

## **Berlyne's Theoretical Contributions to Psychology<sup>1</sup>**

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*The evolutions of Berlyne's theoretical contributions are traced by contrasting his particular developments with seven characteristics of Hullian theory. Berlyne is seen to have dismantled each element and replaced it with a vastly different theoretical position and structure. Berlyne developed a truly general theory, which was then differentiated with special concepts in specific areas as diverse as thinking and aesthetics.*

The title of this paper is somewhat premature. I shall make some comments about Berlyne's theoretical contributions to psychology but it will be some time before a proper assessment of his impact on the field can be made. I shall attempt, instead, to trace some of the history of Berlyne's theoretical development.

While Berlyne took his doctorate from Yale University, he had a thorough European background. He was born in England, near Manchester. In addition, he taught for 6 years in England and several years in the United States before settling permanently in Canada. He was a thorough Continental or even an international scholar in style.

At Yale he worked primarily with Carl Hovland. He had two or three conversations with Clark Hull, but even if he had not, he could not have escaped Hullian theory, which dominated Yale at that time. Hullian theory was his starting point, but he had hardly learned and adopted it, if he ever did adopt it, before he began to dismantle it and replace the parts, piece by piece. It was like a youngster replacing Volkswagen parts with Mercedes parts and doing the job so thoroughly that he ended up with a Mercedes.

<sup>1</sup>Much of the content of this article first appeared in Walker (1961).

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Let me list seven features or characteristics of Hullian theory and then examine how they fared in Dan Berlyne's head (Hull, 1943, 1952).

1. Hullian theory was strictly S-R theory.
2. The optimal drive level was zero, or no drive at all.
3. Any positive value of drive was aversive.
4. Reward was inflexibly tied to drive or need reduction.
5. All learning occurred as a function of reward or reinforcement.

6. Hull believed that it was profitable to correlate behavioral and neurophysiological data and some of his postulates, such as the stimulus-intensity dynamism, were based on neurophysiological data. (As is known, this was a major issue between Hull (1943) and Spence (1956). Spence prevailed to the extent that neurophysiology did not appear in Hull's 1952 book.)

7. Finally, despite what others thought and did, Hull's theory was highly specific and nongeneral. It was applicable primarily to the behavior of the rat in the maze.

What did Berlyne (1960, 1965, 1971, 1974) do to this Volkswagen?

To gain increased range, flexibility, and analytical power Berlyne made a distinction between the *arousal* and the *evocation* of a response. If a stimulus associated with a response occurs, the response could be said to be aroused, whether or not the response actually occurred. If it occurred, it was evoked. This distinction allowed Berlyne to retain S-R terminology but at the same time to deal with central events without the encumbrance of the little *s*'s and *r*'s of Hull's theory.

The freedom thus achieved permitted Berlyne to organize within a common framework data on overt orientation and exploration in animals, perceptual selection and curiosity and patterns of cognitive activity. From an extremely careful analysis he concluded that the major motivational determinants of these phenomena were the same. While his list of variables was slightly different at each presentation, the most common members of the set were novelty, uncertainty, surprisingness, complexity, and conflict. These and others he called the *collative variables*.

Although Berlyne used the term *arousal* in a number of different ways the most fundamental use was as an intervening variable to represent the common motivational effects of the collative variables. In general, the more novel, uncertain, or complex the stimuli, the greater the motivational arousal produced. Thus *arousal*, for Berlyne, became a major unifying concept, and it represents a significant intellectual achievement.

There is not, however, a simple monotonic relationship between the values of the collative variables and the level of arousal. The treatment of boredom and the concept of *arousal potential* rule out this possibility.

Boredom occurs when external stimuli are excessively scarce or excessively monotonous. The conditions for the arousal of boredom are

those that are low in arousal potential. Thus boredom should represent a minimum of organismic arousal. Yet Berlyne suggested that boredom worked as a drive through rise in arousal; boredom is a restless, irritated, and thus a motivated state. Berlyne attempted to resolve this disturbance by appeal to the cortex as a modifying influence on reticular activating system activity. At very low levels of arousal potential, cortical restraint would be released and produce the aroused restlessness of the state of boredom.

There seemed to Berlyne to be too many instances of organisms seeking an increase in drive to tolerate the concept of zero drive as optimal, any value of drive as aversive, and pleasantness as exclusively a function of drive reduction. So Berlyne discarded all three of these elements of the Hull position.

Instead, he began with an optimum arousal somewhere in midrange. The organism will seek to restore the optimum if it is displaced in either direction. As a first approximation, any deviation above or below the optimum was aversive and restoration to optimum pleasant and rewarding. This simple symmetry was confounded by two problems. In his discussion of boredom, he specifically rejected the idea that a low arousal state was aversive. The picture was further complicated by his introduction of the concept of the *arousal jag*. Stimuli could be sought for first the increase and then the reduction in arousal that they produced.

Obvious difficulties with this “beat-yourself-on-the-head-with-a-hammer-because-it-feels-so-good-when-you-stop” mechanism are ameliorated through the imposition of three conditions: (1) such stimulation would be sought only if the expected drive increase is moderate in amount; (2) the situation must offer certainty of prompt relief; and (3) the organism must not have been exposed in the immediate past to supraoptimal levels of arousal potential.

The status of the concept of “arousal jag” typified Berlyne’s intellectual style. Seeking a supraoptimal state defies optimal arousal theory. Yet it is obvious that people do exactly that—they are, on occasion at least, “thrill-seekers.” Berlyne chose to face the facts, even though it required that he live with conflict within the theory.

Berlyne also abandoned the last tie with Hullian theory when he gave up the inflexible tie involving drive reduction, reinforcement, and learning. His first step was to note that while some rewards were the result of drive reduction, many were not. He then built a case for some learning, notably classical and Pavlovian conditioning, depending solely on events preceding and accompanying the performance of the response. Thus some kinds of learning occur without the occurrence of reward, and not all rewards are forms of drive reduction.

Berlyne never gave up the concept of reinforcement, in spite of considerable pressure from me to induce him to do so. However, we had a truly enjoyable public debate at Korsør in 1972 in which he agreed to defend

only the meaning of reinforcement given the term by Pavlov (1927). Pavlov had noted that sometimes the unconditioned response was greater when a neutral stimulus first accompanied the unconditioned stimulus. He described this effect as one in which the presence of the neutral stimulus reinforced the effects of the unconditioned stimulus. A much better translation would have involved "enhancement," "intensification," or "augmentation," because his meaning had absolutely nothing to do with learning. Thus Berlyne, at least in my eyes, gave up the concept of reinforcement altogether, even though he insisted on employing the word as late as 1972.

In the Hull-Spence controversy concerning the role of neurophysiological measurements and concepts in the analysis and conception of behavior, Berlyne clearly agreed with the early Hullian position. The title of his 1971 book was *Aesthetics and Psychobiology*. At that point he used the term *psychobiology* exactly as others use the term *psychology*. For Berlyne in 1971, there was no psychology that was not included in the term *psychobiology*.

Yet his theoretical concepts that attempted to integrate biology and psychology did not fare well. In Berlyne's early formulations, the concept of behavioral arousal was tied closely to the general organismic arousal theory generated around Magoun's (1958) reticular activating system. I think we are now well aware that the concept of a generalized state of arousal did not survive long among neurophysiologists. For example, Routtenberg (1968) expanded the concept from one arousal system to two, and Lacey (1967) demonstrated fragmentation to such a degree that one can hardly expect to have two measures of arousal correlated with each other.

His other major effort to integrate psychological and neurophysiological theory was his effort to account for the Wundtian hedonic curve (see Figure 1). The familiar inverted-U-shaped preference function poses a difficult theoretical problem. In spite of considerable effort on my part, I have not been able to conceive a simple process that could underly a function that increases in pleasantness, then decreases, crosses a neutral value, and then becomes unpleasant. Neither have I been able to find a simple mathematical formula to describe that curve. In short, I have not been able to develop what I would consider to be a reasonable one-process theory.

Berlyne saw a solution to this problem in the neurophysiological distinction between primary reward and primary pain systems. One can generate a Wundtian curve by combining two exponential equations, one for pleasure and one for pain, one positive and one negative in its effects. If the threshold for pain is higher, in terms of arousal level, than that for pleasure, then, as arousal increases, the joint curve can achieve a substantial

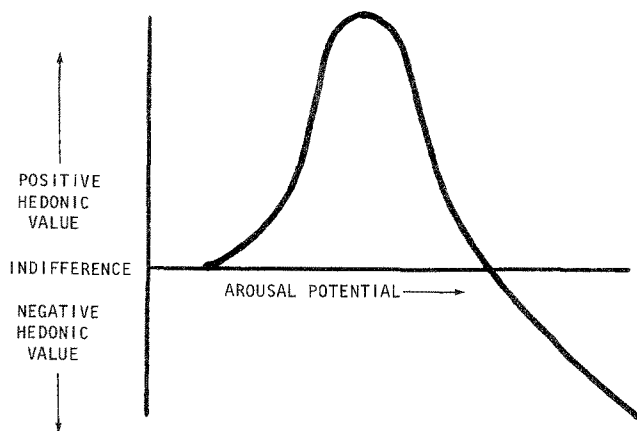


Fig. 1. The Wundt curve. Berlyne (1971, adapted from Berlyne, 1960, and from Wundt, 1874).

positive value before the pain function begins to operate to reduce the pleasure and finally, at very high levels of arousal, produce a net pain.

The matches involving the hedonic curve, the mathematical solution of a two-process function, and the neurophysiological concepts of primary pleasure and pain centers turn out not to be satisfactory. For example, to generate the Wundtian curve with progressive increases in arousal, it is necessary to have an effective one-way inhibition of the pleasure centers originating in activity of the pain centers. In fact, inhibition between the two systems appears to be reciprocal. Furthermore, there is evidence that even intense activity in the pain centers can be entirely suppressed by the stimulation of reward centers.<sup>3</sup>

Despite these theoretical difficulties, Berlyne and others have had considerable empirical success in relating physiological measures to psychological measures in the pattern predicted by the theory. Thus Berlyne was clearly reaching the right goal even though the argument above indicates that he may not have taken exactly the right path to that goal.

The final difference between Berlyne and Hull, at least on my list, is the matter of the generality of the theory and the theorizing. Hull's theory was developed out of and intended to account for a very limited set of data obtained primarily from rats in mazes with a few aspects of conditioning in dogs and eyelids in humans. As a theory of behavior, it did not generalize

<sup>3</sup>This argument is to be attributed to an unpublished paper by Dr. Matthew Olson, now at Hamline University.

well. It can be seen as a great effort to achieve great precision in a very limited domain.

It was Berlyne's ambition to achieve a truly general and universal theory, applicable to many, if not all, aspects of human activity.

Berlyne developed a theory of aesthetics based on diversity and unity in which it is possible to establish a relationship between diversity and the collative variables on the one hand, and between unity and mechanisms for reducing arousal on the other.

He developed a theory of humor based on the collative variables and the arousal jag. He developed a theory of thinking based primarily on the concept of conflict. When two or more incompatible responses or thoughts are aroused in the organism at the same time, the organism is said to be in concept of conflict. When two or more incompatible responses or thoughts acquisition of knowledge reduces conflict and arousal. He developed a long list of conditions that produce cognitive or conceptual conflict, and another longer list of mechanisms for reducing conflict. Some of these mechanisms Berlyne invented, others he borrowed from other theories.

Thus Berlyne strove for generality and applicability and thereby removed himself as far from the Hullian position as it was possible to go. His tactic was to enter an area armed with his own theory and to show that it was relevant. He then began a process of differentiation that was specific to the area under consideration. The result was that while there was certainly some connection between his theory of aesthetics and his theory of thinking, for example, each contained many special concepts.

If one distinguishes between theorists who behave like hedgehogs, and thus struggle to account for everything with a limited set of principles, and theorists who behave like foxes, and thus develop new paths for new problems, then Dan Berlyne was a very clever fox indeed.

I think Daniel E. Berlyne was the most original and creative psychologist of our time—bar none. In an odd sort of way, I feel that his untimely death places a burden on many of us to at least try to fill the void created by his passing. We are unlikely to succeed. We lack his profound scholarship, his incredible energy, and his intellectual brilliance.

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