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Obituary

From Newton's Laws of Motion to David's Law of Motion of Living Beings: A tribute to Professor David Lee (1939 -2025)

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ABBREVIATIONS

GTT	General Tau Theory
ICPA	International Conference of Perception and Action
τ	Tau function

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The untimely death of Professor David Lee is taken as an opportunity to praise his extensive work on actions encompassing different contexts and species. The General Tau Theory is pointed out as the closest call the field of Motor Behavior has for stating a Law of Motion ecologically valid for living beings. The scope of Professor Lee's works is emphasized from two narratives from one of the last scientific meetings he took part.

KEYWORDS: Action | Prospective Control | General Tau Theory | David Lee

The nature of moving things in the world has been the subject of attention for centuries since the Ancient Greeks [1]. All along this period, a lot of thinking and propositions were put forward about the nature of motion, and experiments were also carried out, particularly by Galileo in the 17th Century. However, the definite and very lasting account of motion was given by Isaac Newton with his three laws of motion and the law of general gravitation present in his book *Philosophia Naturalis Principia Mathematica* (The mathematical principles of natural philosophy), published in 1687.

Newton's laws of motion covered almost everything from the motion of planets to the things down on Earth, such as the famous apple falling on his own head. However, it was Newton himself who recognized the limits of the rationale he applied to understand natural phenomena. In particular, he referred to these limits in a letter cited by Gleick [2],

> "The power of life and will by which animals move their bodies with great and lasting force… demonstrate that there has to be other (undiscovered) laws of motion."

It took more than three centuries for such a law of motion to be proposed. I am referring to the insights, ideas, propositions, and experiments carried out by Professor David Lee from Edinburgh University, UK, who sadly passed away on the 3rd of July 2025 at 12.15 am. He passed away peacefully at the Royal Infirmary Hospital in Edinburgh with his family by his side.

Professor David Lee, or Dave as he was affectionately called, developed the *General Tau Theory* over four decades, and he was still working on it lately. Below is his own statement from some years ago:

> "My aim is to discover general fundamental principles underpinning the sensory and intrinsic guidance of purposeful movements in humans and animals. To this end, I am developing General Tau Theory and using the theory to study experimentally, in collaboration with my colleagues and students."
>
> David Lee in https://www.pmarc.ed.ac.uk/people/davidlee.html
> Accessed on July 10th, 2025.

Dave proposed a function, the *Tau function* (τ), to deal with a main feature of the movements done by living beings: their actions are future oriented, which is manifested by "closing the gaps between distances, angles, forces" from one present time instant to a future one. He and one of his closest academic friends, Claes von Hofsten, denominated this capacity of prospective control [3]. In this way, Dave gave us a plausible alternative to Newton's laws of motion, one that considers "the power of life and will by which animals move their bodies". The scope of his research agenda, grounded in the General Tau Theory, was as wide as it was profound, as the list

of his research interests[a] can attest:

(i) the development of basic intersubjective, manual and locomotor skills in human infants;
(ii) musical performance skills;
(iii) sports skills;
(iv) flying skills;
(v) rehabilitation of basic skills in, e.g., Parkinson's Disease and Cerebellar Ataxia;
(vi) sensory guidance of movement by cells;
(vii) the electrical energy patterns in the brain that guide movement.

David Lee in https://www.pmarc.ed.ac.uk/people/davidlee.html
Accessed on July 10th, 2025.

If one takes the sixth item in the above list, one realizes that Dave was working on a theory of movements that should account for almost every living being without respect for their nature. One can have a glimpse of his General Tau Theory (GTT) by reading a chapter he wrote about the coupling body-environment [4] and by assessing a manuscript titled *How movements are guided*[b]. In my field of interest, action development, Dave's Theory has inspired a set of elegant and complex studies integrating neural and behavioral levels of organization [5].

I had the privilege to meet Professor David Lee on some occasions when I attended his lectures and talks (European Science Foundation - Winter School on Motor Development – 1991, Zuoz, Switzerland; Seminar on Motor development at the Royal Society - 1994, London, United Kingdom). However, the most memorable meeting I had with him was in Groningen, the Netherlands, during the International Conference of Perception and Action (ICPA) in 2019 (Figure 1).

Figure 1. At the reception of the ICPA in Groningen, 2019. Next to Dave, on the left side, are Professors Ruud van der Weel and Audrey van der Meer, both were supervised by Dave in their Doctoral Degrees at the University of Edinburgh early 1990s. On Dave's right side is Regine Slinning, Audrey's PhD student at the Norwegian University of Science and Technology. Next to Audrey, right side, are Dr. Priscilla Monteiro Ferronato (Paulista University, Unip) and I.

In the event, Dave was very active, attending every talk and always asking thoughtful questions to the presenters. He gave insightful comments on the talk given by Dr Priscilla Ferronato about "Development of active manipulative behavior in early infancy". Since then, he became interested in her research because it could help the case for prospective control in infants' clutching behavior. By the end of 2023, he asked Priscilla for permission to run an analysis on the data she presented in a paper [6] to search for *Tau's* signatures in the infant's clutching. He sent back his analysis early in 2024, providing her with very good evidence for agency even in very young babies. I the last message he sent to Priscilla, he wrote:

I also attach a 'GTT summary' file which summarizes the theoretical foundation for all the analyses (I may already have sent you an earlier version) In it I use Ella Fitzgerald's riff as an example. You may want to exercise your new-found skills with Kaleidagraph to repeat the Ella analysis with an analysis of a baby clutch.

[a] Since he wrote this list, Dave added new few items on the list as he applied his GTT to speech patterns, in particular using the theory to analyze the vocalizations of human neonates.
[b] https://www.pmarc.ed.ac.uk/ideas/pdf/HowMovtGuided100311.pdf

I hope you are well and find these results interesting.
Best wishes
Dave

Who could imagine that a theory of action control, such as GTT, can allow us to look at babies clutching a bar as well as Ella Fitzgerald singing a jazz riff song "Too close for comfort"? As we know, one good sign for the relevance of a theory is when it is useful to account for very different classes of phenomena: the vocalization of a neonate or the singing of Ella, the Dame of Jazz. The questions Dave posed to us and the data evidence he generously produced for us were and still are invaluable. Priscilla and I are forever grateful to Dave.

On the last evening of the ICPA meeting in Groningen, I walked with Dave together with Dr Rita Cordovil and Dr Frederico Lopes, both from the Faculty of Human Movement, Lisbon, Portugal. Frederico was asking Dave why "conversation among subjects" was not considered in studies that focused on crowding and gathering, for instance, when one person must guide his or her walking regarding a group of people also locomoting, as when we are walking in a crowded mall or leaving a football stadium. How could Dave answer this? He couldn't!!! "I cannot say much as I was never involved in those studies", he said, but he did make an interesting comment. Dave pointed out a fact from Animal Studies showing that hundreds of bats leaving a cave rarely bump into each other. He explained to us that the bats are using their eco sonars devices emitting sounds to each other and that, Dave suggests, might be a kind of conversation (Figure 2).

Figure 2. A beer discussion in a Groningen Pub about bats, actions and General Tau Theory. Next to Dave are Rita, Frederico and I.

David Lee was one of a generation of British researchers whose interest in the movements of living beings led to the pursuit of knowledge across many disciplines – Physics, Biology, Psychology, Anthropology. I can name a few of these British researchers who have left us in the last ten years: Kevin Connolly, Colwyn Trevarthen and Michael Turvey. If there is a Heaven, they should be and now with the company of David Lee. I wonder if they are going to meet for a beer[c] discussion on the movement and actions of living systems. What a conversation this is going to be.

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[c] I presume beer is allowed in Heaven.

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