DOUGLAS VICKERS
(1940 - 2004)
(Photo courtesy of Dr. Ted Nettlebeck)
IN MEMORIAM

Douglas Vickers
(1940 – 2004)

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Douglas Vickers, age 64, died suddenly at his home in Adelaide, Australia, on October 31, 2004. He is survived by his wife Yvonne, children Marc and Anne, and six grandchildren. His astonishing career as a theoretical psychologist, experimental scientist, and mentor to famous students spanned forty years. Held in the greatest esteem, his students refer to him as a teacher of unfailing sincerity who was generous and warm in his dealings with others.

Vickers’ education began in the Scottish city of Dunbar. He advanced with distinction, graduating from Edinburgh University in 1961, and continued to an Honours BA Degree from Cambridge University where he placed first in of the Natural Sciences Tripos (Part 2). In 1967 he received his Ph D supervised by Alan Welford. Later, in 1994 Cambridge honored him with its Sc.D. In 2000-2002 Douglas Vickers served as President of the International Society for Psychophysics. Interspersed within this breathtaking career are the major undertakings that brought him international fame.

Douglas’ scientific career began in earnest with the famous Shallice and Vickers (1964) paper “Theories and experiments on discrimination time” appearing in volume 7 of Ergonomics. This important review of psychophysical models provided an English approach to a topic of deepening interest in Europe and the United States. His Phd thesis “Visual discrimination and the perception of visual depth” (1967) continued his exploration of perceptual phenomena investigated by psychophysical means. But the lure of Australia caught his interest at the time when Australian universities, expanding to meet the needs of a post WWII society, sought outstanding talent from around the world. Professor Malcom Jeeves, Head of the Psychology Department at Adelaide University, offered Douglas a position. In 1967 Doug immigrated to Australia to become Lecturer in Psychology.

At the time Alan Welford championed investigations of models of the time taken to perform judgment tasks. The application of Abraham Wald’s Sequential Probability Ratio test to human choice reaction experiments investigated by Stone at the Applied Psychology Research Unit, Cambridge, in 1960 did much to inspire an English approach to this topic. By 1970 several approaches vied to provide accounts of response time data gathered from both discrimination and multiple choice experiments. Among them were the finite state models proposed and investigated by Ollman, Yellott, and Link, the stochastic models of La Barge, Audley, Christie and Luce, McGill, Hohle, and Link, and the sequential theories of Stone, Edwards, and Laming. Then, in 1970, Vickers added new, compelling, ideas to the ongoing scientific adventure in the fundamental paper “Evidence for an accumulator model of psychophysical discrimination.”
This paper begins a lifelong development and application of an elegant approach to modeling comparative judgments. When discriminating between two stimuli there are three classic measures of performance, the proportion of correct responses, the length of time taken to discriminate, and the subjective confidence that the discrimination made is correct. Presumably a single discriminative mechanism is the basis for each of these responses. Vickers idea was that this mechanism consisted of counters associated with each possible response. The counter that reached a pre-set threshold first gave rise to a response. An illustration of the structure of the model and an illustrative stochastic path appear in Figure 1.

The original theory (Vickers, 1970) can be imagined as a stochastic development of Fechner’s theory of sensory representation and Thurstone’s idea of comparative difference. Two physical stimuli, A and B, are transformed into internal normally distributed random variables $s_A$ and $s_B$ (the Fechnerian theory of sensory representation). A Thurstonian assumption gives rise to comparative differences between two stimuli. The result is a normally distributed distribution of sensory differences for $s_A - s_B$. Suppose $A > B$ so that the mean of $s_A - s_B$ is positive. It is more likely that a value of the difference $s_A - s_B$ will be positive. Call this probability $p$. Of course there will then be a probability $q = 1 - p$ that a value of $s_A - s_B$ will be negative.

The accumulator model posits that the time of making a decision is filled by sampling values of $s_A - s_B$ and adding positive values to a counter $T_A$ and negative values of $s_A - s_B$ into a counter $T_B$. If the counter $T_A$ reaches a maximum (threshold) value of $C_A$ before the $T_B$ counter reaches a maximum of $C_B$ then the response $R_A$ occurs to indicate that stimulus A is greater than stimulus B. Otherwise, the negative counter $T_B$ will exceed its maximum (threshold) and response $R_B$ occurs indicating that stimulus B is smaller than A. The threshold for responding values, $C_A$ and $C_B$ are under control of the subject and proposed to be related to the variability of the sensory representations, $s_A$ and $s_B$.

The simplicity of the theory is its charm: two stimuli, a single distribution of sensory differences (à la Thurstone), two accumulators, and two response outcomes. The beauty of the theory is the vast number of predictions made about response probability and response time. In a way the two counters race to be the first to generate a response. Sometimes, due to the variability of sensory differences $s_A$ and $s_B$, the negative counter will reach its criterion $C_B$ before the positive counter reaches its criterion, $C_A$. In this case the response $R_B$ will occur in error and stimulus B will be judged greater than A.

A stochastic path illustrating the outcome for a single trial for which the distribution of sensory differences is $N(0.2, 1.0)$ appears in Figure 1. The Y axis represents the amount of positive difference values accumulated during a trial. The X axis represents the amount of negative difference values accumulated during the trial. The use of “amount” allows the negative values to be represented as positive increments to an ongoing total. Two response thresholds are shown with values of $C_A = 10$ and $C_B = 12$. That is, more negative values are required to respond $B > A$ than are needed to respond $A > B$. The difference between these response thresholds characterizes a bias in favor of response $R_A$. 

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VICKERS' (1970)
ACCUMULATOR THEORY OF DISCRIMINATION

Figure 1. A single stochastic path illustrating the accumulation of positive and negative comparative differences. In this case five negative differences occur by chance and generate the first increments along the lower boundary. Then a positive difference occurs followed by another negative difference. The accumulation continues until a boundary is breached, in this case the upper bound.

A variable number of differences \( s_A - s_B \) will occur before a response criterion is reached. This duration is the model’s predicted decision time. In Figure 1 the particular sequence of observations creating this single within-trial accumulation of difference values leads to response \( R_A \) in a total of 24 observations. The last difference, which pushes the positive values beyond the threshold at ten, is not shown. If each of these sensory differences requires an average amount of time \( \Delta t \) the then total decision time for response \( R_A \) is \( 24\Delta t \). The response \( R_A \) is a correct response because stimulus A is greater than B.

At the time theoretical interest focused especially on the analysis of correct and error response times. The importance of this result stemmed in part from the proof by Stone that for the Sequential Probability Ratio Test, invented by Abraham Wald, these responses must be identical with respect to decision time. Laming (1968) investigated this prediction and found it to be false. Simulations of the Vickers’ Accumulator Model showed differences between correct and error decision times to be a characteristic theoretical prediction that distinguished it from the previous random walk models that required correct and error decision times to be identical.
The 1976 meeting of Attention and Performance VII in Sénanque, France, offered Douglas an opportunity for an important advancement in the accumulator theory. The title of the paper, “An adaptive model for simple judgment,” does not prepare one for the major extensions suggested and empirically evaluated. The two accumulator model is described and then a three category model is described to account for, in part, judgments of sameness and difference. Confidence in simple judgments is addressed and the manner in which parameters of the theory adapt to experimental conditions discussed. On a personal note, we both attended this meeting. It was my first opportunity to discuss directly with Doug the predictions of the accumulator theory and the distribution-free random walk model I proposed in 1975. I was most impressed by Doug’s knowledge of the literature and his ideas about a general theory of psychophysics. And, he was already a likable Australian.

Then, in a stunning contribution to psychophysical theory Vickers’ provided further theoretical investigations and elaborations that accounted for the third important measurement variable, response confidence. In “Decision Processes in Visual Perception” (1979) Vickers provided a broad survey and theoretical investigation of simple decision processes, confidence and adaptation, and complex decision processes. This monograph followed up Vickers’ previous paper (Where Angell feared to tread: response time and frequency in three-category discrimination, 1975) by proposing a theory of equal judgments that yielded a convincing account of much experimental data. With references to 538 important experimental and theoretical papers, this masterful treatment of decision processes merits the attention of modern scholars, and is one of the most important psychophysical publications in the 20th century.


His contributions to international scientific activities were extensive and welcomed by his colleagues. He was the organizer of many scientific sessions including “Human Decision and Choice” at the Twelfth Annual Conference of the Australian Psychological Society (1977), “Decision and Control Mechanisms in Perception and Memory” at the XXIV International Congress of Psychology (1988), “Theoretical Modeling in Psychophysics” at the Sixteenth Annual Meeting of the International Society for Psychophysics (2000), and “Confidence and Psychophysical Judgments” at the Nineteenth Annual Meeting of the International Society for Psychophysics (2003). He was a member of the Organizing Committee of the 29th Experimental Psychology Conference in Adelaide, Australia, (2002). His contribution to us was to be President of International Society for Psychophysics (2000-2002) and Organizer for the Twenty-First Annual Meeting of the International Society for Psychophysics to be held in Adelaide, Australia in 2005.


His memberships in scientific societies expressed his vigorous interest in advancing our scientific knowledge of mental processes. He was, for example, an Advisory Council Member of the International Association for the Study of Attention and Performance (1978-83), a member or associate of some twelve international learned societies, and President of the International Society for Psychophysics (2000-2002).

But, this marvelous career came to an unexpected halt on Sunday, October 31, 2004. Now, a voice is missing from among us. Our friend, colleague, mentor, our excellent scientist is quiet. The silence is deepened by our remembrance that this year we were to be his guests in Adelaide, Australia. Yet, I believe that in appreciation of this remarkable life, we should celebrate his wonderful career - a career peopled by famous teachers, outstanding contributions to our science, memorable lectures, insight, wit, intelligence, esteem, and international recognition. We can celebrate his many contributions through our fond memories of a charming colleague, an excellent scientist, and, to so many, a very good friend.
Fechner Day 2005

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