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Obituary

Paul Whittle (1938 – 2009)

Paul Whittle, who died in October last year, made important and lasting contributions to vision science and psychoanalysis. He began his academic career at Cambridge University, where he studied mathematics then psychology as an undergraduate. He went on to complete a PhD at Cambridge in 1964 under the supervision of G C Grindley. His thesis topic, binocular rivalry, led to papers that are still cited today. After two years as a postdoctoral researcher with Lorrin Riggs at Brown University, Paul took up a lecturing position in Cambridge, and apart from sabbatical excursions to Minnesota, San Diego, and Bielefeld, he remained in Cambridge until his retirement in 2000.

I first met Paul in 1973. I was a 2nd-year undergraduate and had been assigned to him for tutorials, or 'supervisions' as they were called. Two things about those tutorials have stuck in my memory. The first was Paul's brightly coloured trousers—they were red or green, I forget which—the second was the complicated-looking contraption of mirrors, lenses, and lights in Paul's office. Only much later did I learn that this apparatus was used to make what to this day are the definitive measurements on the relationship between brightness, luminance, and contrast.

Paul's first experiments on brightness perception involved subjects matching the brightnesses of patches on different backgrounds. Later, he went on measure JNDs (Just Noticeable Differences) in patch brightness, and eventually, using a conventional CRT (Cathode Ray Tube) display, Paul added brightness scaling measurements to complete the trilogy. The matching and discrimination measurements were obtained across a range of background luminances and patch contrasts, but Paul's real innovation was to include decrement patch luminances that ranged all the way to zero, or the 'black limit'. It was these measurements with decrements that turned out to be so unexpected and hence so informative. For example, with the JNDs, when they were expressed in terms of raw luminance differences, Paul found that the TvC (Threshold versus Contrast) functions were markedly different for increments and decrements. Whereas the increment TvC functions showed the conventional Weber-like behaviour, with thresholds rising proportionately with patch contrast, the decrement TvC functions were inverse-U-shaped, first rising with patch contrast, then falling as the patches approached the black limit. The matching and scaling data followed similar patterns.

Finding that the decrement TvC functions were inverse-U-shaped suggested that something fundamentally different was going on with decrements. In characteristic fashion however, Paul sought to unify the apparently disparate data. He found that a simple metric brought together and linearised the increment and decrement data. This was $\log W$, with W defined as $\Delta L/(L_{\min} + k)$. In figure 1 illustrating the calculation of W, ΔL is the difference in luminance between patch and background and $L_{\min}$ is the lower of the two luminances (the constant k prevents W approaching infinity when $L_{\min}$ approaches zero and represents the internal noise level when luminance is zero; if $L_{\min}$ is not too close to zero, however, it can be safely omitted). Note that W is calculated differently for an increment and a decrement, by virtue of the fact that $L_{\min}$ is the background luminance for an increment but the patch luminance for a decrement.

Paul recognised that $\log W$ unified the increment and decrement behaviour because it encapsulated two distinct visual processes: local light adaptation, and a compressive, specifically logarithmic, contrast nonlinearity. In all equations of contrast, the light-adapted

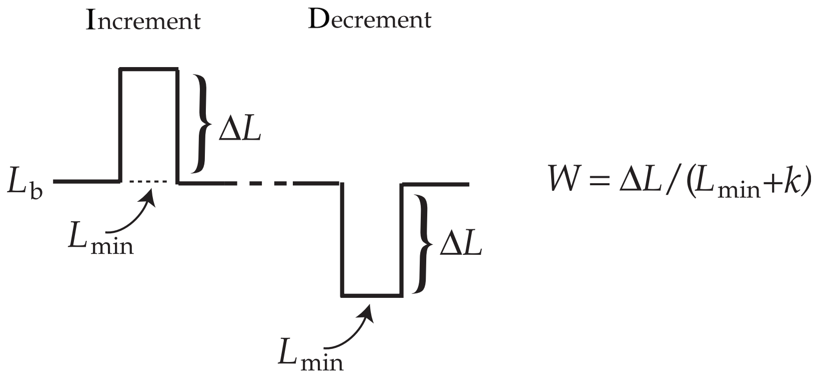

Figure 1. Calculation of Whittle's W metric for contrast, both for an increment and a decrement.

level is embodied in the equation's denominator, and the success of W in using L_{min} as denominator reveals that neural mechanisms sensitive to contrast light adapt to the lower of the luminances that fall within their receptive fields. $\log W$ remains under-appreciated in the literature, in spite of being a plausible explanation for many of the anisotropies in the behaviour of increments and decrements that continue to attract less parsimonious theoretical treatment.[(1)]

Paul's approach to psychophysics was in the tradition of W S Stiles, one of the great pioneers of the increment-threshold method. Rather than designing experiments to test specific hypotheses, Paul preferred to collect comprehensive sets of data that detailed the relationships between a fundamental physical property and its perceptual correlate. He would then spend many hours pouring over the results of his experiments, searching for the mathematical formulation that would unify the data and provide the key to the underlying visual mechanisms. $\text{Log}\,W$ is a testament to the success of this approach.

Paul enjoyed paradoxes. The most notable of these was the contradiction between two different behaviours Paul observed in patch – background displays. Two equal-in-luminance patches on different backgrounds differ in brightness, but Paul noticed that when he dichoptically superimposed the two backgrounds, such that the two patches were seen separately but on the same background, the contrast effects were considerably enhanced. Paul reasoned that there must be two types of lightness constancy, which he termed Type I and Type II. Type I was constancy with respect to the ambient level of illumination, but because it was achieved by computing local contrast, produced contrast errors. Type II was constancy with respect to the varying background, and was achieved by integrating local contrast information across the image. The two types of constancy thus worked in opposite directions, with the Type II mechanism acting to mitigate the effects of the Type II mechanism towards providing a more veridical representation.

Although modest about his own views, Paul delighted in exchanging ideas with others. During the late 1980s he met regularly with a group of vision scientists who went by the name of the 'Trieste group', the other members being Alan Gilchrist, Larry Arend, Walter Gerbino and Sten-Sture Bergström. They would meet in exotic locations

(1) For example, two equal-in-luminance increments on different backgrounds are more similar in brightness that two equal-in-luminance decrements on different backgrounds. Although this has been explained within the framework of Gestalt models of lightness perception, it may instead be explained by $\log W$. Because the decrement pair is less light-adapted than the increment pair (the decrement patches have lower L_{min}s), the difference in $\log W$ between the decrerement pair will be larger than between the increment pair, assuming that the increment and decrement patch ΔLs are commensurate.

like Lappland (!!) for intense and, I gather, sometimes heated discussions about a range of issues in surface colour perception. One outcome of these meetings was a book, edited by Alan Gilchrist, with chapters written by each of the group's members. Paul took this opportunity to bring together his previous work on brightness perception (Whittle 1994a, 1994b). His two chapters are a monument to all that is best in vision research, and a testament both to Paul's tenacity to grapple with and make sense of a large body of data and his skill at making ideas interesting and accessible. These chapters will remain for a long time to come essential reading for anyone interested in the subject of brightness perception.

One of Paul's lesser-known early contributions to vision science was that he was one of the first to recognise that the short-wave cones of the retina contribute little to brightness (I thank John Mollon for pointing this out). Later in his career Paul returned to colour vision, applying his methods to the study of 'contrast-colours', the impressive changes in surface hue that often accompany changes in surround chromaticity.

Besides his work in vision, Paul had a longstanding interest in psychoanalysis. During his time at Cambridge he gave lectures on psychoanalysis and contributed to postgraduate teaching in psychotherapy, though it was only when close to retirement that Paul began to write about the subject. Paul was concerned with what he saw as the ever-widening gulf between psychoanalysis as a therapy and psychology as a scientific discipline. He synthesised his ideas on the relationship between psychoanalysis and psychology in a well-received and much discussed paper in the 2000 edition of the journal *Neuropsychoanalysis.*

Paul was not a prolific publisher. He once told me he was reluctant to publish data that had not been exhaustively analysed to flush out everything that was of value in it. His partner Barbara was also keen for me to emphasise that it was as important for Paul to guide research students into new endeavour as it was to publish his own work.

I last met Paul at the Progress In Colour Studies (PICS) conference in Glasgow held in July 2008. This was a meeting of psychologists, neuroscientists, linguists, artists, architects, and philosophers—just the sort of gathering Paul reveled in. Although Paul's illness had already begun to take its toll, he was forthcoming and upbeat, and made light of his illness. His questions and comments to speakers were the usual ones: penetrating and astute, but, above all, full of curiosity.

Paul was a much-loved figure for his undergraduate and graduate students. His graduate students included Donald MacLeod, Peter Lennie, Janette Atkinson, Risto Vuorinen, Alex Shepherd, and Clara Ovenston.

Paul is survived by his five children, Adam, David, Jane, Bruno, and Conrad, and partner Barbara.

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