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Obituary:
Tribute to Lilian Gobbi

The trajectory of Lilian Teresa Bucken Gobbi (1956-2022): an eminent researcher of gait and posture

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ABBREVIATIONS

LEPLO	Posture and Gait Studies Laboratory
PD	Parkinson's disease
PROFIT	Physical Activity Program for Older Adults
PROPARKI	Physical Activity Program for People with Parkinson's Disease
tDCS	Transcranial Direct Current Stimulation
UNESP	São Paulo State University

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ABSTRACT
Lilian Teresa Bucken Gobbi, or simply Lilian, a beloved friend of many of us, died unexpectedly on October 20, 2022. We wrote this tribute to recognize her legacy in science. We reviewed Lilian's education and career and her contributions to the research on balance and locomotion in children, older adults and people with Parkinson's disease. We also acknowledged her pioneering work on physical activity interventions for people with Parkinson's disease. Finally, but not least important, we tried to show a little bit about the wonderful human being who Lilian was beyond her scientific contributions.

KEYWORDS: Gait | Posture | Parkinson's disease | Motor development | Adaptative gait

Lilian Teresa Bucken Gobbi, or simply Lilian, a beloved friend of many of us, died unexpectedly on October 20, 2022.

EDUCATION

Lilian's relationship with physical activity began in childhood as an avid swimmer. In Lilian's words: "After hundreds of medals, a few trophies and youth spent in the water, vocational tests revealed Physical Education and Teaching as the most suitable for me." [i,1]. Thus, being as determined and objective as she was, Lilian enrolled in two programs simultaneously, graduating in Physical Education at the School of Physical Education and Sports of Paraná and in Education at the Federal University of Paraná in 1977.

After a period working as a Physical Education teacher and swimming instructor, she felt the need to strengthen her knowledge to improve her professional practice. Lilian then started a Specialization in Physical Education Teaching at the Federal University of

[i] Free translation of the following Portuguese text: "Após uma centena de medalhas, alguns troféus e uma adolescência vivida dentro da água, os testes vocacionais apontaram a Educação Física e o Magistério como mais recomendáveis." (Gobbi[1], p. 4).

Paraná, where she met the late Professor Jefferson Thadeu Canfield. This program was critical to awakening her interest in Science[1]. She then completed a Master's degree in Human Movement Science at the Federal University of Santa Maria in 1987 under the supervision of Professor Canfield. Initially in her career, Lilian had a great interest in motor behavior in children. This interest led to her Master's thesis entitled "*A capacidade da memória de curta duração para informações motoras amplas em crianças de 7 a 10 anos*" [Short-term memory capacity for broad motor information in children aged 7 to 10 years] [2]. Then, five years later, she started her doctoral studies at the University of Waterloo, Canada. Pursuing professional progress and learning more advanced experimental procedures were Lilian's main motivation for continuing her research training. During her Ph.D., she wrote a dissertation about the development of obstacle avoidance strategies in children, emphasizing the contribution of visual information and intersegmental dynamics to gait control. She completed her Ph.D. in 1997 under the supervision of the late Professor Aftab E. Patla, with the dissertation entitled "Developmental trends in skilled locomotor behavior over uneven terrain" [3]. This experience was a turning point in Lilian's research career. She always shared with many of us such great stories from that period. We think that the relevance of this experience to her was the reason to encourage several of us to pursue education abroad.

UNIVERSITY CAREER

Following the conclusion of her Master's in Human Movement Science, Lilian joined the São Paulo State University (UNESP) in 1987 as an Assistant Professor in the Department of Physical Education, Rio Claro campus. The undergraduate program was starting in Rio Claro at that period (the Department was formally created in 1986), and she was one of the first academics to arrive and help build the tradition of that program. In 2008, Lilian was promoted to Adjunct Professor (equivalent to the Associate Professor rank as in several universities worldwide) with the thesis "*Locomoção adaptativa e doença de Parkinson*" [Adaptive locomotion and Parkinson's disease] [4]. More recently, in 2019, she became a Full Professor.

Lilian spent all of her career with the Department of Physical Education, where she served in several administrative roles and contributed to the Movement Science Graduate Program to achieve a high level of recognition by CAPES/Ministry of Education/Brazil. Lilian was the chair of the graduate program in several opportunities, and, more recently, she returned to this role in July 2021. She used to say that if we want to change things, we must participate in the decision-making committees. During her 30-plus years in higher education, Lilian taught the undergraduate course "Growth and Motor Development" to several generations of Physical Education professionals. She was also responsible for several graduate courses such as "Posture", "Locomotion", "Neurosciences", and "Biomechanics and Motor Behavior". Lilian was an outstanding and inspiring teacher and mentor.

Throughout her career, Lilian mentored 31 Master's and 11 Ph.D. students. She also supervised three postdoctoral fellows. Several of her former students are widespread throughout Brazil and in different parts of the world, including Canada, Europe, and Australia. For many of us, she continued to be our mentor and provided advice during crucial moments of our careers. She was highly committed to her students and touched the lives of so many of them. She taught them that the horizon was so much further than they thought; she

believed in them sometimes more than they did themselves. Therefore, it is no coincidence that some of them ended up in different parts of the world.

RESEARCH CAREER

Lilian leaves a legacy of contributions to the field of locomotion and posture research. Her research program was dedicated to understanding the mechanisms of adaptive locomotion and postural control across the lifespan and in Parkinson's disease (PD).

After completing her Ph.D. in Canada in 1997, Lilian returned to Brazil and established the Posture and Gait Studies Laboratory (LEPLO). The lab was housed in a tiny room at the UNESP Rio Claro campus and, per her own words, it was equipped with "only one computer, great attitude and energy" [1]. During the next 25 years, the LEPLO expanded not only in physical space and research infrastructure but turned into a site for high-quality research training, multidisciplinary collaboration, and research output.

The initial research endeavors at the LEPLO focused on studying locomotor behavior over the course of the lifespan. Most of these studies were led by undergraduate students, who often moved to the graduate program under Lilian's supervision. Lilian's original interest in motor development influenced many studies focusing on locomotor behavior of typical and atypical developing individuals [5–15]. Along with motor development research in children, Lilian was also active in aging research. Lilian's research program on aging shed light on sensory mechanisms involved in the control of locomotion in challenging terrains and the effects of physical activity on mobility in older adults [16–19].

In the early 2000s, Lilian conducted a series of studies comparing the motor development of children with their actual chronological age. In collaboration with local schools, undergraduate students were trained on a motor skill assessment battery and conducted tests in pre-school and elementary school children under Lilian's and her research team's supervision. In the end, individual reports were generated comparing motor and chronological ages for each child in all motor skills assessed, and Lilian met with school representatives to review the results. Research produced from these experiences included assessing children's motor development longitudinally [5], testing the construct validity of the assessment scale [6], and evaluating the role of extra-curricular activities in children's motor development [7]. While the research on motor development had been prolific, in 2003, a new line of research focused on PD would forever change Lilian's research program.

In 2003, Lilian initiated a new line of research about the influence of PD on gait and balance. This decision was driven by her scientific curiosity to better understand the underlying mechanisms of motor symptoms of PD, which profoundly impact patients' mobility and quality of life. The first experimental study investigated the effects of levodopa (i.e., the typical pharmacological treatment for PD) on gait and obstacle avoidance in people with PD [20]. Although levodopa had a positive effect, it did not restore kinematic parameters of gait and obstacle avoidance to the level of healthy individuals. These findings intrigued Lilian: if medication was not enough, what could we do to help patients live better? The answer was quite obvious to her: exercise! Given her experience with exercise interventions in older adults, Lilian's team investigated the effects of exercise as a complementary intervention for PD. The initial project on exercise took years to complete (due to limited access to people with PD at that time) and was published in 2009: "Exercise programs improve mobility and balance in people with Parkinson's disease" [21]. Lilian was amazed by

finding evidence that exercise could help people with PD. The two seminal studies mentioned above marked the start of the most intense line of research in Lilian's career, with 85 publications involving PD.

Lilian's research team became well known for their studies applying portable brain imaging technologies, namely electroencephalography and functional near-infrared spectroscopy. This new line of research in Lilian's lab emerged from the need to incorporate measures of brain activity to better explain PD-related deficits in gait and balance and the effects of interventions. On multiple occasions during the peer-review process, reviewers had questions that could not be answered by biomechanical or clinical outcomes. Then, in 2015, Lilian challenged her recently graduated Ph.D. student, Rodrigo Vitorio, to pursue the incorporation of measures of brain activity into the lab's research. After careful literature screening, they proposed the application of electroencephalography and functional near-infrared spectroscopy as these techniques allow recordings of brain activity during actual movement, providing greater ecological validity than other neuroimaging techniques that require subjects to remain immobile. In multiple projects over the last seven years, Lilian's team has identified aging- and PD-related changes in cortical brain activity during walking and standing [22,23], and neural mechanisms underlying improvements achieved with interventions in people with PD (e.g., exercise, sensory cueing, medication, non-invasive brain stimulation) [24–27].

In the most recent years, Lilian's research has been focused on understanding the effects of transcranial Direct Current Stimulation (tDCS) on gait, balance and cognition in PD. Brain areas identified as affected by PD during walking and balance tasks are targeted by tDCS protocols (i.e., non-invasive brain stimulation through electrodes placed on the scalp). Lilian's team has demonstrated that tDCS can provide benefits to gait, balance and cognition as a stand-alone intervention and when combined with exercise [25,26,28–30].

Although Lilian became a world reference in PD locomotion, she continued studying other aspects affecting gait and posture control. She had productive collaborations with Professor Jaap van Diëen (Vrije University, The Netherlands) and Professor Tibor Hortobágyi (University of Groningen, The Netherlands). The collaborations resulted in studies about the effects of fatigue on gait and posture in younger adults, older adults and people with PD (~12 studies). She supervised several undergraduate and graduate students in this line of research, including two Ph.D. students in the Netherlands. The main findings from these studies relate to describing motor behavioral changes following muscular and mental fatigue [31,32] and the long-term effect of fatigue (more than 20 minutes) on gait parameters [33]. It was also shown that the influence of fatigue started earlier than expected in individuals aged 40 years old [34]. Another research line Lilian was interested in was the influence of asymmetry on gait and posture control. She investigated how contextual (e.g., obstacle avoidance) and individual (e.g., aging and disease) aspects affect gait and posture symmetry. Her team demonstrated in approximately ten studies that more challenging walking and postural tasks [35–37] and non-faller individuals showed increased gait and posture asymmetry [38,39].

Lilian's research agenda profoundly contributed to understanding several aspects of gait and postural control in different populations, mainly in people with PD. Her commitment to cutting-edge research topics and her resolute dedication to excellence in science is a legacy for the coming generation of researchers.

COMMUNITY OUTREACH: PROPARKI AND RELATED ACTIVITIES

Lilian devoted much of her academic career to PD research, including investigating the role of exercise interventions in people with PD. But basic science research in PD was not enough for Lilian. She wanted means to apply the knowledge gained through research into practice for the benefit of as many people with PD as possible. Then, in 2004/2005, Lilian created an exercise group for people with PD as part of the Physical Activity Program for Older Adults (PROFIT) offered at her academic department. The news that people with PD attending this exercise group were obtaining impressive benefits spread through the city and region, attracting more and more patients. With the growing demand for the service, in 2008, Lilian founded a specific outreach program for people with PD known as PROPARKI (Program of Physical Activity for People with Parkinson's disease).

Lilian directed PROPARKI from 2008 until her death. During these years, Lilian was dedicated to understanding the benefits of different types of exercise for people with PD. Multimodal exercises, locomotion exercises, balance exercises (including slackline training), resistance exercises, respiratory exercises and dance were offered. A total of 346 individuals with PD participated free of charge in the PROPARKI. But not only the participants were touched by PROPARKI. Due to the pioneering and excellence of the program in Brazil, professionals from all around the country visited Rio Claro to learn how to design and implement exercise programs for people with PD.

In order to reach as many people as possible and offer support material for other health professionals who deal with people with PD, Lilian, together with her undergraduate and graduate students authored a book [40] and book chapters detailing some of the physical activity programs offered by PROPARKI [41–44]. In addition, between 2012 and 2018, Lilian organized the annual scientific event "*Jornada de Estudos da doença de Parkinson*" [Workshop on Parkinson's Disease] to discuss the current state of the art in PD with undergraduate and graduate students, health professionals and researchers from Brazil. With the goal of sharing with the participants from PROPARKI and their families the motor, clinical and cognitive benefits arising from their participation in the program, Lilian also coordinated the event "*Encontro PROPARKI*" [PROPARKI Meeting], which took place annually between 2010 and 2019.

Lilian's commitment to offering the best possible exercise program for people with PD had the single objective of providing a better quality of life for this population. She left an immeasurable legacy at UNESP Rio Claro, where hundreds of patients were able to experience a high-quality exercise program. Dozens of undergraduate and graduate students had the opportunity to study, research and understand PD impairments and the effects of exercise on PD supervised by the great researcher and mentor Lilian was.

PERSONALITY

Lilian was a transparent person and unapologetically herself. She was assertive, sincere, and direct. At the same time, she was warm and protective of those around her. Lilian was an inspiration and an influence to students through her passion and commitment to work. She introduced many of us to the academic career where we discovered our own passion for teaching, research, and community outreach. She was knowledgeable but had no problem acknowledging what she did not know, being unafraid of troughing herself into new personal and academic challenges. Lilian had clear goals and was not intimidated by

hard work. She was a skillful leader. Her successful leadership was on display in the management of LEPLO and PROPARKI, as well as in her role as chair of graduate studies (multiple times), coordinating research groups, and collaborative projects.

She was a thoughtful mentor, welcoming students and helping them to develop their professional and personal potential. Despite her busy schedule, she had an unconditional willingness to listen and talk to students. Her office, famously located in the Anatomy Building, had an "open door policy", and students were welcomed to fierce academic debates and editorial work in their writing, as well as to share experiences and receive advice. She discouraged comparisons between students and encouraged people to be the best version of themselves. Lilian encouraged students to take a stand, participate in decision-making processes, and work diligently and ethically. People mattered to Lilian, and she was committed to providing a safe and welcoming environment to students and community participants while ensuring outstanding quality and respect in the work conducted.

She was the "life of the party". Her contagious positivity, sense of humor, and loud laugh were cherished by so many of us. She loved dancing, singing, playing cards, and hosting friends at her house. There were famous barbecues and *feijoada*s (which she cooked herself). In the early 2000s, lab social events that included karaoke required two microphones, as one of them was exclusive for Lilian to sing along to all songs. She was a voracious reader, reading from fantasy books to medical literature. Some of us dove into her collection of Oliver Sacks books available at the LEPLO's library. Lilian was a lifelong swimmer and a champion of her sport. She loved traveling and often would travel with her students to conferences (on a trip in 2001, she stated that from that moment on, she would only travel to conferences with students as it was much more fun to be around students than other professors!) For former LEPLO members, it was a treasured moment meeting her at conferences to learn and laugh together. Breaks at conferences were time to tour, shop and enjoy a nice meal, and it was tough to match her energy level in these activities. Lilian met our parents and spoke highly of us; She attended our weddings; She met and cuddled our children. Yet, and above all, Lilian adored her family: Sebastião, Ronaldo, and Peri. There was no limit to her support and love for them. The way she managed to live meaningfully all aspects of her life is an inspiration to her students. Her professionalism and warm personality did not compete; Lilian mastered being both and will be deeply missed.

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