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INTRODUCTION

Linking hypotheses in visual neuroscience

Davida Teller (1938-2011) brought a rigorous mind and critical thinking to the field of vision science. While the most widely known of Davida's scientific contributions were in the areas of light adaptation, color vision, and infant vision, she also offered to the field a provocative challenge with her writings on the topic of "linking propositions" in visual science. Following others of the time, like Brindley (1960) and Barlow (1972), Davida provided critical thinking about criteria for, and approaches to, drawing inferences linking psychophysical phenomena and perception with underlying neural mechanisms (Teller, 1980, 1984; Teller & Pugh, 1983). This timeless topic only grows in importance as the technologies for measuring brain activity advance and multiply, and the need to apply indirect metrics of brain activity to the understanding of psychophysical and perceptual phenomena increases. It is surprisingly routine today to see claims being made regarding the neural underpinnings of sensory and cognitive phenomena without articulation or even acknowledgment of implicit linking assumptions. With this special issue, *Linking Hypotheses in Visual Neuroscience*, we seek to accomplish two goals. The first goal is to honor Davida Teller and her scientific legacy; the second is to revisit this central challenge in visual neuroscience, re-evaluate the concepts articulated by Davida in the context of current knowledge, and stimulate thinking about a way forward.

Davida began her training as a classical psychophysicist at the University of California at Berkeley with Tom Cornsweet where she characterized the mechanisms of light adaptation. After completing her degree at Berkeley, she moved to the University of Washington in Seattle where she remained throughout her career. She divided her attention mainly between studies of adult color vision and a wholly new focus on visual development, to which she brought the rigor of classical psychophysics and the belief that we could learn a great deal about visual function from knowledge of its development. The care and integrity evinced by her articulation of linking propositions, and her written work more generally, was also clear in her mentoring style. Davida was known for maintaining high standards for those she trained, spending countless hours working with students to induce them to carefully develop, implement and communicate their science. Her commitment to her students endured long after they left the lab. Her legacy lives on in the students and postdoctoral fellows she trained and in the colleagues who had the good fortune to either collaborate (or just sit and haggle) with her about vision science and linking propositions. Many of them have contributed to this special issue.

Davida used to say that the field of visual development can provide much more than simply showing that babies do not see well and then get better as they age. She argued that developmental research, when done rigorously, can reveal much about the neural mechanisms underlying visual perception. She articulated these rules most formally in a seminal 1984 paper entitled *Linking Propositions* (Teller, 1984). She defined linking propositions as "a claim that a particular mapping occurs, or a particular mapping principle applies, between perceptual and physiological states" (Teller & Pugh, 1983; Teller 1984), which pertain to both infant and adult studies. For example, Davida and others have pointed out that if different aspects of visual processing show different developmental trajectories, it is reasonable to conclude that those aspects of visual processing are subserved by different neural mechanisms. The converse, however, is not necessarily true: if different aspects of visual processing show similar developmental trajectories, those aspects of visual processing may or may not be subserved by the same neural mechanisms. At first glance, this logic may seem simple and straightforward. However, this level of thoughtfulness—or careful conclusion—is often not represented in the scientific literature. Her linking propositions can be condensed into three types: equivalence classes, analogy, and bridge locus. The articles contained in this special issue seek to address, either directly or by example, these concepts. A number of the contributions offer direct, critical examination of one or more of these propositions in the context of psychophysics, electrophysiology or fMRI, including the articles by **Atkinson and Braddick**, by **Barlow**, by **Morgan and Solomon**, by **Movshon**, by **Norcia**, and by **Welchman and Kourtzi**. Others evaluate a particular approach to, or problem in, linking performance to underlying neural mechanisms in the context of adult vision, including the articles by **Egger and Britten**, by **Fesi and Mendola**, and by **Maertens and Shapley**; in decision-making, in the article by **Hayden and Pasternak**; or in development and disability, including those by **Brown and Lindsey**, by **Levi**, by **Li, Hagan and Kiorpes**, by **Mitchell and Lomber** and by **Pallett and Dobkins**. We hope that through this excellent compilation we renew interest in careful, rigorous linking of visual performance to the underlying neural substrates in the field of visual neuroscience.

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