Donald E. Broadbent (1926–1993)

Donald Broadbent's great contribution to psychology was his elaboration of the insight that human behavior can be understood in terms of information flowing through the organism. His most important book, *Perception and Communication* (1958), was the first systematic treatment of the human organism as an information-processing system, and in it he proposed a structure of cognition that was specific enough to inspire a program of experimental research the influence of which may still be felt.

Born on May 6, 1926, in Birmingham, England, Donald grew up in Wales and attended Winchester College, an English public school. He entered the Royal Air Force in 1944 and, as his interests were in the natural sciences, elected to take a short course in engineering at Pembroke College, University of Cambridge. During his three years of service in the Air Force he was continually impressed by the observation that difficulties often arose from psychological rather than physical causes. For example, that the difficulty in selecting a wanted call sign from many others on the radio stemmed from attentional difficulties rather than from problems of hearing. Additionally, his flying training was carried out in the United States, where psychology was more established as a discipline than it was in Britain at that time. Having discovered that behavior could be studied scientifically, Donald therefore decided to switch from engineering to psychology, which he studied on leaving the Air Force in Sir Frederic Bartlett's department at Cambridge. The Cambridge department was a particularly appropriate place, given its natural sciences orientation and its emphasis on application. There was also a lot of talk about the "cybernetic" ideas of the late K. J. W. Craik, who had proposed models of human behavior in terms of feedback loops and control systems.

After graduating with a bachelor's degree in 1949, Broadbent accepted a research post with the Royal Navy. His assignment was to study the possible effects of noise on performance, a topic that he continued to pursue fruitfully throughout his career. The research post was based at the Applied Psychology Unit in Cambridge, and Broadbent remained at the Unit for 25 years, serving as director from 1958 to 1974. His experimental work in the 1950s examined the effects of environmental stressors on cognitive performance, problems connected to the detection and understanding of speech and other auditory stimuli, and problems of selective listening and attention. Behaviorism was never such a dominant force in European psychology as it was in America at that time, so when Broadbent brought his experimental and theoretical ideas together in *Perception and Communication* he stressed the importance of an empirical approach to behavior but described his model in terms of a limited-capacity communication channel, preceded by a selection device and a temporary storage buffer. This was a radical departure from the S–R approach of behaviorism; among other things the information-processing approach embodied the idea that behavior was influenced as much by the possible stimuli that might have been present as by the actual stimuli presented to the senses.

The publication of *Perception and Communication* was clearly one major foundation stone of the cognitive revolution. There were other important influences too, but Broadbent's book differed in that it laid out a testable model and explicitly encouraged experimental challenges to aspects of the model. The challenges were taken up, of course, and it is to Broadbent's great credit that when Gray and Wedderburn showed in 1960 that attention switched from the attended to the unattended ear when the meaning of the dichotic message was switched, he immediately conceded that his model must be amended.

In 1958, Broadbent became director of the Applied Psychology Unit. Over the next 16 years he developed and shaped it, giving it the blend of pure and applied research that it has continued to practice to the present day. During these years he became progressively more involved in committee work—for the Medical Research Council, the Social Science Research Council, and various professional societies. Among his many honors, he became a Fellow of the Royal Society in 1968and a Foreign Associate of the U.S. National Academy of Sciences in 1971. In 1975 he received the Distinguished Scientific Contribution Award from the American Psychological Association (APA), and in 1978 he received the Distinguished Foreign Colleague Award from the Human Factors Society.

In Broadbent's 1958 model, selective attention was controlled by a relatively peripheral switching mechanism—a "filter"—that could be tuned to a variety of physically defined input sources. The filter acted as an all-or-none switch to prevent overloading of the central limited-capacity channel. Incoming messages that were not selected were held briefly in a preattentional buffer storage system from where they could be rescued, provided that their traces had not faded too badly. This was the reason for poorer performance on the unattended channel of the dichotic listening task. Messages that had been attended and perceived could be translated into appropriate responses or recirculated by the processes of rehearsal to the preattentional store. From the experimental work generated by the model it quickly became clear to Broadbent that a number of these suggestions must be modified. The Gray and Wedderburn experiment, along with similar results reported by Anne Treisman, made it clear that the attentional switch could not be entirely peripheral. If the unattended message suddenly became highly meaningful, attention also switched automatically and ef-

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fortlessly to the new source. This observation provided an interesting paradox: Somehow the content of the message had been analyzed before it was selected! These and other experimental results led Broadbent to amend his model considerably; the revision appeared in 1971 in another book, *Decision and Stress.*

The new model was more complex and more probabilistic, less compelling perhaps than the elegantly simple model of 1958, but it also gave a better account of the facts. The main changes were that attentional selection could now take place in response to two mechanisms, filtering as before, but also "pigeon-holing"—a typically whimsical expression to capture the idea that currently relevant categorical representations could become active and therefore consciously perceived when the appropriate "evidence" in their favor was presented to the senses, even if the sensory evidence was attenuated by virtue of its presence on a nonselected input channel. Decision theory played a major role in the 1971 formulation, with filtering indexed by d' and pigeon-holing by β. The role of the preattentional store was also modified; it remained as a sensory buffer, but now perceived and rehearsed messages were held in a further output buffer rather than being recirculated to the preattentional s-system. The effects of noise and other stressors were also considered, as were the effects of arousal. These various mechanisms and influences interacted in complex ways to affect attention, perception, reaction time, vigilance, decision making, memory, and learning. Overall, *Decision and Stress* was a considerable achievement, although its complexities and interactions may reflect the stresses and decisions of midlife, as compared with the uncomplicated optimism of 1958! Broadbent saw any scientific formulation as a temporary statement, a bringing together of the available evidence in a coherent way. So he had no qualms about modifying or abandoning aspects of his 1958 model, and although he always presented his current view firmly and persuasively, he never fell into the trap of stubbornly defending an outmoded position.

Broadbent's two other books should also be mentioned. *Behavior* (1961) is essentially an extended essay on the scientific study of both human and animal behavior. It is not quite a textbook, as it does not lay out various results and ideas in a very systematic and explicit fashion; it is more of a commentary on the value of the experimental method and its application to psychology—very broad ranging in its coverage and very lucidly presented. *In Defence of Empirical Psychology* (1973) presents the William James Lectures that he gave at Harvard University in the spring of 1971, plus four other essays, also originally lectures. The informal speaking style has been retained, and the essays are very much in Donald's voice. They also illustrate his gift of presenting complicated ideas clearly and his love of commonplace analogies. Broadbent's theories are replete with desk tops, filing cabinets, library catalogues, Y-tubes, and ping-pong balls!

In 1974 Broadbent moved to Oxford University to pursue his own work without the administrative responsibilities of a unit and over the following years produced a continuing stream of innovative work in collaboration with his wife Margaret and a succession of research workers. He retired from Oxford (with the declared ambition of "writing novels") in 1991. In more recent years, his work extended to the study of the very powerful social stressors that permeate the work environment. Although this might seem to be a very different field from that in which his original work developed, he was adept at showing the links between social factors and the type of cognitive failure or slip of action that can have a devastating effect within a modern technological context. As technology became more complex, the nature of the tasks studied by Broadbent and his many collaborators changed, and he became very actively involved in the area of human–computer interaction.

In addition to Broadbent's scientific impact, he has been a major influence on psychology in two other ways. First, throughout his career he unstintingly gave his time and energy both to the theoretical development of psychology as a science and to its application to important practical problems. He was always willing to give his time for the good of the community, whether this involved spending time away from the laboratory at meetings of research councils or committees or providing help and encouragement to generations of young scientists.

Perhaps Donald's greatest contribution, however, was through the personal example he set. He was utterly committed to a scientific approach to the problems of human behavior and experience, yet he also stressed the humane, personal aspects of the human condition. On the one hand, his theorizing could be quite intellectual and abstract; on the other hand, he continually stressed the need for practical relevance in experiments and theories. His psychology was intended for society and its problems, not merely for the dwellers in ivory towers.

Donald Broadbent died on April 10, 1993. He was a role model as a scientist, as a mentor, and as a committed member of society. We miss him greatly, but his influence will continue to enrich psychology for many years to come.

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