sup>26</sup>.<sup>18, 19</sup>. For this reason, the dancers dedicate themselves as much as possible, and the demand for labor increases vigorously as well as the physical demands<sup>27</sup>.

According to Tajet-Foxell and Rose<sup>28</sup>, dancers have a high threshold for withstanding pain. One of the reasons for this high tolerance is justified by the fact that they are subjected to extreme physical training and are permanently stimulated by psychological factors to endure pain and prove their dedication to dance. Students who hide pain in an attempt to please or gain approval of their teachers, end up increasing their exposure to injury<sup>29, 30</sup>.

Authors advocate a scary calculation for injury rate in dance - every 1000 hours of exposure; meaning that at least one injury will occur every 1000 hours of dance<sup>9, 10, 31, 32, 33, 34</sup>.

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<sup>12</sup> For figures 1, 2 and 3, please refer to the study in Portuguese.

The change in proprioception is also a relevant factor in the appearance of lesions, which can be caused by the lack of rest from the routine of the dancers, which is encouraged to achieve aesthetic perfection to transmit a significant and differentiated beauty through a repertoire of movements<sup>35, 36, 37</sup>. It is believed that this factor may be related to the mechanism of injury of the articular tissues, mainly ligaments and cartilages, where there is the highest concentration of mechanoreceptors<sup>38,39</sup>.

Of the injuries reported in this study, the articular tissue was the most cited, mainly cartilaginous, with 50.53% (Fig. 3). We speculate that this result may maintain some relationship with overuse injuries and the co-related negligent pain behavior.

Other factors also reported are beyond the area of physical therapy, such as nutrition and psycho-emotional health<sup>40</sup>. The tradition of the pain culture in dancers, choreographers, and directors, that stimulate to surpass and transcend, is perceived independent of the damage that it can cause<sup>41</sup>.

## Conclusion

The present study concludes that of the 6 styles studied, the one with the highest injury index was Jazz, in the age group between 20-24 years old, pointing the cartilaginous tissue as the most affected. We speculate that such injuries may have occurred due to overload and lack of adequate physical training. Detecting, understanding the etiology and alerting dancers to the risks they face are concerns that will guide future research, in an attempt to protect the dancer's health and stimulate the longevity of their careers.

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## ANTHROPOMETRIC CHARACTERISTICS AND FUNCTIONAL PERFORMANCE OF TYPICAL CHILDREN AND ADOLESCENTS

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### Summary

The evaluation of child development is extremely important to analyze the performance of children and adolescents within school activities and social participation. The objective of the present study was to analyze the anthropometric characteristics and functional performance of children and adolescents with typical development. The sample consisted of 93 children and adolescents of school age (8 to 14 years old), of both sexes, who attended a public school in the city of Goiânia - Goiás. Anthropometric measures and functional tests were performed with participants after parent's consents. The data was analyzed in the Statistical Package for the Social Sciences (SPSS) program. Regarding the anthropometric characteristics, the results were: Body Mass Index of 19.97 kg/m<sup>2</sup>, right thigh length was 39.72 cm, left thigh was 39.60 cm, right leg was 44.19 cm and the left leg was 40.17 cm. Regarding the results of the functional tests: in the Six-minute Walk Test the distance traveled was 426.17 meters, the Timed Up and Go Test (TUG) was performed in 6.68 seconds and for the test sit-stand, means averages were: 4.6 for the sit and 4.4 for the stand up. We conclude that the values found can be used as reference for future studies for children and adolescents with typical development and dancers.

**Keywords:** Pediatrics; Functionality; Child development.

### Introduction

Child development is a continuous process that needs to be attained at appropriate levels so that the experiences of children are satisfactory. Among these processes we can highlight the development of motor coordination, postural control, balance, concentration and manual skills. The normal movements in the school phase are increasingly controlled, coordinated and fast<sup>1</sup>.

During childhood, as a consequence of the rapid development of the central nervous system, it is fundamental that a wide and adequate variation of environmental stimuli occurs, favoring motor, cognitive and affective-social development. In adolescence, there are biological alterations associated with the peak production of the hormones testosterone in the male gender and estradiol

in the female, with great variability related to age, which entails the need to adjust the motor stimuli according to the stage of biological maturation and previous experiences<sup>2</sup>.

Developmental analysis needs to be performed as early as possible so that motor development delays are corrected and do not extend into adulthood. Thus, risk factors for development issues should be eliminated whenever possible<sup>3</sup>. These delays can be caused by dysfunctions of neurological and musculoskeletal origins<sup>4</sup>.

During this period of life, biopsychosocial changes influence eating behavior and nutritional status, with anthropometry being a methodology used for nutritional assessment, as it is a useful method in clinical or interventional studies, which is easy to perform and low cost<sup>5</sup>. For the evaluation of the children, the body fat, weight and height estimates are used according to reference curves<sup>6</sup>.

Functional mobility is the necessary skill to perform daily functions, such as: sit, stand, move, walk and transfers. It is necessary to have adequate range of motion, muscle strength and coordination to achieve it, and it can be evaluated by different measuring instruments<sup>7, 8, 9, 10</sup>.

The general objective of this research is to analyze the anthropometric characteristics and functional performance of children and adolescents with typical development.

### Methodology

The study sample consisted of 93 children and adolescents, aged 8 to 14 years, regularly enrolled in the Institute of Education of Goiás - IEG. The study was approved by a Research Ethics Committee. Inclusion criteria: children between the ages of 8 and 14, of both genres, enrolled regularly in the morning school period. Exclusion criteria: children with orthopedic problems (e.g. congenital clubfoot, hip dislocation, etc.) or neurological issues (cerebral palsy, Down's syndrome, etc.); children who refused to participate in the study or whose parents did not provide legal consent through the ICF.

To achieve the objectives of the present study the following instruments were used in the evaluation process:

- Anamnesis script included: the identification data of the child or adolescent (age, sex, schooling) and parents (age, schooling, profession, address, telephone), data referring to the gestational, perinatal and postnatal histories of the child, current health data, anthropometric data such as weight, height and Body Mass Index (BMI);

- Sit-Stand up Test: this test was performed on a non-slip flat surface, with the evaluator positioned in a place that allowed assessment of the entire movement, to perceive the imbalances, the need for support and the usage of support when necessary. The evaluated should wear clothes that did not restrict movement and be barefeet. Behind the patient was placed a mat so that he sat in the command to sit, but his feet should be off the mat when standing, avoiding possible imbalances. For the graduation of independent dexterity in the two actions, an ordinal, discontinuous and increasing scale, ranging from zero to five, is used<sup>9</sup>;

- Six-minute Walk Test: this is a practical walking test performed on a flat surface for a period of six minutes. It is able to estimate the patients' submaximal functional capacity by measuring the distance traveled<sup>11</sup>. During rest, the following data is assessed: subjective effort sensation, heart rate (HR), peripheral oxygen saturation (PSO<sub>2</sub>) and respiratory rate (RR). The systolic blood pressure (SBP) and diastolic blood pressure (DBP) were also checked one minute before and one minute after walking. At the beginning and at the end of the test, information regarding dyspnea and lower limb pain was obtained by the analogue-visual scale (Borg Scale). This is a scale ranging from 0 to 10. A value of zero means no dyspnea, and a value of ten corresponds to maximum dyspnea and pain<sup>12</sup>;

- Timed Up and Go Test: the TUG test consists of getting up from the chair, walking 3 meters, touching a star figure on the wall, making the turn, returning towards the chair and sitting again. The child was instructed to walk normally, without running, and should only get up from the chair when the examiner said "Go". The test was performed for three times and the best value presented was considered. Time was calculated in seconds through a timer, starting when the examiner said "Go" and stopped when the child sat in the chair<sup>8, 13</sup>.

The data collected was analyzed in the Statistical Package for Social Sciences (SPSS) program, version 15.0, and the absolute variables were considered for the calculation of the average, standard deviation, minimum and maximum values. The relative variables were considered for the calculation of frequency and percentage.

## Results and Discussion

The sample consisted of 93 children and adolescents, with a mean age of 12.47 ( $\pm 1.47$ ) years, of which 57 (61.3%) were female and 36 (38.7%) were male. The children and adolescents had a mean height of 1.56 meters ( $\pm 0.11$ ), weight of 49.56 kg ( $\pm 13.23$ ) and Body Mass Index of 19.97 ( $\pm 3.53$ ), being classified as eutrophic. The anthropometric characteristics of the children and adolescents participating in the study are described in Table 1<sup>13</sup>.

The scores of the functional tests performed with the children and adolescents of the study are shown in Table 2.

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<sup>13</sup> For Tables 1 and 2, please refer to this study in Portuguese.

According to the results presented in Table 2, it was observed that the distance covered in the 6-minute Walk Test was 426.17 meters ( $\pm 76.43$ ). In a study conducted by Li et al<sup>14</sup> with healthy children with a mean age of 14.2 ( $\pm 1.2$ ) in a Chinese school resulted in a distance covered of 659.8 meters ( $\pm 58.1$ ) for the total group (74 individuals). Separating boys (31) and girls (43), the results of the distance traveled were, respectively, 691 ( $\pm 66.3$ ) and 637.4 meters ( $\pm 38.6$ ). So, this result does not agree with that of the present study.

The study conducted by Martins et al<sup>15</sup> carried out four Walking Tests with 29 children with mean age of 10.28 years ( $\pm 2.25$ ), the first two of which presented the following results: 569.59 meters ( $\pm 86.96$ ) and 564.06 meters ( $\pm 80.85$ ), while the latter two being 556.45 meters ( $\pm 74.61$ ) and 554.19 meters ( $\pm 76.19$ ).

Regarding the results presented in Table 2 for the duration of the Timed Up and Go test, we found a time of 6.68 seconds ( $\pm 1.25$ ). In a study conducted by Butz et al<sup>16</sup> with 160 healthy children between 5 and 12 years (these children were stratified into 20 children for each age), the result obtained for children aged 12 years was 3.83 ( $\pm 0.72$ ) seconds, disagreeing with our study.

A study of 24 children with traumatic brain injury (16 boys and 8 girls) and 24 children with typical development aged 7 to 14 years found in their study that the TUG time for children with typical development was 5, 8 second ( $\pm 0.6$ )<sup>17</sup>.

The distance walked in the Six-minute Walk Test by children and adolescents was lower than in the other studies, and the same was true for the time spent in the TUG test, showing that the children and adolescents in the present study had lower functional performances when compared to the other studies.

In our study for the Sit-Stand up Test, we obtained averages of 4.4 points to stand up and 4.6 points to sit, and 34 (36.2%) of the children and adolescents took the maximum mark to sit and 43 (45.7%) to stand up. We also compared the results obtained in relation to the maximum score when sitting and standing and found that 22 (23.4%) children performed the test with a maximum score in both situations. A study conducted by Nunes, Araújo and Sedlmaier<sup>18</sup> with the sample of 40 children and a mean age of 12.5 ( $\pm 1.5$ ) years, showed that 14 (35%) children performed the test without faults due to imbalance, disagreeing with the present study, as well as with the study of Silva, Camper and Salles<sup>19</sup>, where 31 (83.8%) children performed the test with a maximum score for the two parameters analyzed.

## Conclusion

The study sample was of eutrophic subjects with typical development. The values for the functional tests and the length of lower limbs can be used as reference values for future studies. Normative values are important when the purpose of the study is to compare normal development children and adolescents with some children and adolescents that have motor impairment or who engage in some specific physical activity, such as dance.

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## A COMPARISON OF DIFFERENT EQUIPMENT USED TO MEASURE AND TRAIN FLEXIBILITY

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### Abstract

Flexibility is the capacity of a muscle to reach a range of motion (ROM) in a joint. However, the measurement of the ROM does not explain the behaviour of the muscle tendon unit (MTU) when stretched. Therefore, it is necessary to consider other parameters such as time and applied tension, beyond the ROM, to analyse the behaviour of the MTU after a stretching exercise. Considering the lack of equipment that could measure the described biomechanical and sensory variables to understand the MTU behaviour during the stretch, especially in flexibility trained populations such as dancers, the aim of this study was to analyse the potentials and limitations of the equipment used in previous researches and the Flexibility Test Equipment. A survey of the equipment already existing in the literature was performed and compared with the Flexibility Test Equipment. Then, the potentials and limitations regarding the volunteer positioning and variable measurements were analysed and compared. Six different pieces of equipment were found in the literature to measure flexibility from 1996 to 2014. We concluded that the The Flexibility Test Equipment is the only equipment able to measure all the biomechanical and sensory variables that are necessary for the multidimensional evaluation of flexibility and to understand MTU behaviour during stretching protocols.

**Key words:** Stretching; Muscle-tendon unit; Multidimensional; ROM; Flexibility test.

### Introduction

Flexibility is the capacity of a muscle to reach a range of motion (ROM) in a joint<sup>1,2</sup>. The ROM is usually used to represent this capacity, which is commonly measured in degrees. However, the measurement of the ROM does not explain the behaviour of the muscle tendon unit (MTU) when stretched<sup>3</sup>. Recently, Weppeler and Magnussun<sup>3</sup> (2010) have highlighted the necessity of considering other parameters such as time and applied tension, beyond the ROM, to analyse the behaviour of the MTU after a stretching exercise.

The increase in the ROM may be explained by two properties of the muscle-tendon unit: the biomechanical and the sensory properties. The biomechanical property is related with the MTU adaptations and the viscoelastic and neuromuscular relaxation. The mechanical property may be represented in the Length vs Tension curve as a shift to the right after the stretching protocol, which may result in a greater ROM with the same applied torque. The sensory property is related to the modifications in the tolerance of stretching and may be represented by an increase in the ROM without any shift of the curve<sup>3</sup>.

The behaviour of the MTU during the stretching protocol may be explained by the viscous and elastic characteristics, which together make the muscle behave as a viscoelastic material<sup>4,5</sup>. To understand

this behaviour, it is necessary to measure variables other than the ROM considering both the biomechanical and sensory properties.

The stress relaxation is the accommodation of MTU tissue, which is the difference in torque when an angle is reached and maintained constant per a determined time<sup>5</sup>. The creep is the increase in the angle when the torque is maintained constant<sup>6</sup>. The stiffness is the variation of torque divided by the variation of ROM obtained in the Length vs Tension curve. The slope in the curve represents this, while the area under the curve represents energy. This refers to the potential energy stored by the muscle during the stretch. The first sensation of stretch is classed as the beginning of the stretch, which happens when the participant feels a tension in the muscle. Maximal discomfort tolerated is commonly used as the end of stretching, or maximal ROM point<sup>6</sup>.

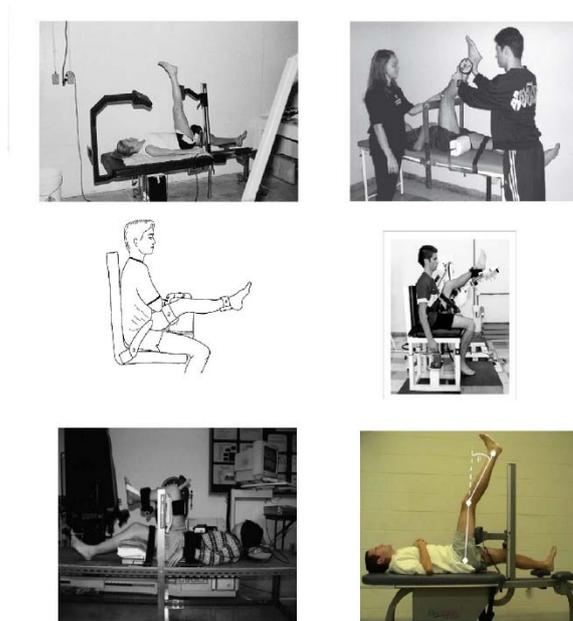
Considering the lack of equipment that could measure the described biomechanical and sensory variables to understand the MTU behaviour during the stretch, especially in trained in flexibility populations such as dancers, the aim of this study was to analyse the potentials and limitations of equipment used in research and the Flexibility Test Equipment developed in the Biomechanics Laboratory of the Excellence in Sports Centre at Physical Education, Physiotherapy and Occupational Therapy of Federal University of Minas Gerais, Belo Horizonte, Brazil.

### Methods

A survey of the equipment already existing in the literature was completed and compared with the Flexibility Test Equipment. Following this, the potentials and limitations regarding the volunteer positioning, and variables measurements were analysed and compared.

### Results and Discussion

Six different pieces of equipment were found in the literature to measure flexibility. The pieces of equipment which have been used from 1996 to 2014 are presented in Figure 1.



**Figure 1.** Equipment used by Burke et al. (2000), Chagas et al. (2008), Magnusson et al. (1996) and Magnusson et al. (1998), Cabido et al. (2014), Chan et al. (2001), Blackburn et al. (2004), respectively.

As can be seen in image 1 (Figure 1), Burke et al.<sup>7</sup> (2000) have performed the stretching through the flexion of the hip with the knee extended. This positioning allows pelvic movement and the hip retroversion may be confused with training effects. Moreover, the lower limbs, both the stretched and the non-stretched, were not properly attached to the equipment, which may have allowed other accessory movements and could be confused with flexibility improvements. Furthermore, this equipment did not allow measurements of the resistance torque nor the first sensation of stretch.

The image 2 (Figure 1) is from Chagas et al.<sup>8</sup> (2008). They have used an apparatus in which the positioning of the participants was well established. The volunteer was better fixed to the equipment using straps with the hip flexed 90 degrees, thus the knee was passively extended. These adjustments have minimized accessories and pelvic movements, however, not all flexibility parameters were accessed. The torque and the first sensation of stretch were done. Furthermore, the maximum ROM measured by the equipment excludes the evaluation of trained in flexibility volunteers, since the maximum ROM was the knee extension with the hip flexed at 90 °.

Magnusson et al.<sup>9</sup> (1996) and Magnusson et al.<sup>10</sup> (1998) (image 3 – Figure 1) have also taken care of the participants' positioning with straps. Besides the fact that the maximum measurable ROM was greater, once the participants were sat and the thigh was flexed 45 degrees from the horizontal axis, the evaluation of trained in flexibility participants was still inappropriate. Both ROM and resistance torque were measured, but not the first sensation of stretch.

Image 4 (Figure 1) shows Cabido et al.<sup>11</sup> (2014) equipment. They have used a device that was able to measure all parameters for a multidimensional assessment of flexibility, ROM, resistance torque and first sensation of stretch, however, this equipment remained restricted to flexible people, allowing research only with those untrained in flexibility.

Chan et al.<sup>12</sup> (2001) have used a device in which the volunteer remained lying (image 5 - Figure 1). The ROM and resistance torque were accessed but not the first sensation of stretch. The volunteer was well positioned and strapped in the equipment avoiding any accessory pelvic movement. The stretching was performed by passive extension of the knees, however, the maximum measurable ROM was the full knee extension with the hip flexed 90°.

The equipment showed in the image 6 (Figure 1) was used by Blackburn et al.<sup>13</sup> (2004), and it only evaluates the active ROM of knee extension, remaining with all the inability to measure the flexibility as a multi-dimensional capability as previously reported.

The Flexibility Test Equipment (Figure 2) allows the measurement of the right and left lower limbs separately during the passive knee extension with the participant lying supine on the equipment. Each one of the arms has two segments, one aligned to the calf and another aligned to the thigh. Together, these segments allow the movement and measurement of the hip and knee joints angles. When laying supine, the segment of hip flexion allows the positioning from 0° (thigh parallel to the table and floor) to 160° of hip flexion. The segment of knee extension allows the positioning from 30° to 180° (knee completely extended). It is possible to establish and fix the hip segment angle between these freedom angles and measure the knee segment ROM, once the knee is free to be extended and to stretch the volunteer until the maximal knee extension (180°).



Figure 2. Flexibility Test Equipment.

The knee extension ROM is recorded by potentiometers located in the rotation axis of the knee in the equipment. The angle speed of the equipment lever arm during the stretch is maintained constant in  $5^{\circ}/s^{1/2}$  when the movement is passive. At the distal portion of the equipment segment was a load cell and its position is adjusted in the ankle of the participant according to individual leg size. To minimize compensatory movements in the contralateral lower limb, straps are used on the anterior superior iliac spines and distal third of the thigh. During the ROM measurements, a control is given to the volunteer that should press the button when the first sensation of stretch is perceived in the hamstring muscles.

The purpose of this equipment was to enable a multidimensional approach of flexibility and allow the evaluation of flexible participants through proper body positioning. This equipment follows all of the volunteer placement requirements. The measurement by passive knee extension and not by hip flexion decreases compensatory pelvic movements that can be confused with the real gain of ROM. Proper fixing of both lower limbs strapped in the equipment also decreases the compensatory movements during stretching. The equipment assesses all the necessary parameters for a multidimensional evaluation of flexibility: ROM, resistance torque and first sensation of stretch. It allows the positioning of the volunteers with the contralateral to the stretched limb in an elongated position, and finally, gives the possibility of increasing the hip flexion of the stretching limb from  $90^{\circ}$  to  $160^{\circ}$  of hip flexion, which enables the use of the equipment for all the populations from non-trained individuals to trained in flexibility athletes, as dancers, gymnasts and wrestlers.

## **Conclusion**

In conclusion, we understand that the Flexibility Test Equipment is the only equipment found in the literature able to measure all the biomechanical and sensory variables that are necessary for the multidimensional evaluation of the flexibility and to understand the muscle-tendon unit behaviour during stretching protocols. The participant is positioned and fixed properly in the equipment avoiding any compensatory movements and the maximal ROM achieved allows the evaluation of individuals with low and high levels of flexibility.

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## EVALUATING THE RELATIONSHIP BETWEEN FATIGUE, PRESSURE AND WEIGHT DISTRIBUTION ON THE UPPER LIMB IN BREAKERS

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### Abstract

Fatigue is a leading perceived cause of injury among contemporary and ballet dancers. Many Breaking movements require accuracy and stability of the upper limb in weight-bearing positions. The purpose of this study was to investigate the effect of a fatigue protocol on upper limb weight distribution, pressure and stability during breaking movements. The study took place at a performing arts medicine department within an institute of sport in the UK. Data was collected on 30 breakers (28 males, 2 females), mean age of 25 years old (range 18-41), mean height 1.71m (range 1.51-1.83m), mean body mass 68kg (range 52-84kg). Each participant performed a warm-up and three breaking movements (baby freeze, air baby, bronco) pre and post a breaking-specific fatigue protocol. The fatigue protocol was designed to fatigue particular muscle groups, mimicking a training session, and consisted of Breaking movements. Participants repeated the fatigue protocol until they reached an RPE of 20 (Borg scale) and then performed the same three breaking movements again. A pressure plate (RS scan International) was used with a 500Hz sampling rate, 100 frames per second for 10seconds. There was significant difference in the COP of the baby freeze and in the peak force of the bronco, pre and post fatigue. Fatigue has a significant negative impact on the stability of certain foundational breaking movements. Fatigue may also reduce the force with which breakers perform certain foundation breaking movements. Fatigue appears to have a significant effect on the relationship between pressure and weight bearing through the upper limbs when performing foundational breaking movements.

**Key words:** Breaking; Dance Science; Breakalign; Bboy.

### Introduction

Breaking (also known as 'breakdance' by the media) is a highly popular dance form with a global participant base. It is the main dance style under the umbrella of the artistic elements of 'hip-hop'. Breaking is characterised by the combination of dancing upright on the feet, as well as weight-bearing movements on different limbs and body parts such as knees, head, shoulders, with acrobatic features, often using a relatively explosive quality of movement in comparison with other dance forms. It is based on an established foundation of movements from which dancers develop an individual and creative movement repertoire.

Although self-report, epidemiological data is limited, and measures differ across studies, injuries appear to be common in both professional and amateur breakers<sup>1</sup>. The upper limb is affected three to four times more in breakers than in ballet or modern dancers (especially at the wrist/hand, finger,

shoulder and elbow). Injuries have a wide range of biopsychosocial and economic impacts through disability incurred through the impact on the individual's ability to dance but also other aspects of daily living and work.

Although high rates of injury are perceived among Breakers, little research exists concerning the epidemiology of injuries in this group, or comparison of injury rates between Breaking and other dance genres. There have been many case study reports or medical reports, dating back in the 80s, and published by physicians who have treated breakers, but information has been limited generally, with the causes of injury not having been examined at the time<sup>2, 3, 4, 5</sup>.

Ojofeitimi et al.<sup>6</sup> (2012), conducted a survey on injury incidence in several dance genres, including Breaking, and concluded that there is a higher prevalence of musculoskeletal injuries among breakers than in non-breakers; it is important to note that non-breakers in that study included lockers, poppers, house dancers, krumpers and hip-hop dancers. In the same study, injury incidence in breakers specifically reached 278% per person, which consists of an average of 3.5 injuries per dancer in the duration of 6 months, a number higher than that of gymnasts. It is not clear how these injuries are caused however. In the same study, the most common self-report injury sites were foot / ankle, forearm / wrist, hand, hip and knee<sup>6</sup>. This information juxtaposes the patterns reported by Kautner et al.<sup>1</sup> (2009), who found spine, knee, shoulder, skin and wrist / hand to be the most commonly reported injured parts of the body in breakers<sup>1</sup>.

Fatigue is a leading perceived cause of injury among contemporary and ballet dancers in the UK. Many Breaking movements require accuracy and stability of the upper limb in weight-bearing positions. It is well established that fatigue can deleteriously affect human performance. Among dancers, fatigue can result in injury through increased three dimensional motion and load, and progressive misalignment through complex interactions between neurological, muscular and psychological components<sup>7</sup>. Breakers cited fatigue as the cause of 57% of injuries, and mechanisms of injury relate to complex physical demands of acrobatic movements such as landing, twisting or slipping. Many of the foundational movements in breaking, in particular those relating to more acrobatic components, involve dynamic weight bearing, balance, jumping and landing by the upper limbs, requiring the processing of high intensity multidirectional forces.

As stated, previous research suggests that the relationship between fatigue, pressure and weight distribution is an important component of understanding mechanisms of injury. The aims of this study are 1) to investigate the effect of a breaking-specific fatigue protocol on upper limb weight distribution, pressure and stability during breaking movements and 2) to develop an understanding of how and why individuals become injured, and start building a research foundation to develop

methods to prevent such injuries occurring. It was hypothesized that there would be a difference in the centre of pressure and the weight distribution on the upper limb, pre and post fatigue.

## Methods

The study took place at a performing arts medicine department within an institute of sport in the UK. It was a collaboration between a breaking health initiative and a dancer' support organisation. The study received ethical approval.

**PARTICIPANTS:** Data was collected on 30 breakers (28 males, 2 females), which were sourced from the regular training locations in London. Their mean age of 25 years old (range 18-41), mean height 1.71m (range 1.51-1.83m) and mean body mass 68kg (range 52-84kg). The level of the participants ranged from intermediate to professional, which was determined by the hours of breaking activity every week, as well as the national and international competition frequency for each person. The participants completed injury reporting questionnaires with exclusion criteria.

Participants performed a standardised warm-up and three breaking movements; the: baby freeze (Figure 1), the air baby freeze (Figure 2) and the bronco (Figure 3).



**Figure 1.** Baby freeze. **Figure 2.** Air baby freeze. **Figure 3.** Bronco. Note. Copyright. N. Tsiouti.

Participants then repeated the fatigue protocol until they reached a Rate of Perceived Exertion (RPE) of 20. The same three breaking movements were repeated post fatigue protocol. The fatigue protocol was designed to fatigue particular muscle groups, mimicking a training session, and consisted of breaking movements (CCs, six-steps, shuffles, press-ups). It is visible on figures 1-3 that the hand that is placed on the pressure plate, is the dominant hand for each movement and each participant; the second hand was placed outside the platform. The height that they got into the movement from (from standing), was not standardised, as this would alter the technique of each dancer. The use of half the pressure plate was used as the surface for collecting data from.

INSTRUMENTS: A pressure plate (RS scan International, 7.7 second edition, Belgium) was used with a 500Hz sampling rate, 100 frames per second for a period of ten seconds. HERO3 Black Edition v03.00 cameras were used to record the different dance moves.

### Results and Discussion

The centre of pressure (COP) was measured, along with the peak force and the area of the hand during the breaking movements, for the duration of contact with the pressure plate. Both baby freeze and bronco movements include a jumping quality into the movement. The air baby freeze is a movement with less velocity before contact, due to the whole body supported next to the tricep, which requires a very precise placement of the body on that body part.

BABY FREEZE: Similar peak force was created from the baby freeze pre and post fatigue. There was significant difference in the mean COP pre and post fatigue. This showed that fatigue has a significant impact on the way in which forces are processed, and responded to, during getting into a baby freeze, as well as a reduction of stability due to fatigue.

AIR BABY FREEZE: No significant difference pre and post fatigue protocol.

BRONCO: COP and area showed no difference between pre and post fatigue. Peak force showed statistically significant difference between pre and post fatigue with a lower peak force post fatigue protocol. This was a result of potentially reduced muscle power when fatigued, therefore reduced speed getting into the freeze, and protective mechanism where the fatigued dancer deliberately uses less force going into the movement due to an awareness of reduced stability/increased risk.

Lack of significant differences pre & post fatigue protocol may be because: the effect size may have been smaller than this study was powered to detect and these factors may not be affected by fatigue. This would suggest the findings are important negatives. These findings correspond to previous research that links alterations in weight bearing, stability and alignment to injuries in dancers (Figures 1 and 2).

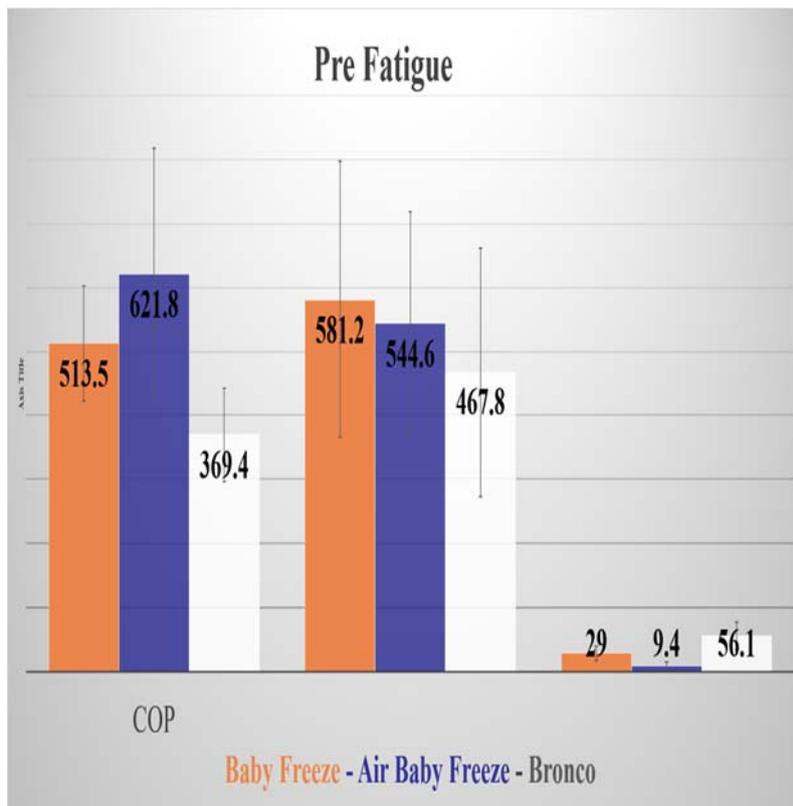


Figure 1. Pre fatigue COP, Peak Force and Area of the Baby Freeze, Air Baby Freeze and Bronco

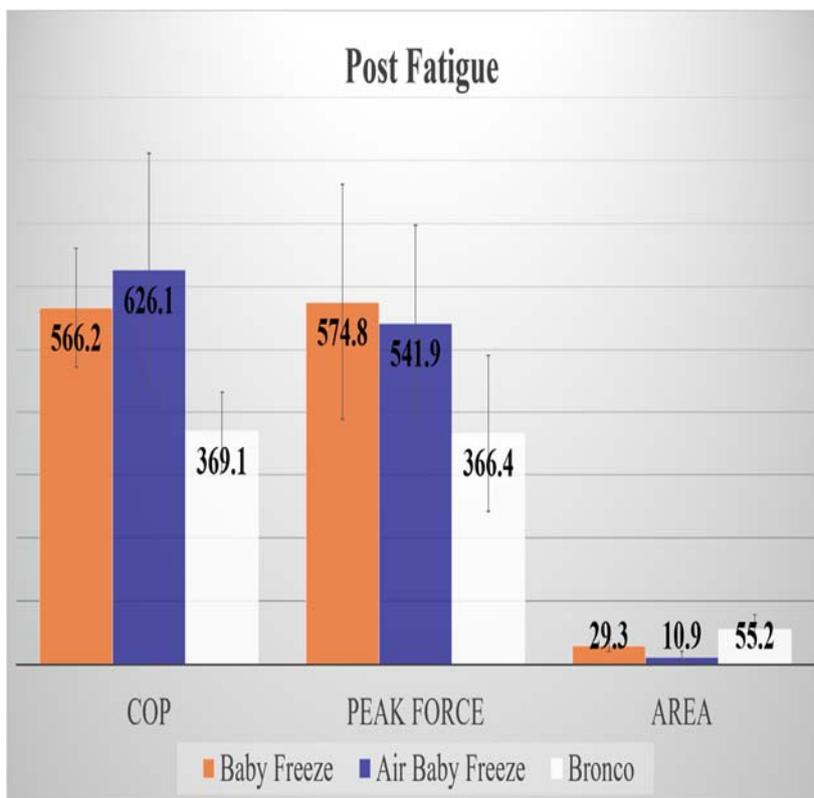


Figure 2. Post fatigue COP, Peak Force and Area of the Baby Freeze, Air Baby Freeze and Bronco

## Conclusion

Fatigue has a significant negative impact on the stability of certain foundational breaking movements. Fatigue may also reduce the force with which breakers perform certain foundation breaking movements. Dancer fatigue appears to have a significant effect on the relationship between pressure and weight bearing through the upper limbs when performing certain foundation breaking movements. These findings suggest that fatigue may lead to injuries in breakers due, at least in part, to affecting the pressure and weight distribution.

There is a lack of high quality dance science research relating specifically to breaking. This study highlights a number of key research areas that should be pursued in relation to injuries in breakers. These include establishing the incidence and prevalence of specific injuries encountered by breakers; more detailed assessments of mechanisms of injury for common and disabling injuries; the impact of focused conditioning programs and injury specific rehabilitation programs.

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## QUALITY OF LIFE AND BODY IMAGE OF WOMEN WHO PRACTICE BELLY DANCE

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### Summary

The theme of this research is quality of life and body image of women practicing belly dancing. Quality of life has been a highly researched subject, but it remains relevant considering that life expectancy has increased and with that, there has also been a growing need to investigate the quality of this extension. The research focuses on women due to the great and profound changes they have undergone throughout history, which has directly and indirectly affected the construction of identity, social roles, health and, consequently, quality of life. Belly dancing was chosen because it allows greater awareness of the body scheme and mainly acts in the perception and modification of the body image of its practitioners, because it works with body awareness. The general objective is to investigate quality of life and body image of women who practice belly dancing. The specific objectives are to trace the socio-demographic profile of these women; to evaluate the perception regarding quality of life and satisfaction with the body image of the practitioners of belly dance and to verify if there is difference in quality of life and body image because of the time of practice of this dance. The research is quantitative, using a cross-sectional method. The data was collected in belly dance schools in the city of Goiânia, totaling 100 participating adult women. For the analysis of the data, appropriate statistical tests will be used.

**Key words:** Belly dancing; Body image; Quality of life.

### Introduction

Studying quality of life, despite being a well researched topic, is pertinent and necessary, especially when the goal is to focus on belly dancing.

Nowadays, women face conflicts related to the various social roles in play. This fact has made women loose much of their feminine primitive force, undergoing a deconstruction of their feminine identity. There is an ideal of women that is reinforced by society, especially through media. This ideal for most women is very far from their realities, which ends up generating many frustrations and discontent with their self images. It is also observed in some physical exercises and fashion, the imposition of an image that is distorted from the real female image.

A woman's satisfaction with her body may vary according to the magnitude of the deviation between her real proportions and what she considers the ideal female model<sup>1</sup>. Depending on the size of this deviation, one can find very frustrated women, constantly seeking the model imposed by society. Such women typically experience a rejection of the body image they possess. They live in

search of another that is idealized and imposed. Body image dissatisfaction among women is greater than imagined, especially among middle-aged women<sup>2</sup>.

There are aesthetic demands that fall on women and make them distance themselves from their femininity, in search of a perfect body. This creates a kind of a distorted relationship with the body which has been commercialized and industrialized<sup>3</sup>.

The conflicts resulting from this exposure will awaken the need to seek alternatives that allow a reunion with their feminine self. This reunion can be found in belly dancing, because dance works not only physical aspects, but also psychological and the ones related to body image.

Belly dancing, in this perspective, is not only considered a physical exercise, but an activity that enables a greater body awareness and also the elaboration of unconscious intra-psychic contents.

Dance has existed since the earliest times and therefore its history is confused with the history of mankind, arising with the need to revere the divine, the sacred. Over time dance has been changing and several concepts and definitions have been formed<sup>4</sup>.

The oriental dance, known in Brazil as belly dance, is of Egyptian origin and was introduced to Brazil 7,000 years BC, with a sacred connotation, for it was performed in temples, in secret rituals performed only by women. This dance gained an artistic connotation only after the Arab invasion in the Egyptian territory, because the traditions and cultures of these two peoples ended up becoming mixed. The Egyptian oriental dance is a technique of artistic body expression that has transposed the limits of time and space, expanding beyond the Arab borders, adding characteristics of other dances, modernizing itself in such a way that it is practiced in several countries of the world nowadays. This fact is due not only to its exoticism and beauty, but mainly because of its benefits<sup>5</sup>.

Many are the benefits of belly dancing and they can be enjoyed by women of all physical types and various ages. These benefits range from improved posture, motor skills, coordination, creativity, reasoning, as well as others resulting from constant pelvic movements.

The belly dance, as well as several other oriental techniques, treat the individual considering mind and body in an integrated way, through the creation of a greater body awareness, thus allowing a better relation to the female body image.

It is necessary to differentiate body schema of body image. The first is related to the representation of the body itself independent of the historical moment, the geographical position or the

environment in which it lives. The second concept relates to the way in which the person wants to be and is directly linked to the history and individuality of each one<sup>6</sup>.

The concepts of body image and schema can be equivalent, being understood as not merely sensations or imaginations. They refer to a different appreciation of the body. It is not a mere perception, although one is aware of the body through the senses. Nor is it a mere representation, although there are mental representations involved.

Belly dance makes possible a greater awareness of the body scheme and mainly acts in the perception and modification of the body image of its practitioners, because it works with techniques that develop better body awareness, through the breathing, the movements, the costumes, the make-up, etc. Belly dancing in the perspective presented here can be used as a technique to improve the health and quality of life of its practitioners<sup>7</sup>.

The concept of quality of life arose from the 1970s on the basis of advances in medicine. These advances made possible an extension of life and with that, it was then realized the need to evaluate or measure the quality of this prolongation.

Several theoretical models of quality of life can be found in research literature, but two of them stand out. For us, the main models of quality of life are the satisfaction and the functionalist models.

In the satisfaction model, quality of life is directly related to satisfaction with the various domains of life defined as important by the individual. The functionalist model considers that in order to have a good quality of life, the individual must be functioning well, that is, performing satisfactorily their social role and the functions they value<sup>8</sup>.

The general objective of this study is to investigate the quality of life and body image of women who practice belly dancing. The specific objectives are to trace the demographic profile of these women; to evaluate the perception regarding the quality of life and the satisfaction with the body image of the practitioners of belly dance; and to verify if there is difference in the quality of life and body image because of the time of practice of the dance.

## **Methodology**

The type of research applied in this study is quantitative, with the use of the cross-sectional method. On a latter stage, the Systematic Review was chosen as a technique for reviewing the literature.

## PROCEEDINGS OF EVENT

At the moment of the search for articles for the literature review, the following descriptors were used in Spanish, English and Portuguese: quality of life, and dance, and woman; quality of life, and belly dancing. This search was performed in journals published in the databases: Virtual Health Library (VHL), Scientific Electronic Library Online (SciELO), Portal of the Coordination of Improvement of Higher Level Personnel - CAPES, Medline-PubMed, Cochrane Library and Embase. Only studies that were not repeated in the databases were used.

For the primary study, it was conducted a field research at Belly Dance Schools in the city of Goiânia, counting on 100 adult women (20 to 65 years) as participants in the research, representing approximately 50% of the total schools of this city.

The inclusion criteria used for the schools were: to be located in the city of Goiânia; offer belly dance classes for at least 04 years and have teachers who have undergone advanced training in belly dancing.

The inclusion criteria of the research participants were: to be adult women and to practice dance classes regularly. Could not participate in the research, women with some intellectual impediment to fill the instruments of data collection.

A socio-demographic questionnaire to characterize the participants was used to evaluate aspects related to age, height and weight, marital status, number of children, religion, schooling, profession, weekly workload, family income, exercise type and frequency, reasons for seeking belly dancing and self-perception of general health status. In relation to the evaluation of the perception of the satisfaction with the body image, the Body Shape Questionnaire - BSQ [2] (Body Image Questionnaire) was applied, which measures the concern with body appearance. To investigate the perception of quality of life, the WHOQOL - Bref<sup>9</sup> Test was applied.

In terms of procedures, the research project was first submitted to the Ethics Committee and only after it was approved, data was collected. Participants received information about the research and after agreeing to participate, they signed the Free and Informed Consent Term (TLCE).

Data collection was done in schools, with the participants completing the instruments at the beginning or end of classes, in the classroom itself. The researcher stayed in the classroom to clarify any doubts. The data collection period was from February to October 2016.

The collected data will be analyzed in November, through statistical tests appropriate to the type of study with the objective of answering the problem raised in the research.

The research offered no risk to the physical and emotional integrity of the participants, nor any type of discomfort, and it required the availability of approximately 30 minutes of each participant to complete the data collection instruments.

It is expected that this research will promote awareness about the importance of regular belly dance practice in order to achieve integral health and consequently improve the quality of life, as well as contribute to the discussion about the feminine and the role of women in today's society.

## Results and Discussion

The data collected for the primary study has not yet been tabulated or analyzed.

The Systematic Review is in the fourth stage, that is, readings of the full articles are being made.

700 articles were found as a result of the search of the descriptors in the databases.

With the use of the Endnote software, it was possible to identify 274 duplicate articles in the databases, leaving 426 articles to be analysed by their titles. After reading the titles, 186 articles were selected for the third stage, that was the reading of the abstracts. The fourth stage consists of reading the complete articles; for this stage, 55 articles were selected.

## Conclusions

This research still does not have conclusions, because it is in the initial phase of analysis of the data collected.

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## HYPERMOBILITY SCREENING IN DANCE AND RUGBY

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### Abstract

Injury is a challenge for Sports Medicine professionals and results from a complex interaction between intrinsic, extrinsic and situational variables. The identification of potential risk factors that may predict injury would be beneficial. Joint hypermobility has been associated with an increased risk of injury in a variety of sports including rugby, however in dance hyperflexibility might be beneficial for performance. This study attempted to identify the range of hypermobility in female university dancers and university rugby union players. Eighty-two female university students volunteered to participate in this study. They were composed of 40 dancers and 42 rugby players. Participants were excluded from the study if they had suffered an injury in the previous 30 days which prevented them from participating in games or training. The Beighton score<sup>1</sup> was used to measure Joint Hypermobility in all participants by measuring range of motion of the 5<sup>th</sup> metacarpal joints, thumbs, elbow, knees and lumbar spines which provided a maximum score of 9. Hypermobility was classified as a Beighton score of  $\geq 4$ . Hypermobility scores were analysed using an independent t-test. The mean Beighton score for dancers was 5.37 (SD +/- 1.45) and for rugby players was 2.19 (SD +/- 2.05). There was a significant difference between hypermobility scores in dancers and rugby players ( $p < 0.01$ ). The prevalence of joint hypermobility in female university dance students is very high in comparison to female university rugby union players of a similar age. This may have implications in terms of injury prevention.

**Key words:** Beighton score; Injury surveillance; Laxity.

### Introduction

Joint hypermobility (JH) is excessive end of range joint motion<sup>2</sup> which exceeds normal limits within one joint. Benign joint hypermobility syndrome (BJHS) is considered to be a benign condition composed of generalised joint laxity with nonspecific musculoskeletal complaints<sup>3</sup>. JH is commonly assessed using the Beighton score<sup>1</sup> which involves the assessment of five joint movements which provide a score out of 9 with scores of  $\geq 4$  classified as hypermobile<sup>4</sup>. The Beighton score cut off point used to classify JH lacks consistency across the literature with cut-off points of 4, 5 and 6 used in a number of studies<sup>5</sup>.

JH is higher within sporting populations than the general population<sup>6</sup>. In a cohort of 267 students (17-26 years) the prevalence of Generalised Joint Hypermobility (GJH) was 26.2% overall (females 36.7%, males 13.7%, Beighton score cut-off of 5/9)<sup>7</sup>. Within dance, hypermobility rates of 90% in ballet dancers have been reported which were approximately 4 times greater than age and gender matched controls<sup>8</sup>. GJH rates of 66% as measured via the Beighton score cut-off  $\geq 4$  in dance students have been reported<sup>9</sup>. In rugby union limited research exists regarding hypermobility prevalence with amateur rugby union GJH levels of 24% been reported and a mean 'ligamentous

laxity' score of 2/9 in 51 male first division rugby players measured via the Beighton-Horan assessment<sup>10</sup>.

JH has been associated with an increased risk of injury in a variety of sports including rugby<sup>10</sup>. However, in dance, hyperflexibility might be beneficial for performance<sup>11</sup>. Aesthetic demands may influence the selection of hypermobile dancers for dance schools, while in rugby union the absence of aesthetic demands and its status as a contact sport provide increased physical demands and injury risk. A review of the incidence of JHS in the Royal Ballet Company and School concluded that hypermobile dancers who had been injured were less likely to progress into the profession<sup>8</sup> and a prevalence of BJHS in dancers of 9.5% and a significantly greater injury risk in those with BJHS has been reported<sup>12</sup>.

The primary aim of the study was to report the prevalence of JH in female dance students and university rugby union players. This information could be used in the development of an injury surveillance study investigating hypermobility scores in two very different physical activities, namely dance and rugby, with an aged and profession matched cohort.

### Methods

Eight-two university students volunteered to participate in this study. They were composed of 40 female dancers (age: 20 years +/- 0.5 years, height: 165cm +/- 4.5cm, weight: 60kg +/- 5.4kg) and 42 female rugby players (age: 20 years +/- 0.8 years, height: 168cm +/- 3.5cm, weight: 68kg +/- 9.4kg). Rugby players were recruited at the relevant team training session if they were: 18 years of age or older; currently a member of the university rugby union team and attending training on a weekly basis. Dancers were recruited at their dance practical session and had to be attending dance classes on a weekly basis. Participants were excluded from the study if they had suffered an injury in the previous 30 days<sup>13</sup> which prevented them from participating in games, training or classes<sup>14</sup>. Participants completed a medical screening questionnaire prior to participating in the study and those who had heart disease and/or were pregnant were excluded from the study. Participation was voluntary and all participants completed informed consent forms and were provided with an information sheet prior to commencing the study and a debrief sheet following participation. Ethical approval was granted from the Edge Hill University Ethics Committee prior to commencing the study.

Participants were asked to eat their normal pre-training meal, avoid performance enhancing energy drinks, supplements and strenuous exercise in the 48 hours before testing to reduce fatigue effects. All testing was conducted indoors to reduce extraneous variables such as weather and was conducted at training or dance sessions which commenced at 17.00 hours. All tests were conducted

under the supervision of the same researcher and prior to testing the participants height was measured using a stadiometer (Leicester Height Measure, Child Growth Foundation) and their weights were recorded using digital scales (Salter 9028, Kent, UK.).

The Beighton score<sup>1</sup> was used to measure JH by measuring range of motion of the 5<sup>th</sup> metacarpal joints (1 point each joint) thumbs (1 point each joint), elbows (1 point each joint), knees (1 point each joint) and lumbar spine (1 point) which provided a maximum score of 9. A goniometer was used to measure all joints except the lumbar spine. All measurements were taken by the same researcher who had received training in Beighton score classification. All tests were performed as described by<sup>15</sup>. The Beighton score has an ICC of 0.91 and a kappa 0.74 for the classification of GJH via these methods<sup>15</sup>. Asymmetric mobility was recorded and was defined as a difference of more than two points between the summed left and right side (Maximum score of 4 for one side). JH was classified as a score of  $\geq 4$  using the Beighton Score as recommended by the British Society of Rheumatology<sup>4</sup>.

Data was analysed using SPSS software version 21. Means and standard deviations were reported and statistical significance was accepted at the  $P < 0.05$  level. Analysis of hypermobility scores was completed using a paired t-test.

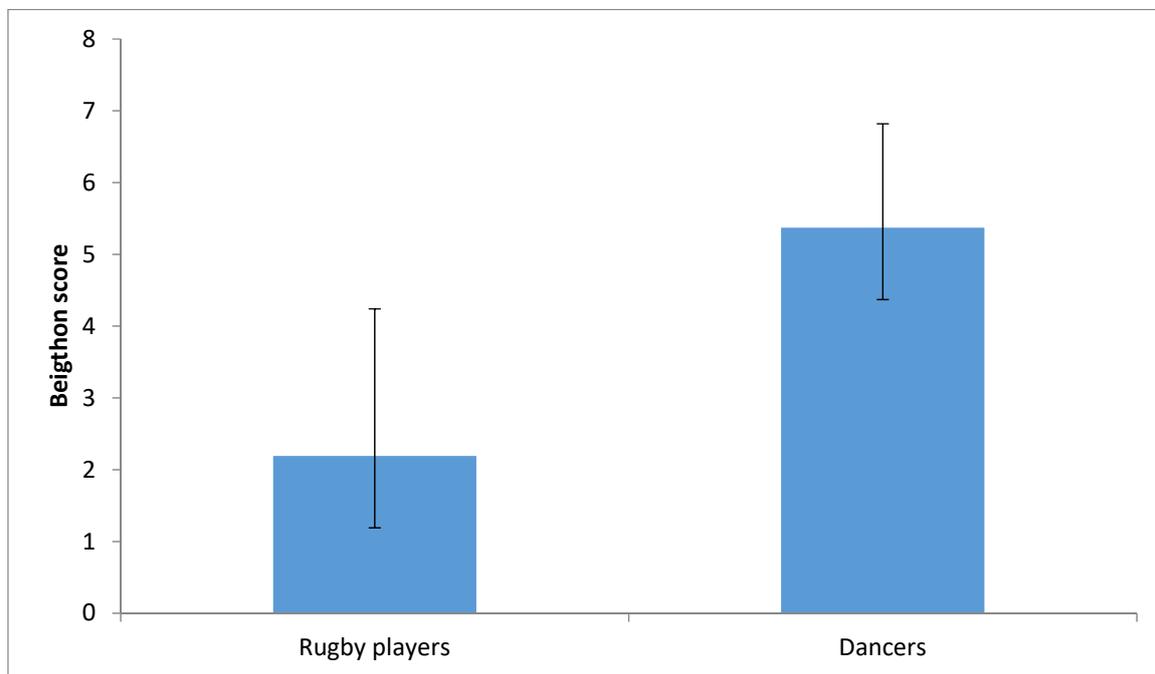
## Results and Discussion

Thirty-five of the dancers (88%) were classified as hypermobile (Beighton score  $\geq 4$ ) while 8 (19%) of the rugby players were classified as been hypermobile (Table 1). These findings are in agreement with previous findings of high hypermobility levels in ballet dancers<sup>8</sup>. More specifically in comparison to student dancers the current findings of 88% dance students having JH are greater than those previously reported by<sup>9</sup>. To the authors best knowledge no previous studies have reported hypermobility prevalence in female rugby players however the the findings of 19% of female rugby players been hypermobile is similar to the findings in male amateur rugby players of GJH of 24%<sup>10</sup>.

**Table 1** - Beighton scores and percentage JH in female university dancers and rugby union players

Group	Age (years)	Height (cm)	Weight (kg)	Mean Beighton score	Percentage with JH
Dancers	20 +/- 0.5	165 +/- 4.5	60 +/- 5.4	5.37 +/- 1.45	88%
Rugby players	20 +/- 0.8	168 +/- 3.5	68 +/- 9.4	2.19 +/- 2.05	19%

The mean Beighton score for dancers was 5.37 (SD +/- 1.45) and for female rugby players was 2.19 (SD +/- 2.05) (Figure 1). There was a significant difference between hypermobility scores in dancers and those in female rugby players ( $P < 0.01$ ).



**Figure 1** - Mean Beighton scores in female dancers and rugby union players.

GJH has been identified as a risk factor for knee injury in a number of sports<sup>16</sup> and in hypermobile joints an increase in arthralgias, joint subluxations, joint dislocations and sprains has been reported<sup>17</sup>. Identification of the prevalence of an injury is the first stage of the Van Mechelen model of injury prevention<sup>18</sup> and information regarding the prevalence of hypermobility could be utilised to allow potential interventions to be developed which may include strength and conditioning programmes, monitoring of training loads and advice regarding sport selection assisted by assessment of the individual. The suggestion that proprioception and neuromuscular control is impaired in hypermobile individuals with Ehlers-Danlos Syndrome<sup>19</sup> which is included under the spectrum of hypermobility connective tissue disorders means that it is important that Sports Medicine professionals are aware of the prevalence of hypermobility. The relationship between hypermobility and proprioception requires further investigation in dance and rugby. The current study allows comparison of hypermobility levels in two very different physical activities with similar populations in terms of age and gender and provides impetus for further research into whether high hypermobility levels in dance is an adaptation to the dance specific training. Future studies comparing injury rates in dance and female rugby which has a documented high injury rate due to the contact nature of the sport would provide an interesting comparison of injury rates and the potential risk factors that may explain these rates.

## Conclusion

The prevalence of JH in female university dance students is very high in comparison to female university rugby union players of a similar age. This may have implications in terms of injury prevention and requires further investigation via a long term prospective injury audit study.

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## VALUES OF VO<sub>2</sub> max. IN CONTEMPORARY PROFESSIONAL DANCERS OF THE CITY OF PORTO ALEGRE, BRAZIL

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### Summary

This study aims to verify the values of VO<sub>2</sub> max. of professional contemporary dancers from different contemporary dance companies of Porto Alegre/RS, Brazil. We evaluated 18 dancers, 10 female (26.70, ± 6.20 years) and 8 male (28.50, ± 10.67 years) contemporary dancers that practiced on average 15, ± 7.17 hours and 4.5, ± 0.53 times per week. For the VO<sub>2</sub>max test, an Inbrasport treadmill, model ATL, connected to the Micromed Ergo PCElite system was used. This system is linked to AeroSport Inc.'s VO2000, which simultaneously obtains metabolic and respiratory parameters through the direct analysis of expired gases (O<sub>2</sub> and CO<sub>2</sub>). The Bruce protocol was used for the test with slope and velocity variations every three minutes. The descriptive statistics data was obtained through the SPSS version 18 program. The mean VO<sub>2</sub> max. was 44.62, ± 7.62 ml.kg<sup>-1</sup>.min<sup>-1</sup> in the females and 51.80, ± 10.28 ml.kg<sup>-1</sup>.min<sup>-1</sup> in the males. In the male contemporary dancers, the average consumption of VO<sub>2</sub> max. is above the reference standards of non-athletes, and also above the levels found in professional classical dancers. In the female contemporary dancers, the average consumption of VO<sub>2</sub> max. is above the reference standards of non-athlete women and similar to that of Brazilian classical ballet professional dancers.

**Key words:** Dance; Physiology; Dance Medicine.

### Introduction

Throughout the ages, dance has developed and diversified to become a universal form of art, transforming and evolving into many different styles. One finds, among these styles, the contemporary dance, that is the form of dance of our time. This dance, in the choreographic aspect, can be translated as one that does not merge in certain rules, steps and technique, although it may be influenced by some principles<sup>1</sup>.

One of the goals of dance as an art form is to work the body as a whole, developing several aspects regarding the functioning of it. In this sense, studies indicate that dance can provide improvements in strength, flexibility and endurance of the dancer<sup>2, 3</sup>.

Cohen et al.<sup>4</sup> studied the energy required in classical ballet, for the bar and center exercises. The bar requirement was 38% of the VO<sub>2</sub>max, both for men and women. For a dance performed on the floor, the requirement was 56% for men and 46% for women. The authors concluded that there was an improvement in the cardiorespiratory consumption of the studied dancers after a period of practice.

A study with professional ballet dancers, with a mean age of  $33.66, \pm 6.86$  years, evaluated the maximum oxygen consumption indirectly using the Bruce protocol<sup>5</sup>. The results found in relation to the mean  $VO_2$ max consumption. were  $41.11, \pm 5.5$  ml.kg<sup>-1</sup>.min<sup>-1</sup> for the females, and, for the males,  $43.6, \pm 4.4$  ml.kg<sup>-1</sup>.min<sup>-1</sup>.

Even so, little is known about the influence of cardiorespiratory resistance on the performance of the professional contemporary dancer. The literature on this subject is almost non-existent, especially when referring to Brazil, and it is very difficult to find studies in this area.

Thus, the present study aims to verify the values of  $VO_2$  max. of professional contemporary dancers from the city of Porto Alegre/RS, Brazil.

### Methodology

A descriptive, experimental, quantitative study was carried out in which the sample was composed of 18 professional contemporary dancers, 10 women, with a mean age of  $26.70, \pm 6.20$  years, and 8 men, with an average age of  $28.50, \pm 10.67$  years, belonging to different contemporary dance companies of Porto Alegre/RS, Brazil. The studied sample practiced contemporary dance on average  $15, \pm 7.17$  hours and  $4.5, \pm 0.53$  times per week and did not perform any other type of physical activity parallel to this practice. This study was approved by the Research Ethics Committee of the Pontifical Catholic University of Rio Grande do Sul, under protocol number 938.459. All participants signed a free and informed consent form, agreeing to participate in the study.

Data collection was performed in a single session at the Laboratory of Physical and Functional Resources of the Faculty of Physical Education of the Pontifical Catholic University of Rio Grande do Sul. At first, an anamnesis was carried out with the studied sample (age, years of practice and hours of practice per week of contemporary dance) and we also measured weight and height. The weight was measured through the Filizola scale with 100g precision and, stature, through the use of a stadiometer.

In a second moment, the  $VO_2$ max test was performed. An Inbrasport treadmill, ATL model, connected to the Micromed Ergo PCElite system (1998) was used to control treadmill speed and inclination. This system is linked to AeroSport Inc.'s VO2000, which simultaneously obtains metabolic and respiratory parameters through the direct analysis of expired gases ( $O_2$  and  $CO_2$ ). The protocol used during the test was that of Bruce (1972), with slope and velocity variations implemented every three minutes.

Descriptive statistics were performed and the data normality was verified using the Shapiro-Wilk test. For the data analysis, the SPSS software, version 18, was used.

## Results

Table 1<sup>14</sup> presents the results of mean, standard deviation and confidence interval of the variables age, height and VO<sub>2</sub>max. of the male dancers; and, in Table 2 the same data corresponding to the female dancers is presented.

TABLE 1 - Descriptive statistics (mean, standard deviation and confidence interval) of males (n = 8)

TABLE 2 - Descriptive statistics (mean, standard deviation and confidence interval) of males (n = 10)

## Discussion

The results indicate a difference of 17% between the values of VO<sub>2</sub>max. of the male dancers in relation to the female dancers, with the male dancers having a higher score. This data agrees with that of Guzman<sup>3</sup>, which states that male athletes have approximately 20 to 25% more VO<sub>2</sub>max. than female athletes.

According to the classification of aerobic conditioning of men and women, obtained in the Cooper Table, the female dancers analyzed would have a VO<sub>2</sub>max. considered superior to that of the general population, since it is above 41 ml.kg<sup>-1</sup>.min<sup>-1</sup>; and the male dancers, a VO<sub>2</sub>max. considered excellent, since it is between 46.5 and 52.4 ml.kg<sup>-1</sup>.min<sup>-1</sup>. These results indicate that, in both male and female dancers, the mean VO<sub>2</sub>max. was above the non-athlete reference standards<sup>6</sup>.

The VO<sub>2</sub>max data indirectly obtained through a treadmill test using the Bruce Protocol, in a study conducted by Dulfrayer<sup>5</sup> with professional ballet dancers from Rio de Janeiro, was similar to those of this study in females, but in relation to males, the dancers of this research were above the dancers studied by the author.

In the study conducted by Cohen et al.<sup>4</sup>, with American professional ballet dancers, the mean data for maximal oxygen consumption is below the sample studied in this study. However, in this study, different collection and protocol instruments were used, so it is difficult to compare these results.

## Conclusion

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<sup>14</sup> For the Tables, please refer to the expanded summary in Portuguese.

After the analysis and discussion of the results, it was concluded that in the male contemporary dancers the average consumption of VO<sub>2</sub> max. is above the reference standards of non-athletes, and also above the levels found in professional classical dancers. In the female contemporary dancers the average consumption of VO<sub>2</sub> max. is above the reference standards of non-athlete women and similar to that of Brazilian professional classical ballet dancers.

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## CORTICAL PROCESSING PATTERNS IN SPACE COGNITIVE TASK PERFORMED BY INDIVIDUALS WITH DIFFERENT PERCEPTOMOTOR TRAININGS (BALLARINES X VOLLEYBALLISTS)

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### Summary

A striking feature of dancers is their well-developed body awareness. Dancers need to continuously monitor the position of the trunk and limbs in relation to space, based on sensory afferents. Cortically, to obtain this more refined control, the sensorimotor integration is fundamental. Physical activities that differ exactly in relation to how their practitioners need to process sensory information to generate movement should result in distinct sensorimotor integrations. This study aims to analyze the electroencephalic activity of individuals with distinct perceptomotor skills (dancers x volleyball players). The sample of the present study was intentional and consisted of 14 right-handed participants, each group consisted of 07 women aged between 18-29 years. Through the EEG, the mean energy parameter (cortical over time) was extracted at points C3, C4, Cz (primary motor cortex), F3 (left motor supplement area), F7 (left pre-motor cortex), P3, P4 and Pz (parietal cortex), evoked by tasks involving the observation and imagination of specific gestures of the two trainings. The main results provide evidence that the group with ballet training presented greater cortical processing over time in the points referring to the primary motor cortex, left pre-motor cortex and left motor supplemental area. These evidences allow us to conclude that individuals with different perceptomotor abilities present different sensorimotor integrations.

**Key words:** Dance; Volleyball; Electroencephalography.

### Introduction

Voluntary movements are the result of the consolidation of different synaptic connections, derived from the individual's motor learning, providing an important source for scientific investigation about these cortical processing patterns. The sensorimotor integration consists of the continuous processing, by the motor system, of the sensorial afferences that prepare for the motor act and improve the execution of fine motor control activities<sup>1</sup>.

A striking feature of dancers is their great body awareness. Dancers need to continuously monitor the position of the trunk and limbs in relation to space<sup>2</sup>. It is assumed that classical ballet training develops a spatial ability where a reference relation of the inner body is created. According to the classification of motor skills of Schmidt and Wrisberg<sup>3</sup>, one can characterize the control recruited to perform the movements in the ballet as being a closed-loop control system (consisting of a type of control that involves the use of sensory information for detection and correction of error) and as having greater relevance of the motor elements (greater importance of the quality of the

movement). Another possible characterization is in relation to environmental predictability. In dance, there is a predominance of closed abilities. The dancer relates to a stable space, whether it be the stage, the classroom, or even another dancer. Does this characteristic of dance, which enables the dancer to develop an inner focus, is the variable responsible for the development of this most striking body consciousness? What would happen if we compared the spatial ability of dancers with the spatial ability developed by athletes who practice an activity where spatial perception plays a different role from that of dance? For example: volleyball players need to monitor their body in relation to a moving object (open ability), whether it be the ball or other players, developing a spatial ability where the reference relation of the body is external and there is no time to detect and correct errors in the generation of movement based on sensory information.

Neural processing is responsible for every cognitive act, and is based on electrophysiological processes that transmit information from one neuron to another, triggered by action potentials<sup>4</sup>. Post-synaptic potentials are probably the main responsible for the generation of extracellular electric fields that can be graphically recorded through electrodes attached to the scalp<sup>5</sup>. This technique is called electroencephalography (EEG). Measures based on the EEG have a prominent role in the formation of current concepts on the cognitive aspects of performance of specific abilities<sup>6</sup>.

The EEG is valid to measure motor learning and to study different cognitive strategies involved in this process<sup>7</sup>, however, the electroencephalic record is sensitive to the individual's movement. One way to avoid this limitation is to model the experiment based on motor simulation theory. The possibility of experimentally accessing cognitive-mental states characterized by the absence of external action represents a great possibility for the neurosciences. This possibility is called simulation theory.

Thus, the objective of the present study is to investigate cortical processing patterns in a cognitive spatial task comparing individuals with distinct perceptomotor abilities. Specifically, the purpose of this study is to compare, through the use of EEG, the pattern of electroencephalic activity (sensorimotor integration) between dancers and experienced volleyball players during an observation test of motor action and imagery. An experiment was modeled where the spatial cognition of individuals was evaluated. Participants in the experiment watched videos containing specific movements of each training and imagined themselves performing these movements. This study is justified on the need to investigate more specific cognitive aspects, seeking to improve the identification and understanding of neural adaptations resulting from specific neural processing related to the different motor learning. In this way, it is intended to contribute to the findings about patterns of organization and functioning of human motor control.

## Methodology

Participants of the study were 14 women experts in classical ballet and volleyball. The group with classical ballet training (BT) was composed of seven professional dancers from the metropolitan region of Porto Alegre (mean age 22.9,  $\pm$  1.8 years), while the group with training in volleyball (VT) was composed by seven volleyball players (mean age of 20.1,  $\pm$  1.6 years) belonging to the main teams that participate of the regional championship of the State of Rio Grande do Sul. All participants did not present a history of neurological, psychiatric or musculoskeletal disorders and provided consent to participate in the study by signing the informed consent form. This study was approved by the Ethics Committee of the University of Caxias do Sul (UCS) in accordance with the guidelines established in Resolution 196/96 of the National Health Council.

For the data capture it was used the EEG equipment developed in the Biosinais Laboratory (UCS), which consists of a cap system with pre-fixed electrodes (24 electrodes and impedance less than 3k $\Omega$ ) according to the international system 10-20% (Jasper System) used to standardize the capture and identification of the neurophysiological signal, together with an impedance adapter system. The acquisition rate of the EEG signals was 1000 Hz per channel.

After a period of familiarization the participants were invited to sit comfortably in a chair with a backrest and head positioned at a distance of 90 cm in front of a 15-inch monitor and connected to the EEG system. The electrodes were placed at the points F3 (left supplementary motor area) and F7 (left pre-motor cortex), C3, C4 and Cz (left, central and right primary motor cortex), P3, P4 and Pz (left, right and central parietal cortex), in addition to two atrial electrodes, which served as reference for the others.

The videos containing a specific gesture of classic ballet and the other a specific volleyball gesture were presented to all participants. The classic ballet video (BV) contained a ballerina performing a turn on one leg ending on the same leg, while the volleyball video (VV) contained a player performing a lateral rolling reception. The stimulus presented consisted of two moments: the first of observation of the gesture (i.e. M1: the subject should watch the gesture); and the second of the gesture's imagination (i.e. M2: the subject should imagine himself performing the gesture). The beginning and the end of this period of motor imagination were delimited by sound signals. The participants were oriented to imagine themselves performing the assisted gesture, where there is the involvement of kinesthetic experiences in the evoked signal<sup>9</sup>. The order of the gestures presented to the participants was randomized. The sections of interest for analysis and obtaining of the parameter were defined as the execution time of the motor gesture during the observation of the gesture (M1), which was three seconds for the two tasks. For the imagination of the gesture (M2), an excerpt was selected with the same duration as the motor gesture, two seconds after the sound signal to start the gesture imagination.

The neurophysiological signals captured at each point were analogously filtered through a 0.01 Hz high pass filter and amplified at 15,000 times. Afterwards, the neurophysiological signals were digitally processed using LabVIEW software. The digitized signals were filtered with a low-pass filter of 100Hz. The dependent variable considered for the present study was the energy mean parameter of the signal, considered to be the cortical processing pattern of each individual during each task extracted from the cortical activation (EEG signal), through the application of mathematical treatments. The study parameter: energy mean of the signal (Joules/Hz) was obtained through the application of the discrete Fourier transform (DFT) by calculating the square area module of the acquired signal representing the individual's cognitive effort during the task<sup>10</sup>.

The statistical analysis of the present study was performed in SPSS 17.0 software. The sphericity of the data was verified by the Mauchly test. A two-way ANOVA for repeated measurements was used for the comparison between groups, moments and parameters in the tasks related to the two trainings at each of the eight points on the scalp (C3/Cz/C4/F3/F7/P3/Pz/P4). For the localization of the differences, a Bonferroni post-hoc test was used. The level of significance adopted in all tests was a  $\leq 0.05$ .

## **Results and Discussion**

The C3, C4 and Cz points were chosen because they represent the primary motor cortex that is functionally related to motor preparation and execution<sup>12,1</sup>. The electrode fixed at point F7 was chosen to capture the activity of part of the neuronal population located in the left pre-motor cortex, which is related to motor planning<sup>13</sup>. The points P3, P4 and Pz capture the activity of part of the neuronal population of the upper parietal cortex<sup>13</sup>. The EEG data obtained in the RV showed significant differences between the groups at points C3 ( $p = 0.05$ ), C4 ( $p = 0.007$ ), F3 ( $p = 0.04$ ) and F7 ( $p = 0.007$ ), on the average of the signal energy. A study using repetitive transcranial magnetic stimulation provided evidence of the fundamental role of SMA for the organization of bimanual configurations in function of the complexity of the task<sup>14</sup>. This evidence highlights the importance of an optimal integration of the SMA (F3) activity to the motor control network (C3, C4, F7) that is necessary for coordinated movements. Structurally, the corticospinal tract is the way in which the cerebral cortex directly regulates alpha motor neurons or spinal interneurons, and is composed of corticospinal fibers originating in parts of the primary motor cortex, part of the pre-motor, of the supplementary motor area and the somatosensory cortex, among other parts of the cortex. The energy mean parameter of the signal demonstrates energy expenditure over time, representing cortical processing. The activity of the population of neurons captured by the C3 and C4 points, related to the preparation and execution of the movement, presented a greater activity during a

longer period of time in the BT group than in the VT group. This evidence corroborates with the assumption that the dancers use cortical processing different from that used by volleyball players, by developing an internal focus for the generation of movement using the kinesthetic sense as a form of movement correction (closed loop). This leads to greater cortical processing, because when visualizing the gesture the dancers evoke the memory of this gesture and with the use of sensory feedback, reprocess that memory to generate the internal motor plane. These assumptions are in agreement with the report of the participants of the BT group who, after collecting, reported that when watching and imagining the dance gesture, they tried to correct the placement of arms, posture, etc. On the other hand, the participants of the VT group reported that they only watched and imagined performing the dance gestures, even though they could note the degree of difficulty.

The significant difference found between the groups at point F3 can be explained by the fundamental role played by the SMA for the organization of bimanual configurations according to the complexity of the task<sup>14</sup>. The two trainings require the upper limbs differently. The dance gesture watched by the two groups consisted of a turn on a foot in which the other leg is in a position called ouvert (open), that is, away from the central axis of the body, resulting in an increase of lever. The use of the arms during the execution of the turn assumes different functions according to the step of the gesture: in the preparation of the turn, the arms play a driving role; during swing the arms play a balancing role - helping to compensate for the increase of the lever generated by the ouvert leg; and at the end of the movement, the arms help to brake the turning holding the trunk. All these different functions performed by the arms during all the phases of the gesture lead to a greater processing. Based mainly on the kinesthetic direction, the result is a greater activity for a longer period of the population of neurons of the region related to the organization of bimanual functions in more complex tasks that are captured by the electrode F3. The electrode fixed at point F7 captures the activity of part of the neuronal population located in the pre-motor cortex. Studies using HRP revealed that the pre-motor cortex does not only send projections to the corticospinal tract, but also sends projections to the brainstem, originating the system of descending projections. Evidence in the literature demonstrates that patients with lesions of these pathways presented a deficit in maintaining the upright posture necessary for the integration of the body with limb movement and independence of extremity movement<sup>11,12</sup>.

Therefore, it is quite significant that differences have appeared in these two points, since they are the points related to the control of the bimanual movements (F3) and the postural musculature and the proximal limbs (F7). The two trainings differ in the way their practitioners make use of the postural musculature and limbs and the dance video reflects these differences. The significant differences found between the groups at point F3 and at point F7 can be taken as evidence of the neural modulations resulting from the differentiated uses of these muscles by the two trainings. In addition,

the differential use of space in each modality and the predictability of action factor also assumes differential aspects in each training.

### Conclusions

The results found in the present study allow us to conclude that dancers present different cortical processing when compared to that of the volleyball players in the dance tasks, due to presenting a greater cortical processing over time, reflecting the cortical adaptations inherent to the different perceptomotor trainings.

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## KINEMATIC ANALYSIS OF THE VERTEBRAL ALIGNMENT IN DANCE

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### Summary

Lower back pain and various injuries to the spine are frequent in dancers due to various factors such as repetitive exertion, inappropriate technique, posture and dynamic characteristics of technical dance gestures. Possibly, different styles of dance, such as classical ballet, belly dance, contemporary dance, and flamenco, among others, lead to different postural adaptations. This text presents a research project that aims to investigate the kinematic behavior of the spine and to develop low cost methods of postural evaluation in dance. A postural database of dancers will be constructed and a module for automatic tracking of retroreflective markers will be developed in the Dynamic Posture kinematics system. Constructing an objective instrument to measure and know the behavior of vertebral curvatures in dance movements can contribute to the establishment of objective parameters for their teaching in schools, respecting the characteristics of each child.

**Key words:** Biomechanics; Dance; Posture; Spine; Cinemetry.

### Introduction

Dance is an art that often requires an exhaustive process of psychomotor training<sup>1</sup>. Lower back pain and various spinal injuries are frequent in dancers due to various factors such as repetitive effort, inappropriate technique, posture and dynamic characteristics of the technical gestures of dance<sup>2</sup>. Possibly, different styles of dance, such as classical ballet, belly dance, contemporary dance, and flamenco, among others, lead to different postural adaptations.

To create an objective instrument for the evaluation and to know the behavior of vertebral curvatures in dance movements can contribute to the establishment of realistic parameters for its teaching in schools, respecting the characteristics of each child. However, there is scarce work for these purposes in the specialized literature. In general, biomechanical methods and studies are focused on lower limb analysis, on sports techniques and basic activities of daily life such as locomotion.

Optical systems present an attractive solution for measuring body movement<sup>3, 4, 5, 6, 7, 8, 9</sup> because they are precise, non-invasive, nonradioactive, and because they allow a good estimation of skeletal movement through the placement of retroreflective markers in the skin, adjacent to the bone accidents of interest. The movement of these markers can be traced to quantify posture during body movement.

Free, non-commercial systems based on visible light digital camcorders such as Dvideow<sup>10</sup> and Dynamic Posture<sup>11</sup> can be very attractive because today we have low cost cameras and good optics, which allows us to measure the position of markers with errors below 1mm<sup>12</sup>. However, tracking markers is not trivial and free systems have limited solutions for automatic marker tracking, especially in uncontrolled situations and environments where there is occlusion and impact, such as in various dance movements. For realistic measurement of the spine alignment, it is recommended to use methods that allow a great detailing of the geometric format of the structure<sup>13, 14, 15, 16</sup> which implies using markers close to one another, which also makes it difficult to automatically trace.

Some commercial systems such as VICON, APAS, Optotrak and Elite-Plus have high automatic tracking capability and are quite accurate. However, these trading systems are "closed packages" (you cannot access and change their source code) and are expensive to purchase and update. In addition, even these systems may fail under uncontrolled measurement conditions, as indicated in the VICON system manual.

Dynamic Posture<sup>17</sup> is a free system that makes it possible to measure the posture of the spine in locomotion on a treadmill, in orthostatic posture and in a cycle ergometer, in a laboratory controlled environment. Various situations such as dance movements can limit its use and this project aims to qualify the system and develop specific modules for these applications.

This text presents a research project that aims to investigate the kinematic behavior of the spine and to develop methods of low cost postural evaluation in dance. In order to achieve these main objectives, the following specific objectives were established: a) to develop a low cost module in the system Dynamic Posture, for the analysis of posture of dancers; B) to analyse and quantify the alignment of the spine in different exercises of classical ballet, such as: *développé*, arabesque and the grand rond de jambe; C) to assess the alignment of the vertebral column of dancers from different styles, like classical ballet, belly dance, contemporary dance, and flamenco, among others; D) to evaluate the postural adaptations in students who practice dance at schools; E) create a database of posture characteristics of dancers, compared to the common population; F) to study the relationship between postural characteristics, quality of life, body image, and performance in dance.

### Methods

Research Participants: the protocol of this study was approved by the Research Ethics Committee of the University (process number 961,140). Dancers from different dance styles in dance companies, universities and schools of Goiânia/Brazil will be invited to participate voluntarily of the research. After being clarified about all the experimental procedures, they will sign a Consent Term of participation in this research. Children, adolescents, and all legally incapacitated persons who are invited to participate in the survey must obtain authorization from a legal representative and fill out a consent form in which they will state their consent to participate in the survey.

For the assessments, each participant must wear his/her preferred footwear for dance practice, and tight elastic shorts or pants. The male dancers should be without a shirt, with the back clothless. The female dancers should wear a bikini or top that is narrow in the back.

Measurement of Spinal Posture: in the upright position, flat, rectangular (10 x 12mm) retroreflective markers, with antiallergic adhesive, will be affixed to the skin along the spine. There will be placed around 37 markers on the back, 25 being in the alignment of the column and 12 bilaterally thereon, at the height of reference points, as exemplified in Figure 1<sup>15</sup>. Spherical markers (1.7 cm in diameter) will be used to mark other accidents in the entire body, requiring a total of 75 markers for full marking of the body.

Digital cameras and five high-resolution Optitrack model Flex10 (100Hz) digital cameras will be used, which have illuminators with visible and infrared LEDs coupled for recording movement.

The volume of interest will be previously calibrated to allow three-dimensional reconstruction using the Direct Linear Transformation - DLT method implemented in Dynamic Posture. In the laboratory environment, plumb lines will be used with markers at known locations to define a calibration object and, in an uncontrolled environment, a calibration object shall be constructed of aluminum bars.

For all the participants of the research, an orthostatic posture assessment, a gait analyses and an evaluation of the dancer running on a treadmill will be performed as proposed by Campos et al. (2015). A pilot experiment will be carried out to define specific protocols for measuring specific movements of each dance style.

Algorithms will be developed to track markers in each type of movement with the Dynamic Posture system. In Campos and Brenzikofer, an algorithm was developed for the automatic tracking of markers with control points. They are points placed in isolated places in the back, that present

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<sup>15</sup> Please, refer to the expanded summary in Portuguese to see the figures of this paper.

movement similar to the points placed in the spine and that are easily traced. The pattern of movement of these control points as well as the relative position between them and the column markers are adopted as prediction criteria for tracking. This algorithm will be tested and adapted for each dance style.

In the analyzes, it will be measured the two-dimensional geometric curvature of the vertebral column in the frontal and sagittal planes, and the trunk locations, as proposed in Campos et al.

The maximum absolute values of curvature of the Neutral Curve in the lumbar and thoracic region will define the lordosis and kyphosis peaks in the sagittal plane and lateral deviation in the frontal plane. Mean values will also indicate reference values for lordosis and kyphosis in the sagittal plane. In addition to the vertebral curvature, other variables such as trunk twisting and joint angles in other joints may be evaluated by means of Euler's angles, depending on the movement analyzed.

To construct a postural database, the postural variables mentioned above will be analyzed in percentiles defined from variables that will be obtained in the characterization of the sample as age, quality of life, level of disability, qualitative scale of pain, body image and level of skill.

In this study, all statistical tests will be performed in Matlab® 2013 software. Data will be analyzed with descriptive and inferential statistics. The level of significance adopted for all inferential tests will be 5% ( $p < 0.05$ ).

## **Conclusion**

Constructing an objective instrument to measure and know the behavior of vertebral curvatures in dance movements can contribute to the establishment of objective parameters for their teaching in schools, respecting the characteristics of each child.

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## THE INFLUENCE OF BALLET IN THE BIOMECHANICS OF THE DANCER'S GAIT: A REVIEW OF THE LITERATURE

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### Summary

The strenuous practice of anti-anatomical ballet postures promotes permanent adaptations in the ballerines' movements. The gait is the most common functional activity in the day to day living, presenting great demand on the joints. It is believed that if there is a change in joint function due to the mechanical actions of dance on the body, the gait will undergo adaptations and these can already be documented through the analysis of the gait of dancers. The aim of this study is to describe what has been written about the gait of dancers. Therefore, a literature review was done, using the Scielo, Medline, Pubmed and Lilacs databases, in Portuguese, English and Spanish, of data published between 1992 and 2015, considering the following descriptors: gait, biomechanics, dancers. It was possible to verify that passive ranges of motions might be altered in all articulations of ballet dancers, which probably can generate changes in gait, being this a study that needs to be carried out with this population. The present study begins, then, to study the gait of dancers, a theme still little explored by the current published research.

**Key words:** Ballet; Ballerinas; Gait; Biomechanical changes.

### Introduction

In its structure, the word biomechanics has the prefix "bio", which means "life", and "mechanics", that refers to an area of Newtonian physics that studies the dynamic effect of forces on the bodies. It is the scientific discipline that studies the mechanical principles of human movement and provides information about muscular function and its characteristics<sup>1</sup>.

Perry<sup>2</sup> defines the gait cycle as the period between the heel touch of one end and the subsequent heel touch of the same end, dividing it into the support and the swing phases.

Classical ballet is the result of a succession of poses, and choreographic movements must harmonize with the aesthetics of time and space of its execution. Everything is coordinated by the rhythm, whose cadence can vary infinitely<sup>3</sup>. Its practice develops sensitivity, musicality, precision, high psychomotor coordination, flexibility, laterality, spatial notion and physical conditioning<sup>4,5</sup>.

In Europe, the ballet's basic positions were defined, all of which are anti-anatomical and can lead to misalignment of the joint structures, describing the beginning and end of all steps<sup>6</sup>. The evolution of this technique was guided by the search for lightness and agility. The dancer seeks total mastery of the body, its muscles and its movements, so that it can be used expressively, without being bound by natural limitations. The technique has certain principles of posture and placement of the body that must be maintained in all movements, maximizing the potentialities of balance, agility and harmony. Thus, the primary factor involved in ballet is a good postural placement<sup>3</sup>.

Although it is known that dance contributes to good motor performance, the art might be compromised when the technique is used without concern for the general body coordination, disrespecting the age group or provoking stereotyped movements and attitudes<sup>7</sup>. Optimal performance requires that body segments be properly positioned to support body mass and allow correct movement<sup>8</sup>.

The dancers stand out from the other athletes for the qualities and skills that make them artists. They should follow norms and dance techniques with the body properly prepared, demonstrating expressiveness and a biomechanics of extremely complex human movement. Although ballet is known as an aesthetic discipline, it also requires enormous athletic preparation, which predisposes dancers to a wide spectrum of injuries<sup>8</sup>.

In ballet, the hip joint is almost always in lateral rotation, causing the knees and toes to be facing outwards. This rotation in French, ballet's world language, is named *en dehors*<sup>9</sup>.

Dance requires a lot of physical skills and athletic training, so professional dancers devote themselves to this practice, especially by overloading the lower extremities of the body. The musculoskeletal system is often pushed to the limit. This is due to the requirement of large ranges of lateral rotation and hip abduction that produce high articular moments and induce extreme force gradients in the joints.

In this way, the present study aims to describe the influence that the biomechanical alterations resulting from the practice of ballet can determine on the dancers' gaits.

### Methodology

A literary review of studies published between 1992 and 2015 was conducted using the Scielo, Medline, Pubmed and Lilacs databases and the key words: ballet, dancers, gait and biomechanical changes and their synonyms in Portuguese, English and Spanish. References included in this study

ranged from books specific to the theme and articles whose descriptions contemplated the analysis of the gait of dancers.

## Results and Discussion

The literature review showed that the posture assumed by ballet dancers is reflected in their other daily living movements and, in this way, gait can present adaptation in ranges of motion and in joint positions that reflect this practice. There is an increase in the passive range of hip lateral rotation, knee varus and exaggerated plantar flexion of the ankles.

In ballet, movements follow a determined axis and plane that generate a force which is divided into energy, power and resistance, so that movement occurs in a defined direction associated with speed, momentum and lightness, translating the naturalness of the gesture interpreted. Thus, if at some point this cycle is interrupted or poorly performed, the body harmony will be lost, generating negative repercussions<sup>10</sup>. In this way, the internalized dance posture becomes the dancer's own postural arrangement, reflecting in all his other daily movements, including his gait.

Koutedakis<sup>1</sup> states that in general, biomechanics can help dancers detect the causes of anatomical imbalances during specific dance movements in order to avoid motions that can potentially cause injury. Awareness of the muscular functioning, by the monitoring of the muscle tightness, can help in the detection of overtraining, a condition that can negatively affect the performance and well-being of the dancers<sup>1</sup>.

Achour<sup>11</sup> points out that the uneven development of flexibility in classical ballet can cause problems in the hip, since a training routine usually emphasizes abduction and lateral rotation, excluding the adduction work. This imbalance can cause damage to the natural motion of the hip required during gait, for example.

Gomes et al.<sup>12</sup> state that by observing the lower limb angulation during the gait of classical ballet dancers and girls of the same age who do not practice it, it can be said that the dancers have a greater angle of lateral rotation of the lower limbs, which is even more evident with a longer practice time and technique training. Steinberg et al.<sup>13</sup> also proved that passive lateral rotation of the hip is significantly increased in the group of dancers when compared to a group of non-dancers.

According to Gage<sup>14</sup>, the angle between the knee axis (bicondylar axis) and the pelvic axis is the essential component of hip rotation. The greater the anteversion, the greater the angle of lateral rotation of the hip.

Toledo et al.<sup>15</sup> say that from the initial stages, ballet dancers make a huge physical effort to reach the ideal external rotation. So, it is possible that an anatomical adaptation occurs, in which the repetition of some movements and stretches makes the head of the femur go into a greater anteversion in relation to the acetabulum, resulting in increased external rotation of this compartment. According to Hamilton et al.<sup>16</sup>, the fact that dancers are able to obtain a greater range of hip external rotation can be attributed to torsional changes in the femur with capsular stretching. The external rotation of the lower limb occurs in about 60% above the knee, and the remaining 40% results from the distal region of this limb<sup>17</sup>.

Gilbert et al.<sup>18</sup> report that although en dehors is one of the most common movements in dance, his research, that assessed passive hip range of motion, using a goniometer, of 20 female ballet dancers aged 11 to 14 years, showed no increase in passive hip external rotation according to age or practice time. This shows that hip external rotation may not be the only criteria used to predict the functionality of the en dehors for the five feet positions of the classic ballet, due to the individual differences in pelvic, hip, knee and foot mobility that also contribute to this. The authors conclude by saying that this result contradicts the popular view among ballet teachers that en dehors is generated exclusively in the hips.

Bennell et al.<sup>19</sup> report that there is a significant increase in hip external rotation range for both the ballet dancers and control group (ages 8 to 11 years) in a one-year study. Steinberg et al.<sup>13</sup> have shown that passive hip abduction is significantly increased in the group of ballet dancers when compared to a group of non-dancers. In addition, the adduction force was also significantly lower than that of abduction in 25% of the ballet dancers studied by Cohen & Abdalla<sup>17</sup>.

Simas & Melo<sup>20</sup> and Prati & Prati<sup>5</sup> state in their studies that most of the ballet dancers presented varus of the knees. The authors suggest several reasons for such alteration, being the technique taught and practiced in a wrong way and the lack of physical fitness the main ones. The knee joints of most dancers also present alterations in the range of lateral rotation, which is justified, according to Winslow & Yoder<sup>21</sup>, due to the excessive lateral rotation of the hip, which leads to shortening of the iliotibial band, and generates a lateral rotation of the tibia as compensation.

Hamilton et al.<sup>16</sup> stated that an intensive long-term ballet practice and extreme ankle postures cause changes in the gait patterns of the dancers<sup>16</sup>, since they find it hard to lift their toes of the ground while walking<sup>22</sup>, due to keeping them in point shape.

When the leg is taken in external rotation, the talus and the calcaneus move into a tilt and lateral rotation to varus. The forefoot is inverted, the foot becomes cavus, and the weight of the body

impinges on its outer edge<sup>23</sup>. Jaarsma et al.<sup>24</sup> found a strong and significant association between the progressive angle of the foot during gait and the external rotation of the femur.

In a study conducted in Porto Alegre, 20 ballet dancers with 18 years of continuous ballet practice were filmed, with four cameras, performing a Plie, and the following items were evaluated: 1- stability of the midfoot; 2 - positioning the pelvis in a neutral alignment; 3 - pelvic stability represented by the variation of the pelvic angle and 4 - vertical alignment of the knee joint with the second ipsilateral toe. The results showed that for item 1, the 20 dancers showed good stability of midfoot; for items 2 and 3, 18 dancers presented pelvic instability tending to retroversion during execution; and for item 4, 13 dancers presented medial misalignment of the knees in all phases of Plie<sup>25</sup>. This study shows a misalignment and a lack of motor control in one of the most executed steps in the routine of ballet, being thus biomechanically verified the influence that this practice can bring to the locomotor system.

Another study observed, with a five-camera system, 27 professional, advanced and intermediate ballet dancers performing six repetitions of an Arabesque sequence with the right leg. Differences were found in pelvic postural control and movement coordination. The authors concluded that pelvic control appears to be an important domain requiring longer practice and more training<sup>26</sup>. This control would probably offer this group more functionality to the altered gait.

According to Kendall et al.<sup>27</sup>, good body mechanics requires that the range of joint motion is adequate, but not excessive. In this way, the dancers encounter important muscular imbalances, which suggests a possible change in gait that, however, is little studied.

## Conclusions

It is concluded that little has been studied about the gait of ballet dancers, and there is no literature that describes the adaptations that occur in the planes of movement during gait. However, it was found that passive ranges of motion are altered in practically all joints of ballet dancers, which can probably generate changes in gait and justify the carrying out of future researches. The quantification and description of these biomechanical changes seem to indicate a viable path for future interferences in the training of dancers and in the development of preventive measures.

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## EFFECT OF THE BALLET SHOE AND THE ARABESQUE EXECUTION STRATEGY IN THE EXTERNAL FORCES OF BALLET DANCERS

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### Summary

It is believed that there is a relation between point shoes and the occurrence of injuries in ballet dancers. The present work questioned this relationship and tested different ballet shoes and arabesque execution dynamics. Sixteen experienced ballet dancers performed selected movements on a power plate, with a frequency of 100Hz. The ground reaction force values (GRF) are discussed here according to the effect of different shoes and tasks. The calculated GRF variables are related to the moment in which the dancer touches the ground, period of permanence in the pose and instant that precedes the completion of the task, chosen for being significant for this study. The results reveal that the way the movement is performed interferes with the load generated and distributed on the body of the dancer, and this does not change with the different shoes used.

**Key words:** Ground reaction force; Ballet; Shoes; Arabesque.

### Introduction

Arabesque is an elementary pose of the classical ballet technique, in which the dancer balances on the lower limb, while the other lower limb, the "working limb", is *en L'air Derriere*<sup>1</sup>, characterized by the maintenance of sustained body weight in one of the lower limbs, while the other lower limb is raised and extended behind the body, performing an extension of the hip joint with the foot off the ground<sup>2</sup>. The Oxford Dictionary complements, by showing that the knee of the lower working limb should remain extended, the body vertically erect, and the upper limbs positioned so that the line created by the arabesque extends harmoniously. In the different methods of classical ballet teaching there are several types of arabesques, but in all methodologies, the arabesque in which the lower limb of

support and the upper limb that remains extended forward and on the same side of the body is called 1<sup>st</sup> Arabesque<sup>2</sup>.

The arabesque can be performed at half point, position reached with 90° of dorsiflexion of the metatarsophalangeal joints, and plantar flexion of the ankle, with the center of gravity passing through the anterior part of the metatarsal head and the posterior part of the tibia blocking the calcaneus; or at point, where the dancer is supported by the tip of the toes<sup>2</sup>. In order to achieve the arabesque with the support of the midpoint or the point, typical ballet strategies are used, among which we highlight two: relevé, started with knees flexed reaching the support on the toes along the full extension of the lower limb; and the piqué, characterized by directly supporting the end of the foot on the ground, with the remainder of the lower limb fully extended. Both ways can be performed by the ballerina using point shoes or sneakers.

The present study questions the differences in the behavior of the GRF in the accomplishment of the 1<sup>st</sup> arabesque initiated by piqué and relevé, with point shoes (PS) and half point/sneakers (HP). The 1<sup>st</sup> arabesque and its forms of achievement were selected because they are basic elements of the classical ballet technique, being part of the dancer's routine in their training, besides being present in many choreographies. Ballerinas usually perform in their classes these possible combinations without recognizing if different motor strategies are required for it.

The hypothesis, once the movements are analyzed qualitatively, is that there are differences in the distribution of forces since the movements generate different ranges of motion, either by the change of the footwear or by the change in the way to start the task. These results may help teachers and dancers to choose the adequate and safe training, taking into account the influence of gesture and footwear as a supporting information for their practice.

## Method

Sixteen female dancers (23.5, ± 7.4 years old, body mass 57.8, ± 8.7 kg and stature 1.62, ± 0.05 m) participated in this study. Inclusion criteria were: minimum 5 years of classical ballet practice and PS use for at least 2 consecutive years (15.1, ± 5.2 years practice classical ballet and 9.9, ± 4.9 years PS use), minimum training volume of 3 hours per week (8.4, ± 4.2 hours per week), no recent musculoskeletal injury limiting or undergoing treatment.

Prior to data collection, the dancers were informed about the procedures and objectives of the study and allowed their participation through the signing of the informed consent form. The project was previously approved by the Research Ethics Committee of the Medical School of the University of São Paulo (protocol nº 407/15). The experimental procedures were performed at the Laboratory

of Biomechanics of Movement and Human Posture (LaBiMPH) of the Department of Physical Therapy, Speech Therapy and Occupational Therapy. After the initial clarifications, the dancers answered a questionnaire related to the anthropometric characteristics and inclusion criteria described above.

After the application of the questionnaire, the dancer was instructed to the movements chosen for this research (piqué and relevé) and the ballet shoes used (PS and HS), then received a sealed opaque envelope containing the sequence of the previously randomized movements. For this randomization a random numerical sequence was prepared in Clinstat<sup>5</sup> software by an independent researcher who did not know the numerical codes for each movement and footwear. This sequence generated blocks of four, being a sequence for each dancer, with the order of accomplishment of the movements. The order of these blocks was also randomized, placed in numerical order and kept secret, in opaque, sealed envelopes, following the order generated by the software. The randomization process followed the instructions of Randelli et al<sup>6</sup>.

Each participant performed four different forms of tasks: (1) arabesque piqué in half-point; (2) arabesque piqué in point; (3) arabesque relevé by half point and (4) arabesque relevé by point. A previous warm-up of 10 minutes was conducted by the dancer herself.

Each movement was repeated 6 times per form of task, totalizing 24 movements per participant, according to specific studies of classical ballet<sup>7</sup> and reference studies for kinetic data collection<sup>6,8</sup>. The rhythm of execution of the selected movements followed a musical tempo suitable for its execution. The dancer waited for the beginning of each arabesque through the introduction given by the music, performing the movement and touching the plate, when the time began to run and the data began to be stored.

The participants performed the movements on the power plate (AMTI OR-6-1000, Watertown, USA), with dimensions of 47 cm x 51 cm, level with the ground, and adjusted to a sampling frequency of 100 Hz to obtain the vertical component of GRF. For data acquisition and storage, a computer with a 12-bit data acquisition A/D board (DT 3002/AMTI) was used.

The calculated GRF variables were (Figure 1<sup>16</sup>): first peak of vertical force (P1), normalized by body weight (PC), equivalent to the moment of the touch of the tip of the support foot in the ground; second peak of vertical force (P2) (PC), equivalent to the instant of preparation for the completion of the movement; preparatory peak (PP) (PC), found only in the movement initiated by relevé, equivalent to the moment of support of the base lower limb in the plate with knee flexion getting to the elevation on the tip of the foot with the complete extension of the knee; charge rate 1 (Tx1),

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<sup>16</sup> To access the images, please refer to the summary in Portuguese.

equivalent to the rate of 0 to 100% of the first peak of the vertical force; charge rate P (Txp), equivalent to 0 to 100% of the preparatory peak; integral of the vertical force.

The vertical GRF data was exported, analyzed in a custom routine developed in a MatLab environment (version R2012b) that selects the valid attempts by assigning the chosen variables to the chosen variables, filtered by a low-pass Butterworth filter of 4<sup>o</sup> order with a cut-off frequency of 40Hz, and normalized by the body weight of each dancer. The routine allocated the data in an Excel table for further statistical treatment.

Statistical analysis was performed in Software Statistica v.8 (StatSoft, Inc.), after confirmation of data normality (Shapiro-Wilk test) and homoscedasticity (Levene test). The comparisons between shoes and movements were made through Anovas. This procedure was performed for each variable studied and the Anovas were followed by Newman-Keuls post-hoc test. We adopted  $p \leq 0.05$  for significant differences.

Figure 1. Graphical representation of the reaction force variables of the vertical ground in the typical curves of each movement, where: (P1) 1<sup>st</sup> peak of reaction force of the vertical ground; (P2) 2<sup>nd</sup> peak of reaction force of the vertical ground; (PP) arabesque preparatory peak by relevé; (Tx1) charge rate of the 1<sup>st</sup> peak of reaction force of the vertical ground and (TxP) charge rate of the preparatory peak of the reaction force of the vertical ground.

## Results and Discussion

Regarding the different shoes used, only the integral variable of the vertical GRF presented significant difference (PS x HP) in the relevé movement. The other variables were not different in both point and midpoint.

The effect of movement was observed for the following GRF variables: 1<sup>st</sup> peak of vertical force, load rate of 1<sup>st</sup> peak of vertical force and integral of vertical force when comparing the different movements performed with the same footwear. With both HP and PS, the movement by relevé showed a greater 1<sup>st</sup> peak of force.

Table 1 - Means, standard deviations and p values of the comparison between the arabesques performed by piqué (PQ) and relevé (RL) of the vertical ground reaction force variables, normalized by body weight (BW) with the sneakers (HP) and point (PS).

This study aimed to identify the influence of the dance shoes on the kinetic patterns of the lower limbs during the arabesque, taking into account the different techniques used to perform this movement.

The main results of this study provide evidence that the different shoes do not lead to significant changes in the GRF patterns of the arabesque studied here. As already described by studies evaluating the GRF together with the plantar pressure during movements with PS<sup>9</sup>, it can be observed that the GRF does not undergo significant changes when compared, in the same movements, to the performance with HP. What actually occurs is the different distribution of the load along the foot, which can often give the impression to the dancer or her masters that there has been an increase in overload caused by the change in pressure points. The other variables evaluated did not reveal significant differences in the PS x HP, which contrasts studies that relate the occurrence of injuries using PS<sup>10-12</sup>.

We can thus speculate that the physical injuries and overuse characteristic of classical ballet would not only be related to the use of PS, but would involve other more complex elements, such as the lack of knowledge for its proper use, the diffusion of the early use and the form of learning the technique in point. New studies comparing the effects of different shoes on the achievement of a same movement should be done to fill this gap in the literature, which often compares the shoes in similar and non-identical technical movements, making it difficult or impossible to obtain trustworthy results.

When investigating the GRF to compare arabesque techniques, it was clear that, regardless of the shoe used, the greatest change in strength values occurs through the movement execution mechanism. When we observe the increase of the 1<sup>st</sup> vertical force peak and the load rate in the arabesque initiated by relevé, we can conclude that apparently similar movements occur from a completely different mechanical execution.

The results of this study indicate that the different shoes do not increase the GRF variables. For future studies, a comparative verification of arabesque, techniques of accomplishment and differences between shoes is suggested, by investigating the magnitude of the knee joint moment, in an attempt to clarify how these forces act in this joint.

### Conclusions

The analysis of the vertical forces did not reinforce the fact that the dancer is submitted to intense loads when performing movements with PS; in addition, it showed that the execution of the steps of the classical ballet technique present significant mechanical differences and must be observed in order to improve the understanding of these movements.

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## THE PATHS OF THE BODY IN DANCE AND THE DANCE PATHS IN THE BODY: WAYS OF THINKING ABOUT HEALTH AND PREPARATION OF THE HYBRID BODY FOR DANCE

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### Abstract

In dance, the hybrid body conforms not to an established technique but to temporary means of dance - an emerging proposal, as important as the traditional technical training. Understanding that the hybrid body handles a wide range of possibilities to move, the attention given to health, and training, needs to be considered. Choreographers / directors generally think of movement aesthetically, leaving a gap in the biological understanding of the body. Somatic Education plays a role in mediating the performance / body / health. However, studies in health care show the need of a specific training that promotes the physiological qualities of the dancer. In dance, the discussion of the artistic aspects deepens, while the biological aspects of the movement remain marginal. The intention of this reflection is to indicate that, to ignore any of these parameters is to make a superficial discussion of the dancing body.

**Key words:** Body; Technique; Hybrid; Health.

### Introduction

If we consider the performance of the body, health research aimed at dance increasingly places it within the same parameters of sports science. The objective is not only the sophistication of performance, but the expansion of the available tools so that the dancer can carry out his professional activities in a safe and efficient way.

Angioi<sup>1</sup> says that dance is comparable to sport, since it depends on elements related to technique, physiology, nutrition, medicine, economics and the environment. In addition, he says that, like athletes, professional dancers must be physically prepared to achieve their aesthetic specificity and movement technique.

As a fundamental element in the construction of the body in dance, technique: can be understood as the degree of ability or mastery of fundamentals exhibited in any performance. Thus, in contemporary dance, technique contributes to the development of skills related to the spheres of

body, movement and expression and this is revealed in the various ways of dancing. In what way, then, technique definitely relates to contemporary dance?

Louppe<sup>2</sup> describes in *Hybrid Bodies*, a body that is revealed in contemporary dance, no longer shaped by a specific technique or as a reference of a method. In this sense, it is important to differentiate the concepts of hybrid and mestizo.

The mestizo may be possible for an end of choreographic, scenic or aesthetic construction, lending elements to it. This mixture occurs superficially, not directly affecting the bodies of the dancing subjects<sup>2</sup>. The hybrid is "[...] totally isolated and atypical, it is the result of a unique and accidental combination."<sup>2</sup> (p. 30). Hybridism builds a subject who receives and assimilates what is presented to him and what is available to him, in a unique way: "Hybridization is today the fate of the dancing body, a result both of the demands of choreographic creation and of the elaboration of its own formation."<sup>2</sup> (p.31). Thus, the body that stands out, is a body artistically powerful and ample in possibilities.

Lima<sup>3</sup> says that beforehand, the body was a meeting point between aesthetics, philosophy and technique of a certain current of dance style. Later this logic was replaced by the so-called "dance of the author", proposed by Davis (*apud* LOUPPE<sup>2</sup>) - the choreographer's own conception would dictate a kind of temporary technique/aesthetics, which the dancer may suit. Lima<sup>3</sup> updates this notion, saying that the roles of the choreographer and interpreter, today, are diluted, so that the two parties make agreements between bodies, allowing a mutual contamination. Thus, the hybrid body that presents itself to dance, conforms, not to a consecrated technique, but to other needs, dictating an emerging proposals that can not be considered of less importance than the traditional technical formations.

The construction of the hybrid body for dance is a matter of health, since it is known that a body that no longer has a single technical guideline as a foundation, and that now deals with the temporary, can risk in unfavorable trainings detrimental to his/her well-being.

Several studies clarify the mechanisms by which technique is revealed in body and dance. Strazzacapa<sup>4</sup> says that learning a dance technique goes through the same construct as any body learning, but that in the arts, specific training is needed.

There is no single technique in contemporary dance. Usually the choreographers, within their creative research, select the training for the artist to go through. There are also groups that do not have a fixed choreographer and who need their dancers available to adhere to different propositions. In view of the emerging plurality of possible bodies for dance, based on the authors here exposed, we

consider three aspects as fundamental for the body of the interpreter to be discussed: biography, access to body preparation and access to health care.

The biography points out to the choices and possibilities of the artist. Strazzacapa<sup>4</sup> says that as much as there is a plurality of bodies, there is also a plurality of techniques, and that the act of choosing a technique by which the body is to be designed for dance goes through two processes, simple preference, or the search for a technique that works the difficulty presented.

The preparation of the body should serve the dancer, collaborating for his performance. Strazzacapa<sup>4</sup> clarifies that when this does not happen, the technique can erroneously create a myth, becoming an end and not a means. A technique employed in the wrong way, does not have the effectiveness that is sought in its purpose - that is, the preparation of the body for dance.

Finally, the concern with the health of this body, from which performative results are expected, is essential. Contemporary dance may be ungenerous with the dancing body, as it can sometimes establish that the dancer is available to meet its multiple desires.

Studies related to medicine and dance science have been concerned with the performance and injuries caused by the dance practice and are advancing looking for elements that can complement the dancer's usual activity, enhancing this body's ability to reach out for a healthier practice<sup>1</sup>. Confronted by the need to adapt to artistic longings, the artist who does not receive effective guidelines directed to the health and preparation of the body may be at risk.

### **Methodology**

The present research was based on a theoretical construct. It is created by a dialogue between the ideas of authors who seek to understand the relations between the body in contemporary dance and the implications of this relation to the health of dancers. Studies on technique, hybrid body, somatic education, contemporary dance and health were used.

### **Results and Discussion**

#### **Somatic education and other care as collaboration**

The group of professionals who founded somatic education is called reformer of the movement. According to Strazzacapa<sup>4</sup>, somatic education required of its students anatomical and physiological knowledge as areas of science that collaborate for the understanding of the body.

An element of importance in this practice is observation. Bolsanello<sup>5</sup> says that the teacher or therapist can lead the student to do a self-study. This is an exercise in somatic approaches and goes against the automation of actions in our day-to-day lives. With this experience, Bolsanello<sup>5</sup> explains that the body, movement and even possible pathologies are understood through the individual's own perspective.

As an educational strategy, somatic education enters dance in order to facilitate artistic performance and treat possible injuries. For Bolsanello<sup>5</sup> some of the benefits related to this entrance are: "[...] activation of underused muscles; [...] transformation of inappropriate postural habits and the development of the capacity for expression." (p.22). In addition, somatic education serves the plurality of the bodies in contemporary dance, since "[...] the reformers of the movement did not think about the standardization of bodies, nor did they have an aesthetic preconception [...]" (p.158). The thought about the body were also considered as common sense: taken as integral and at the same time multiple, or even transient.

The relationship between somatic education and dance has proven to be efficient, and somatics has been part of the technical dance class. Amorim<sup>6</sup> says that the challenge for teachers, choreographers, and rehearsers is precisely to empower the dancer to develop fitness-related competencies without compromising the artistic aspects of dance. In addition, she says that physical fitness and performance must work together for health.

## Conclusions

Health studies have been carried out to understand the specificities of the movement in dance, as well as to propose ways to encourage discussion about body preparation. In the field of consecrated techniques, such as classical ballet, these analyzes are constantly advancing, but, as far as contemporary dance is concerned, these studies are still premature.

Angioi's studies<sup>1</sup> point out that dancers in contemporary dance are deficient in their physical preparation and that this does not prove sufficient for the physiological stress in demand. They still see the need for a complementary exercise that can overcome the lack of adequate preparation, with which contemporary dance, in its time of existence, has little concern.

We understand that a possible barrier to the progress of studies in contemporary dance is related to the difficulty of standardization, since it is not limited to a specific technique, but we also know that this cannot impede the advancement of it, since it is a fertile field for countless studies and analyzes. In the art of dance, the discussion of artistic aspects deepens, while discussions of the biological

aspects inherent to movement do not. Given the above, we can understand that to ignore these parameters is to make a superficial discussion of the body in dance.

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## NOTES ON THE HISTORICAL CONSTITUTION OF HUMAN SENSES: THE CHALLENGE OF DIALOGUE BETWEEN THE FIELDS OF AESTHETICS AND NEUROSCIENCE

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### Summary

This is a bibliographical research in progress, which is based on the academic-scientific dialogue between areas of knowledge historically distant, namely, the areas of philosophy, especially the field of aesthetics, arts, with emphasis on dance, and the so-called neurosciences. The main objective is the production of a reference synthesis on the historical constitution of the senses that allow the human being to live different and diverse aesthetic experiences. From this platform, we hope to subsidize other research projects focused on aesthetic education.

**Key words:** Dance; Plane of the sensible; History; Education of the senses.

### Introduction

Historically we have observed how difficult it has been, if not impossible, the dialogue between the humanities and the biodynamic sciences in areas of knowledge that have a hybrid identity, such as physical education and even dance. Even though dance is located in the great area of the arts, several studies have shown the possible links with the fields of biomechanics, neurophysiology, anatomy, and neuroscience.

The very constitution of an academic-scientific area called Dance Medicine & Science (DMS) shows how these fields can contribute to the understanding of movements and postures, the prevention of injuries, body preparation, decision making in pedagogical projects of teaching dance and training of dancers and, finally, with more critical choices in all the processes that involve the experience of dance itself.

Through the works presented at the BR-UK DMS Network Workshop 2016, it was possible to see how, thinking of the gains involved, the possibility of a dialogue between those areas is a two-way road.

The separation of the great areas of knowledge as a whole ends up making it difficult the understanding of the human being and his dispositions in a dimension of totality. Faced with this difficulty of academic-scientific dialogue, but already abreast of concrete possibilities, this study

points to an attempt to approximate the field of aesthetics and neuroscience, more specifically neurophysiology and studies on ontogenesis and phylogenesis of the human being.

Thinking about the aesthetic experience, which is a peculiarity of the human being, we know that the dance that today excites and dares contemporary men and women is not the same as the time of the engrave drawings on the caverns' walls. The formation of the five senses is a work of the whole history of the world up to now<sup>1</sup> (p.110).

It took thousands of years to form organic structures that gave men and women, living in society, conditions for developing language and transforming the world around them to satisfy their needs. When Marx names work as an activity by which the human being seeks to satisfy his needs, he makes it clear that it is not only the so-called "stomach" needs, but also the so-called "spirit" needs, and that includes aesthetic experience, the art:

In the words of Engels<sup>2</sup>:

"In the course of history the human being transforms nature and himself. The hand is not only the organ of labor; it is also his product. Only by working, by the adaptation to new and new functions, by the hereditary transmission of the special improvement thus acquired by the muscles and ligaments and, in a wider period, also by the bones; only by the ever renewed application of these abilities transmitted to new and more and more complex functions was that the man's hand reached that degree of perfection that could give life, as by magic, to Rafael's paintings, to the statues of Thorvaldsen and to music of Paganini." (p.16)

We emphasize, especially in modernity, the advancement of the capacity of creation of the human being, the multiplicity of possibilities that are presented to us and still a set of potentialities that is announced in the field of artistic creation and especially in the field of dance. From this complexity, new questions arise for modern societies, there is a new demand for aesthetic education, which has a direct impact on the educational ideal of this historical time.

We know that there is already a group of researchers that move through the field of the so-called neuroaesthetics, investigating relationships between the spectator's aesthetic experience and its organic mechanisms, in view of a pedagogical strategy<sup>3</sup>.

The main objective of this work (still in progress) is to produce a reference synthesis on the historical constitution of the senses that allow the human being to live different and diverse aesthetic

experiences, starting from an academic-scientific dialogue between the fields of aesthetics and neuroscience. Based on this reference synthesis, we will continue the broader research process in new research projects focused on aesthetic education, its relevance and its potentialities, making use of different methodologies.

## Methodology

It is a bibliographical research, based on a survey and analysis of works - books, articles, theses, dissertations, among others - on the central themes, namely aesthetic experience and human senses, constitution of the human senses, aesthetic education throughout History, contributions of the field of neuroesthetics, etc.

## Results and Discussion

In a previous work<sup>4</sup>, we undertook the critique of an understanding of dance as a high performance of extreme technical mastery, identified with values of high productivity. Such expression could only materialize in centers of excellence, rare, closed, and very difficult to access, where, in the name of dance, what is sought is the technically perfect execution of the movements and a maximum standard of performance of physical skills and abilities.

At that moment we were in doubt: is there room for the aesthetic experience in such places? what would support the pedagogical process in this case? what place does the body occupy in this perspective of dance? We concluded our analysis stating that:

The body becomes a hostage of a dictatorship of technique and image, and worse, certain techniques and certain images of perfection. The teaching of dance in this case becomes practically in training, in repetition, in improvement of skills, without the corresponding possibility of handling these elements in artistic creation, in the appropriate re-reading of a subjective or particular nature.<sup>4</sup> (DE PELLEGRIN, 2007, p.53 )

In the current research, already in possession of a critical analysis including other nuances of dance, we perceive that there is an advance in several fields of scientific research. However, as a rule, for a variety of reasons, this knowledge is not yet available to the people who work with the training of these performers, which can further deepen some pedagogical misunderstandings, including physical damages (muscle, joint, etc.).

## Conclusions

So far, we can make some preliminary inferences, which point, albeit timidly, to attempts at academic-scientific dialogue between the different areas of knowledge, with emphasis on the arts and neurosciences, seeking to understand the human being in a perspective of totality.

In addition to this perspective of broader understanding, we see potentialities for new propositions of pedagogical strategies in the field of art. It is possible that this movement is still less expressive in the field of dance, but we consider that there is a concrete announcement of progress, in view of the interlocutions with related areas.

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## NEUROSCIENCE AND CREATION PROCESSES IN DANCE

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### Summary

Dance has directed its interest in the study of brain processes involving the expression, creation and execution of the movement. In its different approaches - somatic education, performance, reception - dance was greatly benefited by the contribution brought by the neurocognitive studies, especially in the 1990's. The creation process is of special interest in neuroscience applied to dance, considering the individuality of the creator and at the same time the multiplicity of possible operational procedures. This study aims to understand mental manifestations of the creative process in dance, highlighting the emotions that lead to decision making. The conceptual basis will be defined from concepts such as creativity, memory and mirror neurons. It will use functional brain imaging methods and will be carried out as a doctoral research project between 2015 and 2019.

**Key words:** Dance; Choreography; Creativity; Mirror-neurons; Artistic creation.

### Introduction

Dance and cognitive neuroscience are intriguing themes that can be combined in building a coherent research proposal. Moving beyond the boundaries that still separate them is something inevitable in the present artistic, scientific, social and market moments. They are, apparently, disciplines with opposite methodologies. However, in the last two decades, they have become coherent majors, even if they are full of challenges and methodological pitfalls.

Several researchers in the area of Dance Medicine think that scientific research has a clear priority over research in arts, at least in terms of funding and research incentives. It will not be the intention of this academic paper to validate one over the other. Research in science is driven by hypotheses, whereas in art it is driven by discoveries. However, intuition, unexpectedness and experience also play an important role in science, just as systematization can offer resources to art. The use of terms such as improvisation, serendipity, trial-and-error, exploration, and others common to both areas serves to make the researcher aware of the relevance of cross-referencing concepts. The unpredictable is necessary to both the arts and the sciences and helps to clarify and consolidate the artistic practice as research.

Jola<sup>1</sup> instigates: "We have to be patient; research in the arts is still an emerging discipline." And he proposes that for artistic research to fulfill its objective of broadening our knowledge of the world and of ourselves, aligned with the lines of scientific research, it must meet certain requirements. They are: originality; rationale: clarity in the justification of the study of the theme, reference to previous studies and situate it beyond its own discipline; experimental methodological approach, in which there is no exclusive method for academic research, and the choice of method does not necessarily determine its validity as an investigative process. However, whatever the procedures, they must be very clearly stated. Methodological pluralism must be present in order to guarantee the criticism and constant revision of practices; accessibility - ensure visible results through presentations, performances and documentation; reliability: preserving authenticity, recognition of authorship; guarantee ethical precepts of education in dance.

Dance is an immensely rich source for the study of brain processes involving the execution of body movement, its creation, perception and expression<sup>2, 3, 4, 5, 6</sup>. Ideally, dance and neuroscience share research topics whose questions can only be answered by an approach that considers both fields.

In this way, the general objective of the project is to deepen the understanding of the discoveries of neuroscience on the creative process in dance. The specific objectives are to analyze, in the light of neuroscience, creative processes of choreographers relevant to the contemporary dance scene; and propose a methodology of creation in dance based on neurocognitive optimization.

### **Accepting the Collaboration Dance - Neuroscience**

Dance is a remarkable tool for the study of cognition and the sensory processes of the human brain, extremely convenient to the use of researchers. The number of publications using dance and neuroscience, as well as the number of scholarly works using substantial neuroscientific frameworks has been remarkable since the 1990s. Each decade, specific interests are highlighted by the World Health Organization, leveraging investigative progress through preferential incentive. In the 1990s, determined by WHO as the "Decade of the Brain", special incentives were directed to neuroscience research, bringing new knowledge decisively relevant in areas as diverse as Law, Anthropology, Mercadology, Informatics and the Arts, among other<sup>7</sup>.

The scientific interest in dance is growing. In the northern hemisphere, several research institutes have been supporting successful encounters between art and science, particularly medicine. The recent popularity of dance in the field of cognitive neuroscience is based on the discovery of the mirror neurons<sup>8</sup>. A Italian group of researchers demonstrated in monkeys that a particular group of neurons

was activated when the animal got food, but also when he was just watching someone picking up food. Thus, he inferred that such neurons were activated by the action, regardless of the system (visual or motor - *see take the food, or take the food properly*).

Current techniques of neurophysiological investigation make it possible to investigate these assumptions more closely. Transcranial electrical stimulation (TES) allows us to measure which neural pathways are prioritized for a given muscular movement. Functional magnetic resonance imaging (fMRI) demonstrates which regions of the brain are active<sup>9,10,11,12</sup>.

Kinesthesia (sensation of movement and position) has already been discussed in fields such as phenomenology and aesthetics. Neurophysiological investigations using TES and fMRI have shown that the kinesthetic response is more likely to be activated if the viewers themselves have the experience or technique required to perform the observed action. The project "Watching Dance: Kinesthetic Empathy"<sup>13</sup> relates qualitative public research, quantitative neurophysiology and choreography. The goal of the project was to increase understanding of how we perceive and promote body representation by comparing lay or novice viewers in dance with experienced dancers. Jola<sup>13</sup> also proposed, in these studies, that the frequent spectator exhibits characteristics of expertise in the observed movement. Despite the controversies that still exist, it is believed that these connections are central to the viewer's awareness, perception, and response, and that dance audiences may experience bodily and imaginative effects of movements without moving their bodies. That is, the viewer may react, in a sense, as if he were moving, or preparing to move.

Dance in all its processes - somatic education, creation, performance, reception - has greatly benefited from the light thrown by neurocognitive studies.

### The Choreographic Creation Phases

The process of creation is a special interest in neuroscience applied to dance, in view of the creator's individuality and, at the same time, because of the multiplicity of possible operational procedures.

Movement is everywhere: "Life is full of it and it is only possible through it," says Jola<sup>1</sup> (p.209). To understand a movement, it is imperative to understand its logic. It can be seen as a physical process or as a significant element of action.

Movement is the result of a release of energy through the muscular response to an internal or external stimulus. This response generates a noticeable result in time and space. The trigger for movement can be a thought, a feeling, a memory, or any other perceptible agitation of the soul. (...) We all feel something, but the great secret is to find just that form of movement that is

going to touch something inside someone. (...) Developing a choreography is a process of exploring a theme, finding something to say, developing and defining a believable expression in some language of movement. There are things I could express much more accurately with dances than with words. The idea is to create an expression of the body that other people can understand with their minds, their insides and their hearts (...). I am a persecutor of the movement. I am continually seeking ideas, suggestions and inspirations. But what enables me, as a choreographer, to find my own new ideas and movements day after day? How can I continually recreate the individual physical expression of myself or my dancer?<sup>1</sup> (p. 211)

The art of finding new movements is to grope inner impulses and carefully work their expression through the physical body. This quest is closely related to diligence and persistence. Creativity is also involved in repeatedly experiencing a movement in various forms until it satisfies its creator. To discover and create movements, it is essential to keep the intellect available and exercise curiosity. What is seen when a dance is presented in the scenic space is the result of a creative process based on intense work, consolidating the choreographer's intimate speech.

Gregor Zöllig<sup>14</sup>, choreographer of the Tanztheater Bielefeld (Germany) exemplifies his choreographic process, while supporting the neuroscientific study of it:

I go through the phases of the creation process looking for images, scenes and movements for a dance. If you miss a single of these phases, a decisive element may be lost. In the end, it is the audience that experiences the visual and acoustic result of the choreography, and interprets it to make it a singular affirmation.<sup>14</sup> (p. 218)

The phases described by the author for the choreographic work are: 1) to explore the theme and find full accessibility to it - reading specialized literature, video assistance, museum visits, field research, searching for everything that can be found on the topic. The seek, at this stage, of an insight from the choreographer, images that fit in his/her feelings and associations; 2) build the "frame of creativity": concept of set design, characterization and music. The theme is established as a written concept and the choice of theme determines the selection of the song. The musical style models the content and atmosphere of the dance. The way music is used can be brought as a preponderant dramatic element. For example, the decision to contrast music with dance or to dance the movement exactly according to music can establish important interpretive accents and decisively change the meaning of a dance. It is not the concept that dictates the forms to be developed, but the creative work; 3) build a creative environment for the group of artists involved in the work. It is

necessary to establish a mental space from which creativity can emerge. All senses must be accessed, at all levels. The dance space becomes a playful and permissive space. The role of the choreographer is to inspire and motivate the team:

They must be passionate about the theme, and each one must be free to try without constraints. So while we're improvising, strangers are not allowed in the rehearsal room. The spontaneous actions of the dancers generate many new ideas and impulses that are simply the product of that singular moment. And everything can change from moment to moment.<sup>14</sup> (p. 219)

4) improvisation: find ideas, movements and paths through space. At this stage, the dancers become co-authors; each has its own individual argument. There is no universal expression for pain or joy; different dancers will find different ways of expressing boredom, anger or passion. Improvisations are recorded on video; 5) fixing and fine adjustments: design movements, scenes and ideas in terms of sequences and structures. Work them out in detail, and rehearse them. Only 5 to 7% of the ideas developed during the improvisation phase will be used to finalize the choreography. Movements are refined, group timing is rehearsed, and sequences are coordinated and fixed in space. Once the movements are dominated by the dancers, they know exactly what they are doing; they understand the intention, the form, the dynamics, the temporal and spatial structure of the sequence of movements. They begin to "play" with it and interpret it in fine nuances of expression. 6) move things from rehearsal to stage, with set design, costumes, props, lighting and sound. Adaptation of the sequences to physical spaces different from the one where it was first constructed; sensory adaptation to new dimensions.

## Conclusions

The material presented in this expanded summary is part of the theoretical basis for my doctorate, which is in the process of fundraising for the experimental phase. It is intended to use functional mapping techniques of subjects' brains at the time of choreographic creation. The measurements will take into account the context of these subjects and the discussion should overcome purely neurofunctional issues, finding the pertinent reflections related to the creative processes in the performing arts.

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## RESEARCHING CREATIVITY, NOVELTY & THE IMAGINATION IN DANCE SCIENCE

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### Abstract

Dance educators have used mental imagery for many years to facilitate dancers' alignment, technical skills, neuromuscular coordination and general conditioning. However, the extent to which mental imagery is used in the teaching of choreography is less known. Here we present an overview of our research in progress, where we undertook the first experimental study of the benefits of training in imagery for overcoming creative habits in dance. Contemporary dance students (n=232) were recruited to the research as part of a three-year longitudinal study into creativity and imagery in the dance setting. Participants were tested on entry to the contemporary dance programme (Time 1), six months after entry (Time 2), as well as at an 18 month follow up (Time 3). Students were divided into two groups; half of the students participated in normal dance curriculum, whilst the second half participated in the normal dance curriculum and received a six-week imagery training intervention between Time 1 and Time 2. Although our results are yet to be analysed, we highlight the implications of this research for broadening dance science as a discipline, as well as for questioning pedagogical approaches to teaching creativity in contemporary dance.

**Key words:** Imagery; Creation; Choreography; Contemporary dance.

### Introduction

Early research tended to refer to mental imagery within a unisensory modality, such as motor imagery, which is described as the internal rehearsal of movement without physical execution<sup>1</sup>. Humans, however, are able to image in multiple sensory modalities such as smell, sound and taste, through recreation of ideas in the mind, in the absence of perception<sup>2</sup>. It is widely accepted that dance educators have used mental imagery as part of their pedagogical repertoire for many years<sup>3</sup>. Since the 1930's, many dance experts, particularly within a number of somatic techniques, have developed systematic imagery use. Established as a result of her own bodily limitations, Todd<sup>4</sup> argued that imagery grounded within mechanics could be used for reimagining and enacting biomechanical changes, resulting in changes in poor postural habits. Emphasising the somatic experience, Todd believed that all images should be incorporated within the body, thinking through and within one's own body, rather than thinking outside of the body. Shortly after, Sweigard coined and popularised the term *ideokinesis*<sup>5</sup>, referring to an idea of movement. In ideokinesis, the body and image are seen as one entity in order to gain greater control of posture and alignment. Franklin<sup>6</sup> extended this idea, capitalising on discoveries about neuroplasticity, arguing that imagery allows changes in mental representation of movement, facilitating musculature changes.

Mental imagery is popular within sport and exercise motor learning. Research has demonstrated that imagining movement when combined with physical practice can enhance skill execution<sup>7</sup>. In addition, sports psychologists have also proposed a number of additional benefits of imagery for sporting and performance optimisation<sup>8</sup>. Mental imagery has been widely advocated for increased focus, confidence and motivation and is identified as the most commonly used psychological technique amongst United States sports psychologists<sup>8</sup>. Consequently, performance psychologists have developed Psychological Skills Training (PST) which encourages mental imagery use as one of four discrete behaviours which aim to increase performance success and personal well-being. Increasing numbers of dancers are now accessing systematic PST throughout their education and career.

Mental imagery has long been supposed to play a role in creativity, with researchers indicating that a rich imagination is necessary for creative processes to occur<sup>9</sup>. However, systematic research has shown only a weak association between imagery use and creative production<sup>9</sup>. Whilst imagery and creativity are thought to be linked, the exact nature of the relationship is unknown. Given the prevalence of imagery, dance pedagogy may be an ideal applied setting for testing a number of questions surrounding imagery and creativity. Movement creation is of specific interest as a field that may benefit from enacting training of imagery control, since contemporary dance is a genre invested in overcoming habitual tendencies to create new movement material.

Initial enquiries have been made into the role of imagery use in dance movement creation through the application of a cognitive theory of mental representations known as *Interacting Cognitive Subsystems*<sup>10</sup> (ICS). This macro-theory offers an evolutionary explanation of a wide range of mental phenomena, which might be understood through nine subsystems which process information as a mental code. Working alongside a professional, internationally renowned choreographer, researchers have begun to systematically investigate mental imagery in choreographic movement generation<sup>11</sup>. Data were collected via an experience sampling methodology, whereby recent imagery experiences were probed during the movement creation, using a newly developed an imagery experience measure, to facilitate the collection of imagery responses within the ICS framework. Using the measure, professional dancers reported their responses to spatial-praxic and emotional imagery tasks, finding that the task itself affected imagery use across the multiple modalities. For example, emotional tasks tended to produce more intuitive images. This research offered a snapshot of dancers' imagery use within the ICS framework for generating material. It did not consider the relationship between imagery use and creative output, the extent to which systematic training in imagery can lead to changes in imagery use, or the extent to which this imagery use related to creative ability. It is to address some of these points that our research has been developed.

## Methods

This project was a 3-year investigation into dancers' use of mental imagery within creative dance educational contexts across three UK academic institutions. Adopting a quasi-experimental research design, the dance students (N = 232) were divided into either a control group or experimental group. Both groups participated in their regular dance program while the experimental group engaged with specially created teaching materials designed to enhance dancers' use of mental imagery. Participants were tested on entry to the contemporary dance programme (Time 1), six months after entry (Time 2), as well as at an 18-month follow up (Time 3). At each time point, participants took part in a 90 minute data collection session, prepared and delivered by the research team.

Each session began with completion of consent forms and students were asked to generate an ID code to be retained throughout the three-year research project. Following this, participants completed creativity measures under timed conditions. Students then completed a measure of typical imagery experiences when creating movement. Next, students were asked to conduct their own warm up before being lead into a movement generation task, which encouraged exploration of ideas for creating an original piece of movement. Students were advised to draw on all of their knowledge, experience or ideas about movement in exploring the task. Students were informed they would be interrupted every few minutes to complete the imagery experience measure about their current imagery experience.

The task was an imagery-based movement generation task which had been developed by the principal researcher in collaboration with choreography and research staff. Efforts were made to balance each variant of the task to feature multi-modal imagery, and not to be biased toward any particular imagery modality (visual, acoustic and kinaesthetic/schematic). The imagery task was read and was not repeated to the group, unless a specific request was made by a student. Students explored the task, and after five minutes they were stopped and asked to complete the first imagery experience measure, at which point the stopwatch was immediately restarted for five minutes. Students were asked to note what was at the forefront of their mind, and complete the measure, before continuing with the movement task. After five minutes on the stopwatch, students were again stopped to complete the next imagery experience measure, while the stopwatch was restarted. This procedure occurred four times in total, with students moving from movement task to imagery experience measure. On completing the fourth imagery experience measure, students were invited to continue moving if they wished. Students then completed a general creativity test, which measures divergent thinking.

## Discussion of Training Materials

To form the intervention, a series of teaching materials were adapted from a previously designed set of materials<sup>12</sup>. The re-development of the materials was a collaborative endeavour by the research team, informed by four practitioner-teachers, and underpinned by *Interacting Cognitive Subsystems*<sup>10</sup> (*ICS*). *ICS* distinguishes between nine subsystems and offers an explanation of how cognitive processes can be explained by the interlinking functioning of reciprocal loops between subsystems. Each of the nine subsystems is thought to share a common internal structure, which allows information from functionally independent processes to be organised in parallel. Each cognitive process is abstracted in a mental code and can be transformed into other representation.

We developed a series of workshops underpinned by *ICS*, where students received six weeks of working with videos, exercises, movement tasks and discussions, delivered in groups by the four practitioner-teachers, between Time 1 and Time 2. Teachers followed a teacher's guide, to ensure similarity of experiences across all students. Each element of the training materials and exercises was specifically designed to encourage the strategic use of mental imagery to support new creation, allowing us to understand whether training in imagery can facilitate creativity. Each session targeted three core skills:

1. 12 Principles for manipulating imagery;
2. Navigating an Attentional Score based on the knowledge that just as we can be directed to navigate around the visual world, we can also navigate around the structure of the mental world;
3. Application of skills in imagery modalities: auditory (Morphonolexical), schematic (Implicational) and visual (Spatial-praxis).

The results of the research are still under analysis, in order to determine a) the relationships between imagery and creativity and b) the effectiveness of enhancing creativity using our imagery intervention training material. This research demonstrates a means of implementing systematic imagery training into the dance curriculum. We suggest that there will be a number of meaningful implications of this research, particularly through the broadening of dance science as a discipline into a new era of interest of the dancer as creator.

We emphasise the importance of investigating the scientific nature of artistic experiences in dance, moving beyond the health-based traditions of dance science. We hope that our research will also draw attention to the need for questioning pedagogical approaches to teaching creativity in contemporary dance.

## Conclusion

In a review of motor imagery<sup>13</sup>, the authors conclude that an individual's knowledge of, and control over, their mental imagery skills is an important area of future imagery research. Our study seems to be the first of its kind to scientifically investigate the ways in which dance students use mental imagery when creating movement material in choreographic contexts. A secondary aim was to examine the inclusion of practitioner-teacher expertise as an effective means of implementing scientific questions. It is suggested that application of rigorous imagery models will bring many benefits to researchers and practitioners, thus the development of research that addresses the nature of the imagery and creativity relationship *and* systematically applies imagery is imperative. This research is, to our knowledge, the first systematic investigation of the relationship between imagery and creativity in dance. Additionally, it is the first to interrogate the supposition that new movement creation can be facilitated by dancers' reflection on mental imagery habits, supplemented with education of ways to overcome these habits. Whilst the research is still underway, we can conclude that a science-practitioner collaboration is possible, allowing psychology research to take place outside of the laboratory, in the dance studio.

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## EXPERIENCES WITH SOMATIC EDUCATION: FROM BODY PREPARATION TO COMPOSITION IN DANCE

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### Abstract

This text brings a reflection about processes of technical and artistic training in dance developed from 2012 to 2014 in community academic projects of a graduate dance course aimed at educating future dance teachers. In considering the Poetic Anatomy of somatic practices as a fundamental and meaningful element for the preparation and composition in dance, and in search for a somatic methodology of research from and within practice, it is understood that the transdisciplinary characteristics of Somatic Education favors the development of more horizontal relations. The new body and relational configurations from the experiments performed tend to favor a multiple environment of healthy bodies in creative states.

**Palavras-chave:** Body-Mind Centering; Transdisciplinarity; Practice as a research.

### Introduction

While I selected what aspects of my research that I would share with the colleagues, scientists and artists, that were at the Workshop of the BR-UK Dance Medicine & Science Network in August 2016, in Goiânia/GO, some memories came to the surface especially about the relation of art and science.

I remember, for example, that the theme of the 6th Congress of the Brazilian Association of Research and Graduate Studies in Performing Arts - ABRACE, the most important congress of the area in the country, held in São Paulo in 2010, was *Arte e Ciência: abismo de rosas* (Art and Science: abyss of roses). The theme is emerging, especially in Brazil, where graduate and postgraduate courses in dance and theater have been consolidated as an invitation for artists to reflect on their practices and to forge methodological approaches to research motivated by practice, without necessarily having to be adapted to preexisting and generally borrowed models from the sciences. During this period I could not perceive very well the possibilities of this interaction nor its challenges, which are certainly not few<sup>1</sup>.

Coincidentally, in the same year I had a scientific article published in a book that compiled texts about somatic approaches and their applications, called *Em Pleno Corpo: Educação Somática*,

*movimento e saúde*<sup>2</sup> (In the Body as a Whole: Somatics, movement and health). This article was my first attempt into the field of scientific research, considering that it was the result of a project developed in a postgraduate course in Exercise Physiology and Sport Science at the Federal University of Uberlândia. At the time, I was guided by a biomechanician. This first and only attempt into sports science research made me return with all my strength to the art research. After all, I did not find many gaps for the exercise of artistic creativity in the various statistical and quantitative tables that I had to submit with the data obtained.

So, over the last ten years, I have dived deeply into the practice and research of two specific somatic approaches, *Body-Mind Centering*<sup>®</sup> (BMC), and the G.D.S<sup>®</sup> Muscular and Articular Chain method.

The practice of BMC was developed by the North American Bonnie Bainbridge Cohen and collaborators. This practice involves a deep understanding of child development and body systems as a foundation for the mapping of the body tissues and repatterning through touch, movement and voice. The didactics of the method involves basically three fundamental aspects: visualization, somatization and embodiment<sup>3</sup>.

G.D.S is a method developed by Belgian physiotherapist and artist Godelieve Denys-Struyf, who studied aspects of human behavior, observing how the musculature organizes and structures the human body according to the function and conditioning habits of posture. She brought her contribution to a therapy based on the totality and the integration of the typologies of muscular chains, that is, a postural problem in one part of the body affects the whole precisely and vice-versa. It is an approach that changes paradigms in the prescription of physical activities, stating that each person needs to do specific exercises and that it is neither possible nor recommended to have a general prescription for groups of people without checking which muscular chains need to be released or potentiated in each individual. Although, there are procedures designed for group work<sup>4</sup>.

Both methods share the affinity of belonging to the field of somatic practices, which Thomas Hanna defined as "the art and science of the processes of synergistic interaction between consciousness, biological functioning and the environment"<sup>5</sup>. The two also share the experience of experiential anatomies developed according to their specific goals. More than repeating what the traditional anatomy proposes, they recreate the anatomical approach, suggesting new classifications and practices that favor the development of expressiveness. So, the experiential anatomy can then be thought as poetic anatomy. In exploring a new anatomy from somatic practices to creative dance processes, I am interested in developing an anatomical-performative approach.

This is the theme I currently develop in my PhD research: precisely with the aspects of the poetic anatomy in the experience with the expressive movement, which in dance includes the aesthetic aspects to which this education can be destined. In addition to ensuring that dance practice is nurtured by a knowledge of the limits of one's own body and from them to find new meanings without forcing themselves to go beyond their structural and functional capacities at present. Mainly by dealing technically and expressively with dance from the body at that specific moment in time, and not based on an image or ideal of perfection in dance focused on the future.

I offer here, briefly, a summary of the creative experiments in dance and somatic (BMC and G.D.S.), developed from 2012 to 2016 with groups of students of the dance course of the Federal Institute of Brasilia. The experiments were developed from in university community projects subsidized by PROEXT 2013 and PROEXT 2015 from MEC/SESu.

## Methods

In the quest to describe the method of research used, I chose to delve into practice as research, to forge a path connected with to the very practice of creative processes. However, this is an immense challenge not only for me. First, most research requires a description of an "accepted" and perhaps consolidated method, and secondly, because over the last few years I have had to adapt my research to qualitative methods in order to find financial subsidies for its development in the educational institution where I teach.

In his *A Manifesto for Performative Research*, Brad Haseman<sup>6</sup> criticizes the "methodological constraints of qualitative research and its emphasis on written results", highlighting that this type of method tends to look at practice more as an object of study than as a method of research. In this sense, he affirms that in a practice as research, other forms of expression, such as moving images, drawings and performance itself, for example, can be considered as "texts". The author is radical in saying that dance itself is the way of publishing a research in dance, for example. However, within consolidated institutional schemes, it is rare to find a loophole like this.

The somatic-performative research of Fernandes is methodology that tries to propose new paths for the research in Performing Arts, involving several principles, such as: foundational, thematic and contextual. It is an approach that includes several possibilities, being based in the concept of "Art to the Art" as a fundamental element of its procedures. Subject and object are integrated into their roles within this research. By affirming the unique ability of the artist-researcher to "transform secular dichotomies into somatic and ecological modes of contemporary life"<sup>7</sup>, the author seems to affirm another type of privileged intelligence in this approach, a somatic intelligence.

However, this type of Intelligence, which is usually part of the cellular consciousness, long before it is recorded by the nervous system, has another time, quite different from the actual time of the productive and "reproductive" demands of the academic universe. Somatic-performative research products also include multisensory data records such as drawings, texts, testimonials, moving images, still images and sounds, among others. This should not be confused with lack of rigor in research, but the research rigor in somatics aligns itself with other paradigms, which may be fallible, because they do not necessarily have to be "proven."

The researches carried out in the extension projects described here were based on somatic-intelligent practices as a starting point, diminishing body-mind and subject-object dichotomies. In this path, the multisensory expression of the data is fundamental. Thus, cut through by somatics, research starts from practice and ends in practice, even considering that writing is also a kind of practice.

In this manner, from August to December 2012, we conducted experiments with the practice of Contemplative Dance (PCD), a dance improvisation structure based on sitting meditation, which was proposed by the North American Barbara Dilley (2010). From March to August 2013 we worked with Esferokinesis®, developed by the Argentinean Silvia Mamana, which suggests a BMC application on inflatable balls of various sizes. From August to December 2013, affected by the two practices, the process of composition of the choreographic work *O [não] Costume de Adão* was given, whose continuity and investigation followed through the year 2014. In 2015 the principles of BMC and G.D.S. started to be integrated into the proposed practices and served as a basis for the composition of the work *Pequeno Tratado de Violências Cotidianas*. In the same year, inspired by the "subcellular system" of BMC, we developed the work *Mitopoiesis*, whose theme revolved around the creation of collective myths from the anatomical and physiological aspects of cellular organelles. In 2016 we created a new version of the previous work and presented it in public schools in the Federal District. In addition, we have developed *Margem Funda*, a work of choreographic solos created as a result of the technical and artistic trainings experienced by participants in the projects and activities developed since 2012.

The main goal of the described projects was to provide participants with long-term technical and artistic training in contemporary dance, familiarizing them with practices close to the professional world of the contemporary dancer, such as experience in creation processes, stage experience, experiences in body preparation for dance, interaction with the public, language and movement research and healthy practices through Somatic Education.

Most of the proceedings, trials and public presentations were filmed and photographed. Participants produced dances, drawings, photos, testimonials, oral and written reflections. The appreciation of the multisensory productions of the participants elicited the brief discussion shared below.

## Results and Discussion

Somatic education, according to Fortin<sup>8</sup>, Bolsanello<sup>9</sup>, Strazzacappa<sup>10</sup> and Ginot<sup>11</sup>, finds three fronts of action, including art, health and education in its genesis. Thus, it tends to work with a process of expanded understanding for the awakening of the senses, beyond vision and learning by reproduction and repetition. Although Strazzacappa and Costa<sup>12</sup> affirm the multidisciplinary character of this field by investigating which areas produce the most articles and other academic texts on the subject, we can affirm that, from the point of view of how somatic practices self-organize, this is a transdisciplinary field. Especially for its experimental, sensory, inclusive, complex and performative character in various levels of reality, besides not necessarily configuring itself in a new discipline and favoring a "trans" state, of experimentation and inclusion of possibilities.

Of the 29 participants in the projects over four years, nine of them took part of the activities proposed on a few occasions, 15 for at least one year, and only four in all the activities carried out. Of these four, three are women and one is a man. The inclusive character of the collective and the somatic practices developed favored an environment in which each one was responsible for their choices and desires. The autonomy of each one in deciding how long and how far to go was built based on trust and the horizontality of the relationships. In this sense, the projects showed that it is possible to break with the hegemony of the relations that traditionally formed the professional and academic environments of dance, based on the instrumental vision of the body, on the subjugation of the dancers by the choreographer, in excess and virtuosity as a rule, despite of their own health, favoring the development of sometimes irreparable injuries<sup>13</sup>.

It is perceptible, in the trajectory of the participants, what we call during the processes of "stripping layers". With each process we perceived that layers were being stripped, similar to the investigation of the different body tissues through BMC, in which, by using touch, we invited them to find ways of expression. Therefore, I consider that the four participants that stayed for a longer period of time could "undress" deeper layers of artistic expression and self-knowledge. The expressive dimensions of gesture (qualities of movement) were developed with more emphasis through somatic practices. Figure 1<sup>17</sup> shows these four participants on a scene in the performance *Pequeno Tratado de Violências Cotidianas* (Little Treaty of Daily Violences), 2015.

According to Fortin, Vieira and Tremblay<sup>14</sup> the technology of Somatic Education can be understood as a technology of the self, which would serve as a seizure of power in processes of subjectivation

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<sup>17</sup> For this image, please refer to the expanded summary in Portuguese.

against the technologies of domination, that tend to objectify and instrumentalize bodies, dances and the research.

In the field of dance studies and practices, technologies of domination would manifest themselves in the prevalent discourse of dance, which preaches the perfection of an ideal body and the attainment of a model assumed as desirable for all who seek to become dancers. Those with the intention of becoming dance teachers can sometimes only follow this idea, reaffirming the existing statement that to become a dance teacher it is necessary to have been a "great" dancer.

Thus, the dominant discourse of dance to which the authors refer is consistent with an instrumental approach of the body, while the so-called marginal discourse aligns itself with the processes of subjectivation. Again, the experimental nature of somatic practices is evident, placing it within what we know as transdisciplinarity, an experimental, open, unstable and inclusive terrain.

### Conclusions

The power of the experiential anatomy of somatic education, discussed here as Poetic Anatomy, opens the way for dancers to recreate their imaginations and dance from the expression of different body tissues, finding in themselves the artistic inspiration. With this "marginal" practice, which is not a rule and which by its very nature does not accept to fit into models or even to propose them, it seems possible to forge open, multiple and performative artistic processes. Including here the inherent power of promoting health from the creative act itself

Although it is evident that further research is needed to weave such statements, observing the trajectory of dancers and dancers moved by these practices in the long run raises prior considerations that corroborate a fertile path. Still, other types of research, including scientific, with quantitative approaches, for example, can be generated according to the research interests of each researcher. I leave this invitation to you all, to dive into this kind of approach, so that the inherent interest in Somatic Education can be experienced as art, health and education.

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## SOMATIC EDUCATION AND DANCE CONTRIBUTING TO THE EDUCATION OF PHYSICIANS

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### Summary

In this text, I describe two studies carried out together with the training of physicians, teachers and other professionals in the health field. One that takes place since 2000, with USP medical postgraduate students, and another, started in 2010, with students from the 1<sup>st</sup> to 4<sup>th</sup> years of the UNICAMP Medicine graduate course, where practices of somatic education, dance and theatrical improvisation provided a change in the empathy degree (Jefferson Scale) of these future professionals. From the question "How can artistic knowledge of dance contribute to the training of physicians?", I analyze the practices performed in the classroom in which somatic education exercises are integrated to dance techniques, and present how much knowledge of the body built through these experiences has contributed to a more humane formation of health professionals.

**Key words:** Body awareness; Empathy; Medical education; Body; Humanization.

### Introduction

Since 2000 I have been working with Medicine on two different fronts: first, with an intervention by a clownish character created and incorporated by me, Dona Clotilde<sup>18</sup>, along with a compulsory module of the postgraduate course in Medicine of the University of São Paulo (USP); second, providing an elective module<sup>19</sup> for students from the first to the fourth years of the medical graduate course at the State University of Campinas (UNICAMP).

I shared with those present at the BR-UK Dance Medicine & Science Network Workshop, which took place in Goiânia in August 2016, these pioneering works that began in the State of São Paulo/Brazil and have already been published in different national and international<sup>20</sup> congresses. In addition to having performed an intervention by Dona Clotilde at the opening ceremony of this event, my oral communication at the roundtable entitled "The Role of Dance in Health and in Education" pointed out that it is not only the medical knowledge that contributes to dance. The opposite direction is also true, as it proves how much dance, that is, art, has contributed to medicine.

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<sup>18</sup> For more details about the character and her interventions: [www.donaclotilde.com](http://www.donaclotilde.com)

<sup>19</sup> MD 885 Theater for Improvement of the Physician-Patient Relationship.

<sup>20</sup> In Brazil, the results were presented at the COBEM, the largest congress of the Brazilian Association of Medical Education (ABEM), and abroad, at AMEE International Association for Medical Education, by team members Marco Antonio Carvalho Filho, Jamiro da Silva Wanderley, Marcelo Scheller, Flávio Sá, Adilson Ledubino, Leticia Frutuoso and Marcia Strazzacappa.

In the present text, I present in a more systematized form the studies developed so far, indicating what and how the approximations between the fields of art (specifically dance) and medicine, and their respective contributions, might occur.

It is important to note that both fronts started off from invitations. The first one began as an invitation to perform a cultural activity with my clownish character in a state congress of medical education. When I realized that the audience I was going to face was one whose problems I did not know of, in order to compose the gags of the clown, that is, the little comic scenes, I put myself in the position of a creative laboratory. Weeks before the presentation, I wore a white coat and, with a badge on my neck, I began visiting different sectors of the university's Hospital, observing facts and collecting stories from what I saw and heard, more precisely, about the work relations happening at that venues.

The second invitation was for a one and only collaboration in the actors graduate course, where I acted as a teacher responsible for the elective modules<sup>21</sup> related to body awareness. At that time, I was invited to direct actors who volunteered to represent patients in simulated consultations. When watching the first simulation, my educator side was suddenly awakened: there was much more to be done in simulated consultations than to direct student actors. In that scenario there appeared a fundamental question regarding the training of the health professional. Thus, alongside with Professors Marco Antonio Carvalho Filho and Flávio de Sá, from the Medical Faculty, in order to respond to that call, we created an elective in which the tools commonly used in the training of performing artists, such as theater games, improvisations, body awareness and dance classes were used to improve the education of future physicians.

These fronts became pieces of research developed at the LABORARTE/Laboratory of Studies on Art, Body and Education, just over two years ago, in the forms of a doctorate in progress and two scientific initiations. The objective of the doctoral research is to analyze the impacts of theatrical improvisation in the classes of simulated consultations, through the analysis of interviews carried out with participants of these activities. The purpose of the scientific initiation researches is to digitize, tabulate and analyze the answers of the questionnaires that were applied after the interventions of Dona Clotilde in the compulsory module of the postgraduate course in Medicine of USP. After 15 years collecting data, we now have around 450 questionnaires responded, of which, until then, only multiple choice answers were tabulated.

## Methodology

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<sup>21</sup> The subjects AC 148 and AC 248, respectively "Technical Elements of Body I and II", compulsory for the first year students of the bachelors in Performing Arts of the Institute of Arts of UNICAMP.

Dona Clotilde is a clown<sup>1</sup> that plays both with the comic and the lyrical. She is a cleaning lady with a humble background who, like all invisible professions<sup>2</sup>, is unnoticed everywhere, becoming a great observer of the world. With little schooling, she apprehends the world very directly and makes critical comments to everything she sees, speaking in a debauched way. Thus, her appearance causes laughter and, at the same time, reflection. As the pedagogue Jorge Larrosa says: "Laughter shows reality from another point of view. (...) Laughter questions the common habits and places of language. And, to the limit, laughter carries the suspicion that all language is false, that all clothing, including skin, is a mask." (LARROSA<sup>3</sup>, p. 178).

The intervention of Dona Clotilde in the USP postgraduate course has been taking place for 15 years. It has been received very positively by the masters and doctoral students of this institution. Even though it is a factual activity, that is, a single intervention of 4 hours within a module of 60 hours, the gagues presented by Dona Clotilde are sharp like knives. All are based on true events, collected throughout observations of different professional venues. Sometimes Dona Clotilde receives some homework, such as to act the NR32 standard work safety case, that was enacted at the time of the epidemic of the H1N1 virus. She was booked to perform for a team of professionals at various hospitals in the State of São Paulo to assist them in memorizing the rules of that act. In order to create the scenes, in addition to reading the own normative and some scientific articles on the subject, she put herself again in a laboratory condition, visiting the centers in which problems of contamination had been detected. Her observations, added to the NR32 data, served as the basis for the creation of the scenes.

After the interventions of Dona Clotilde, participants are invited to fill out an evaluation questionnaire with an open question and a multiple choice question, the results of which I will present below.

The second front developed, which deserves more attention here, is related to teaching in the Medicine graduate course. The first experience occurred in 2010, within an elective module of the Faculty of Education called "Education, Health and Work". In it, we had a mixed crowd of medical students, students of the teachers course (Licenciate and Pedagogy) and some special students, that are already graduates. Also participating in this experience were medical professors from the Faculty of Medicine. It should be noted that the latter came to the course with the intention of only attending classes as observers. But a first lesson was learned: there is some knowledge that is processed only by experience and practice<sup>22</sup>. So, there was no way they could just observe the classes. It was necessary to take/experience the lessons. Interestingly enough, everyone, without exception, later on volunteered to fully participate of it.

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<sup>22</sup> ABEM - Brazilian Association of Medical Education, May 2001, UNICAMP Convention Center.

Some time after this experience, we created an elective module within the medical curriculum, called "MD 885 - Theater for Improvement of the Physician-Patient Relationship". Those who work (or have worked) in the administration of a public institution know the investment of time that this achievement takes and what it represents.

The initial objective of this elective module was to develop communication skills and to increase the empathy of medical students through the interpretation of scenes inspired by everyday hospital life, not necessarily ambulatory. The idea was that they could go through different situations and characters, living in their own bodies the tensions and emotions of others. The classes started with body and vocal activities, seeking the contact of the student with his/her own body in movement, through practical exercises of some techniques of somatic education<sup>5, 6, 7</sup>.

Then, with all the senses awakened, they went on to activities that used theatrical and improvisational games, having as main references the works developed by Augusto Boal and Viola Spolim. Finally, we got to the construction of scenes from chosen subjects.

Before this module is offered, a questionnaire on empathy (Jefferson Scale of Medical Empathy) is applied. This same questionnaire is reapplied at the end of the term to analyze if the participation in the module had, in fact, contributed to the increase of the empathy of the students.

### Results and discussion

After the debut of Dona Clotilde in the medical universe she never left the university hospitals. Unlike the works of *Doutores da Alegria* or the *Hospitalhaços*<sup>23</sup> that focus the patients, Dona Clotilde's interlocutors are the health professionals themselves: doctors, nurses, speech therapists, physiotherapists and social workers, among others.

Dona Clotilde's factual interventions in hospitals among health professionals and at USP postgraduate programs have been successful. The feedback from the stakeholders indicates that 92% of the participants considered her intervention to be "excellent", taking into account only the data collected from the closed question. At the moment, as stated above, the answers to the open question, namely: "Comment on Dona Clotilde's life experience in relation to her professional performance." are being analyzed (transcribed and classified). At that moment, the professionals that are taking this compulsory module are asked to write a little more (in a truthful way) about the reflections that were fomented by the gagues, situations and speeches presented by the clown, especially in what concerns their current professional practices. In addition to thinking about the

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<sup>23</sup> *Doutores da Alegria/Doctors of Joy* is a non-governmental organization founded by Wellington Nogueira in 1991, inspired by the Clown Care Unit of New York, where Nogueira worked. This Non-Governmental Organization aims to bring comfort to the sick child. *Hospitalhaços* is an Non-Governmental Organization, created in 1999, based in Campinas/SP, aiming at the humanization of the hospital environment through the participation of volunteers in hospital toy libraries.

professional practice as a physician, he/she also think about his/her role as a future university professor. This is because it is assumed that the physician, nurse, physiotherapist, and finally, the professional of the health field who attends a graduate degree at a doctoral level aims to develop investigations as a researcher of a group, or to become a university professor especially in the public health system, in which the minimum requirement for admission is precisely the title of Doctor of Philosophy.

I find in my university professional practice some approximations between the fields of education, art and health and this does not only refer to the fact that I teach in different teaching units: Faculty of Education, Faculty of Medical Sciences and Institute of Arts<sup>8</sup>. There is a close approximation between the educational and the medical practices, as pointed out by Lima: "As a physician and educator, I am pleased to support the thesis that all therapeutic action is only complete when it manifests itself as a pedagogical, educational action, assuming, as a counterpart, that all educational action will only be complete if it presents as a circumstantial result a therapeutic facet." (LIMA<sup>6</sup>, 2010, p. 78).

The second front, related to the creation of a module at the Faculty of Medical Sciences of the State University of Campinas, although still in the consolidation phase, is an action that lasts longer (six months). The data about that intervention, although preliminary, also points to the success of this activity by the increase in the empathy of the doctors in training.

This is a practical module of 60 hours, distributed in 15 meetings of 4 hours each. It takes place in the premises of the Faculty of Education in an unconventional classroom: a room with wooden floors and no sits, equipped with large rubber balls, mats, stackable chairs, wooden sticks, as well as other materials which are available to teachers in a closet (textiles of different textures, mats, cans, rubber balls, craft paper, to name a few).

Classes are taught by a team of teachers from different backgrounds, with body and theater activities running under my guidance. Based on my experience as a teacher in the area of body awareness, the focus given in the first meetings is precisely the development of this awareness by the future doctor. Accustomed to studying the body from the anatomical point of view, that is, from a dead and fragmented body, revealed in pieces (macro), or in laminas (micro), the student is invited to feel his/her own body through touch and self-massage. Then, the body of the colleague is played with, from which the differentiation between touching and contacting takes place. This activity takes the form of a warm-up and then goes on to theatrical games, getting towards the end to touch upon improvisation and the building of scenes from themes such as fear, anger, guilt, loneliness and death (among other provocateurs of negative feelings) and availability, courage, temperance, affection and love (among the provocateurs of constructive feelings). We came to choose these

topics after discussing among the responsible teachers which ones were the most recurrent and that deserve our attention in the meetings.

After several offerings of this elective module, another one, this time with a compulsory nature, was offered to the students of the second year, also aiming at developing communication skills and improving student empathy. All these modules are being studied by our team that already predicted significant positive results. In the case of first-year medical students, for example, the increase on the Jefferson Scale ranged from 117.9 to 121.3.

The results of these experiments have been disseminated in different national and international congresses attended by members of the team, among professors and doctoral students, with the following communications, published in Europe and the United States, to name a few: Schweller M, et al. Active methodologies for the teaching of empathy in medical graduation: an experience from UNICAMP; Carvalho et al. Empathy as a cornerstone of medical professional identity formation - a Brazilian experience, 2015; Schweller M, et al. To be or not to be: learning the art of being on another person's shoes through theater improvisation, 2015. In March of this year I participated in a meeting of the board of the Faculty of Medicine of the University of Rennes, France, to present the project and sign a partnership with this institution.

The success of these initiatives (creation of modules and interventions of Dona Clotilde) was confirmed when I received the award "Academic Recognition for the Dedication to Graduate Education" from UNICAMP, in December 2013.

## **Conclusions**

The introduction of academic modules that propose and apply an experimental bodywork through activities of body awareness, exploration of movements and theatrical improvisation games collaborate to improve communication and increase the level of empathy of future physicians. The interventions of the clown Dona Clotilde help in the reflection on the professional performances of physicians, nurses, physiotherapists, speech therapists, psychologists and other health professionals. These proposals should be widely disseminated in scientific congresses, university events and meetings of class associations, given their novelty approach and proven contributions to a more humane formation of professionals in the health field.

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