BJMB
Brazilian Journal of Motor Behavior

Special issue:
"In memory of Michael Turvey"

Remembering Michael T. Turvey: A tribute to an extraordinary teacher & mentor

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https://doi.org/10.20338/bjmb.v17i6.415

ABBREVIATIONS

CESPA Center for the Ecological Studies of Perception and Action

PUBLICATION DATA
Received 17 12 2023
Accepted 21 12 2023
Published 22 12 2023

ABSTRACT
This essay is a tribute to Michael T. Turvey, my PhD mentor at the Center for the Ecological Studies of Perception and Action (CESPA), University of Connecticut, and a distinguished figure in the field of motor behavior research. My narrative aims to showcase the exceptional qualities of Turvey as a teacher and mentor and share the insights I gained from him in the specific context of his emblematic action course. I hope these insights will enlighten and inspire others as they have me, thereby perpetuating his legacy.

KEYWORDS: Homage | Accolade | Lessons

INTRODUCTION

It has been only four months since I went to Storrs, Connecticut, to celebrate the life of Michael T. Turvey, my PhD mentor and dear friend. Writing this essay in his honor has been a challenging exercise, one that has brought me in touch with the tough reality of his passing. Initially, I planned to sidestep the pain of engaging with my personal memories of him and focus on describing how Michael Turvey, the scientist, transformed the landscape of research on motor behavior in general and impacted my research program in particular.

As I sat before the blinking cursor on my screen, however, a vivid memory of a conversation I had with Michael sneaked into my mind, transporting me back to my office in the Psychology Department at UConn. Michael had the routine of stopping by daily to check-in on us, students. "Making discoveries?", he would ask with a blend of seriousness and cheer, reminding us of our job as budding scientists. On one particular day, I was working on a manuscript. Frustrated with my pace, I asked him when I could expect writing to *just come easy and fast*. He responded nonchalantly: "It hasn't happened to me yet, mate". As he walked out, unbothered, he told me to always remember that the key to getting writing done was to *stay glued to the seat* when things got hard.

Writing still does not come easy nor fast to me. Ever. Yet, Michael's perspective has helped me appreciate that my struggles are not a reflection of personal inadequacy. Writing *is* hard—a fact compounded by institutional and societal barriers that disproportionately affect female scientists and those from minoritized backgrounds (see Mazak[1] for a brief discussion on these barriers and excellent strategies to get writing done as an act of resistance to them). There is much for us to fix in academia and beyond, no doubt. But Michael helped me notice what is always in my power to do. I can make time for writing and honor it. Even small windows of time matters. "*If you have a few minutes, you can always get a figure caption done*", he would say anytime he found me sitting around waiting for a class or for a participant. Over the years, I have followed his advice to make time for writing and use small windows of time between appointments as effectively as I can—a critical practice particularly after I became a mother. Most importantly, I have managed to *stay glued to the chair* and have resisted (often enough) the urge to divert my attention when writing feels arduous. I own much of the success I have enjoyed in my career to this practice.

After this unplanned reflection, I turned my attention back to the blinking cursor on the computer screen, touched by a feeling of deep gratitude for the many moments I shared with Michael in both formal and informal settings. Undoubtedly, he merits every accolade for his extensive scientific achievements and impact. Yet, in composing this essay, my choice was to honor Michael Turvey, *the teacher and mentor*. My narrative centers on our early encounters during my participation in one of his signature courses: Action.

THE ACTION COURSE

Action was the first course I took with Turvey, marking the beginning of my PhD journey at the Center for the Ecological Studies of Perception and Action (CESPA), University of Connecticut. I vividly recall the mix of excitement and apprehension that I—then a young scholar in training—experienced as he outlined the course in his opening lecture. It promised to be an intensive exploration of the science of motor behavior, demanding the weekly reading of 200+ pages of theoretical and empirical papers, a rigorous oral questioning session (dubbed "Socratic Hour") every Friday, a comprehensive written mid-term, and a final three-hour oral exam. Almost two decades later, I—now a more seasoned movement scientist—continue to benefit from the lessons I learned from embracing the challenges he presented to us. In the following sections, I am going to share five key lessons I learned, hoping they might enlighten and inspire others as they have me.

Lesson 1: A Strong Foundation for Conceptualizing Motor Behavior Research

Throughout the 14-week span of the Action course, Professor Turvey guided us through a comprehensive exploration of the science of motor behavior. He started the course with an in-depth look at Bernstein's work [2,3], who better than anyone before him, articulated the fundamental question facing students of movement: how do organisms regulate their myriad degrees of freedom to achieve the orderly patterns of coordination that support their activities in constantly changing contexts? As the weeks progressed, Turvey navigated through the intricate challenges—which he referred to as problems—that any scientist poised to address this fundamental question must grapple with. These include: the problem of units, the problem of tuning, the problem of synergy, the problem of anticipation, and the problem of organizational style.

In the session on the problem of units, Michael emphasized the importance of deliberately considering the candidate building blocks of action—specifically, those that give rise to context sensitive and goal-oriented movement patterns. He presented us with two options. One option is to assume, as is usual practice, that action is constructed from elemental, context insensitive, mechanisms tied to specific anatomical structures. The second, unorthodox option, is to entertain the possibility that action arise from elementary functions whose component parts and their relations vary depending on context [4,5]. The study of action coordination sure takes very different routes depending on which viewpoint one chooses to adopt and he helped us appreciate that.

The week focusing on the problem of tuning brought to light hypotheses about the processes that allow coordinated movement patterns to be tailored to contextual contingencies, underscoring the crucial role of perception in the study of action [6,7]. It was within this context, that Turvey asked us to grapple with one of his most famous and thought-provoking questions: "*How does light get into muscle?*". As a side note, I feel compelled to invite readers of Turvey's work to attend to the questions he poses. They are profoundly insightful and any motor behavior researcher can certainly benefit from grappling with them.

During our exploration of the problem of synergy, Turvey guided us through the study of candidate processes that support the functional groupings of degrees of freedom that render movement controllable [8,9,10]. The problem of anticipation exposed us to contrasting views on the processes that support regulation of movement with respect to future events [11,12]. Does anticipation necessitate explicit modeling of the future or can information that arise from ongoing organism-environment interactions guide the organism towards desired future states? Finally, the problem of organizational style prompted a critical re-evaluation of the view that the action system is a hierarchy of body structures and functions. Turvey exposed us to alternatives. He presented us, for instance, to the possibility that the action system is a functional hierarchy as proposed by Bernstein [13] or even more intriguing, that the action system is a coalition that encompasses both organism and environment [14]. Explanations of motor behavior will dramatically differ in scope depending on assumptions about how we define the action system and its organization.

For each of the action "problems" we studied, Michael not only outlined our options but also the empirical work underpinning them, modeling to us how scientists go about addressing challenging questions that have advanced the field. Nearly two decades later, the conceptual framework I obtained from the action course continue to guide my thinking. I challenge myself to think back to the described "problems" when I conceptualize and interpret the findings of my research on human performance of individuals with wide range of capabilities across the life span.

Lesson 2: Intellectual humility in Scientific Inquire

In the Action course, Turvey explicitly distinguished between two perspectives on the systematic regulation of the body's many degrees of freedom: the artifactual and natural. The artifactual perspective looks to manmade machines as model sources of ideas for understanding movement coordination and control, while the natural perspective aims to understand movement coordination, in all its aspects, in terms of the laws of self-organizing, complex systems [15].

My introduction to the natural perspective came years earlier from my first research mentor, Sergio Fonseca, during my time as a Physical Therapy student at Universidade Federal de Minas Gerais. Turvey, a pioneer of the natural perspective, had written compelling arguments in its favor. I chose to go to CESPA because I resonated with these arguments. Thus, I expected that, in the action course, Michael would present a harsh critique of the artifactual perspective and focus on (and provide support for) his own theoretical viewpoint. However, the reality of the course took an unexpected turn.

Throughout the action course, Michael ensured that we engaged deeply with the most significant works from both perspectives. I was at points confused, thinking that he might have "changed theoretical camps" or something. At the end of the course, I actually asked him about this and he said it was intentional: when teaching a particular perspective you have to put yourself in the shoes of scientists who have embraced that perspective, he shared. This approach fostered in me an attitude of intellectual humility towards scientific knowledge and respect for those who invested their time and creativity into it. It is important to clarify that Michael never advocated for a "hybrid" approach to action by merging the best elements of both perspectives. Instead, by elucidating the fundamentally opposing assumptions of natural and artifactual perspectives with respect to the issue of coordination and control of the body's degrees of freedom, he made it clear that a "hybrid" approach was *not* a viable option.

What Michael did exceptionally well in this course was model how one can at once hold strong views and ideas and be opened to understanding and engaging respectfully with opposing viewpoints. In fact, he showed us that one can only appreciate the true limits of a scientific perspective to a problem of interest, insightfully critique it, and propose more fruitful alternatives *after* understanding its historical context, motivation, assumptions, and empirical contributions. This lesson has been invaluable in my professional career and in my life—particularly in times of deep polarization.

Lesson 3: Embrace the Discomfort Inherent in the Learning Process

Turvey's lectures laid a foundational framework for each week's topic. He was a fantastic speaker and easily drew my attention and interest. I enjoyed every minute of his Wednesday evening classes. The true challenge emerged when we had to read the assigned papers and grapple with the many concepts, ideas, and empirical work related to each topic. This task necessitated engagement with concepts and methodological and/or analytical tools from various branches of science: neurophysiology, mathematics, physics, engineering, ecology, philosophy. Much of it completely new to me, presenting a formidable learning curve.

There were moments when deciphering these readings felt like an impossible task. Early in the semester, faced with a particularly daunting paper—more equations than words—I sought Michael's guidance in his office. Michael's response after hearing my concern and plea for some clarity was unexpected: "on Friday, at Socratic hour, you will get some clarity". This reply was at once puzzling and deeply disconcerting. To us students, Socratic hour was an examination; I had hoped for clarity *before* I was put on the spot with questions about the paper. I was seeking a shortcut, a way to bypass the discomfort of continuously confronting the limits of my current knowledge.

Reflecting on it now, I see Michael's apparent detachment from my immediate frustration as a strategic teaching moment. His decision not to rush to my rescue—whether intentional or intuitive—forced me to tolerate my discomfort and persevere. This realization hit home specially after discussing the incident with my senior students, who predicted: "you know that *now* you are definitely going to get a question on this paper". I did not feel I had any choice but try again. I returned to the office, identified the barriers to my understanding of paper, found additional resources that helped me begin to decipher it, exchanged ideas with my more technical colleagues. I prepared. Socratic gave me some more clarity, as Michael promised it would.

The invaluable strategies I developed in Turvey's Action course for engaging with and making sense of complex materials have been a cornerstone of my career as a scientist. Michael did not just teach me about Action, he instilled in me a trust in my own capacity to continuously learn new things and grow. This, undoubtedly, is one of the greatest gifts I received from him.

Lesson 4: Preparedness and Openness to Engage in Challenging Scientific Exchanges

Every Friday, 12:00-1:00 pm, we had our weekly Socratic hours, perhaps the most pivotal and memorable part of the Action course. Michael always arrived prepared with a set of questions, each serving as a catalyst for exchanges that helped us identify and better understand key concepts, ideas, and experimental methods included in the week's material. Our task was clear yet challenging: provide the best possible answer to the question posed to us. Michael's adept follow-up questions compelled us to build on whatever knowledge we had managed to demonstrate—no matter how minimal—to uncover further nuances in the materials that we had initially failed to notice.

The Socratic hours were characterized by a high degree of uncertainty. We never knew exactly which question would be directed to us or how the exchange would evolve, which was contingent on the precision of our responses. This unpredictability gave me no option but to learn to think on my feet and sensibly engage with questions that probes the very limits of my understanding of a topic. This skill, honed in those rigorous, scary sessions, has become invaluable in my professional life. Whether it is presenting research at conferences, leading workshops on advanced analytical methods, or participating on podcasts, I engage in thorough preparation and then draw upon my well-practiced ability to think on my feet to provide sensible and well-informed responses to challenging questions that invariably arise. Much like what I used to do for Socratic Hours.

Most importantly, perhaps, the experience in Socratic hours significantly diminished my reluctance to share my thoughts and ideas with colleagues and fellow researchers due to fear of not knowing enough. Instead, I see challenging exchanges, as intimidating as they may sometimes be, as opportunities for personal and professional growth. Pointedly, if I share something that lacks clarity, precision, or sound logic, the questions that follow can help me identify the limits of my knowledge and refine my ideas in the process of answering them and beyond. I dreaded Socratic Hours when I was a student. I am so profoundly thankful for all I gained from it.

Lesson 5: The importance of balancing rigorous work with personal wellbeing

The action course demanded an unprecedented level of dedication and hard work from me. The weekly Socratic Hours were a constant source of pressure, ensuring I remained focused and diligent in my studies. But then Friday evenings came. Michael and Claudia Carello (his life partner and incredible scientist in her own right) offered us relaxing evenings at the Sweet William's Pub situated at their basement.

Jose (my life partner) and I, who lived nearby, rarely missed Pub. It was a happy place for us; a home away from home where we could unwind and enjoy company of our peers, mentors, and the numerous incredible scientists that visited CESPA during my time there. These evenings at the Pub underscored the importance of blending the intensity of our academic pursuits with much-needed moments of relaxation and social connection. I am incredibly thankful to Michael and Claudia for nurturing this space. To this day, I still hold Friday evenings as sacred downtime, no matter how incredibly long my to-do-list may look.

FINAL REMARKS

In this essay, I have strived to encapsulate a few of the many lessons I gleaned from my experience as Michael Turvey's student. These lessons have profoundly influenced my professional career, serving as a constant reminder to approach challenges with curiosity about the unknown, respect for scientific knowledge that supports what we do know, resilience to learn and grow, and the courage and discipline to write and share with others what I learned in the process. He was an extraordinary teacher and mentor. I will honor his legacy not only by disseminating and building on his scientific contributions to the field of motor behavior but also by carrying forward the spirit of inquiry, perseverance, and generosity that defined his presence in our academic community. It will never be the same without him.

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ACKNOWLEDGMENTS

I would like to take this opportunity and acknowledge the other amazing mentors and teachers I had the privilege of having at CESPA. Thank you, Bruce Kay, Jeff Kinsella-Shaw, Till Frank, Bob Shaw, and Carol Fowler for the time you invested in educating me.

Extra special thanks to Claudia Carello & Claire Michaels for being the best role models I could have ever hoped for, and for your continued friendship and support.

Citation: Silva PL. (2023). A Remembering Michael T. Turvey: A tribute to an extraordinary teacher & mentor. *Brazilian Journal of Motor Behavior*, 17(6):326-330.
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Funding: Nothing to report.
Competing interests: The authors have declared that no competing interests exist.
DOI: https://doi.org/10.20338/bjmb.v17i6.415