Brief Communications

Is motivation really modulation? A comment on Wise

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In an article that appeared in the first issue of the new incarnation of this journal, Wise (1987) provided a useful and provocative reevaluation of the concept of motivation. He asserted that motivational theory has been hampered throughout its history by a failure to define its central terms adequately. Definitions of motivation, he argued, are typically vague or preliminary, or else amount to nothing more than arbitrary lists of behaviors that are or are not motivated. Following Skinner (1953), he claimed that even systematic definitions suffer from two fundamental problems. First, such definitions are typically circular, because they define motivation in terms of constructs such as attractions, aversions, or goal-directedness, constructs that are inferred from the behavior that the concept of motivation is used to explain. Second, definitions of motivation such as, "the concept we use when we describe the forces acting on or within an organism to initiate or direct behavior" (Petri, 1981, p. 3) are trivial and theoretically empty because they fail to distinguish between motivated behaviors and nonmotivated behaviors.

Wise proposed an alternative definition of motivation that, he claimed, is neither trivial nor circular. Motivation is defined as a state in which responses to environmental releasing stimuli are modulated. This definition is nontrivial in that it identifies nonmotivated behaviors as those *fixed action patterns* (FAPs) that are elicited in pure form by environmental releasing stimuli. This concept is borrowed from ethology, where FAPs are defined as invariant responses that are inevitably released by an animal when the appropriate releaser is presented (Tinbergen, 1951). Unfortunately, it is now recognized that virtually all FAPs are flexible in their form, intensity, or probability of occurrence (Schleidt, 1974). Accordingly, Wise's definition of motivation hinges on the hypothesis that this variability is modulated by isolatable physiological mechanisms. He offered *variable action patterns* (VAPs) as the units of motivated behavior. These are action patterns that, like FAPs, are elicited by environmental releasing stimuli but that, unlike FAPs, are modulated by internal motivational variables.

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This definition is nontrivial but would, by itself, be circular. Thus, Wise explicitly defines the motivational variables in terms of their hypothesized neural substrate. He proposes that releasing stimuli are sensory inputs that transmit information to the motor centers via classical detonating neurotransmitter systems. In contrast, motivational modulation is mediated through the actions of neurohormones and neuromodulators, neural mechanisms that cannot cause excitatory or inhibitory postsynaptic potentials by themselves, but can alter the effectiveness of other afferent inputs (see Dismukes, 1979, and related commentaries for vigorous debate over the definitions of these terms and the status of these concepts).

There is considerable appeal to this approach for those who favor tough-minded physiology over tender-minded psychology. However, this appeal is based on a misconception. Rather than bringing motivation into the realm of "real science," such an approach throws it into an ephemeral Wonderland of theoretical neurochemistry. Wise goes to some pains to point out that "the distinction between neurohormone and neurotransmitter is not a clean one" (Wise, 1987, p. 11). Indeed! Along each dimension upon which neurohormones and neuromodulators have been distinguished from classical neurotransmitters (e.g., nature of the presynaptic element, releaser-receptor distance, duration of effect, etc.), there are intermediate steps and ambiguous cases. This state of affairs is most confusing in cases in which a single neurochemical is capable of functioning either as a neuromodulator or as a neurotransmitter. For example, dopamine is typically characterized as a neurotransmitter when it is released in the striatum, but it appears to act more like a neuromodulator in the superior cervical ganglion (Libet & Tosaka, 1970). In extreme cases, a neurochemical may even act as both a neurotransmitter and a neuromodulator at one and the same synapse. To cite a familiar example, in the abdominal ganglion of the aplysia, serotonin causes an immediate inhibitory postsynaptic potential, a typical neurotransmitter effect, but also a long lasting decrease in responsiveness to sensory stimuli, a neuromodulator effect (Klein & Kandel, 1980).

Given this ambiguity, what will provide a solid basis for designating certain neurochemical effects as neuromodulatory? We suspect that ultimately there may be no more valid criterion than the impact the neural event has on behavior. In that case, the definition of motivation would rest on a neurobiological distinction based in turn on a priori expectations of what behaviors should be mediated by neuromodulators by virtue of being motivated! The definition would again be circular, although by a longer and more tortuous path.

Consider a more fundamental point: Even if it were possible to unambiguously tie psychological concepts to

specific physiological mechanisms, would it be possible to define these psychological concepts in terms of those mechanisms? Let us suppose, for the moment, that neuromodulation and neurotransmission can be unambiguously defined. Let us also imagine that it has been conclusively demonstrated that neuromodulators mediate behaviors such as feeding or egg-brooding but not behaviors such as coughs and FAPs, such as the aggressive displays of the male stickleback. Now let us imagine that a physiologist determines that sneezing is triggered by some peptide-mediated activation of a "sneezing center." On the basis of this hypothetical finding, would we say that sneezing is a motivated behavior? What if, 10 years from now, the peptidergic theory of sneezing were repudiated? Would we then strike sneezing off the index of motivated behaviors? This would not seem to be sound psychological theory.

Picture another scenario. Suppose we were to observe love or aggression in a machine built out of scraps of hardware, as proposed by Braitenberg (1984). Would we want to say that these behaviors were not motivated simply because they did not involve neuromodulation? Such a strategy could force us to dismiss any behaviors as non-motivated solely because they were found to be mediated by complex circuitry involving only classical neurotransmitters. Such a procedure would make a sham out of any definition of motivation. Clearly, the status of a psychological construct, such as motivation, must be judged at a psychological level. A physiological orientation may be entirely appropriate for answering questions of mechanism, but definitions of psychological constructs must be couched in psychological terms. Otherwise, noncircularity will have been purchased at the expense of validity and coherence.

Although we disagree with Wise's attempt to reduce motivation to a physiological construct, we do not embrace the conventional definitions of motivation he and Skinner have so cogently criticized. These traditional approaches are not workable. We suggest that this is not because of a lack of ingenuity on the part of motivational theorists, but because there is an inherent flaw in thinking of motivation as a force that controls how animals act. Motivation is not a *cause* of behavior.

We prefer to think of motivation as the study of why animals do what they do when they do it. An animal always has more than one stimulus around it to respond to, and it always has more than one response that it can perform. Which responses the animal selects and rejects (consciously or otherwise), and why it selects them, are the questions of motivation. For example, why does the rat stay in its burrow rather than look for food? Which dieter will say no to lasagna and which will say goodbye to size 7? Any factors that can influence response selection are potential "motivational variables" whether they are internal states, external stimuli, or within the animal's

genotypic or phenotypic history. As such, they warrant attention from the student of motivation. Otherwise, the investigator is committed to a specific position on the determinants of response selection prior to the commencement of empirical investigation.

Despite fundamental differences, we agree with important features of the position put forward by Wise. Like Wise, we acknowledge that behavior is typically elicited by environmental stimuli. Similarly, while Wise acknowledges that responses to releasing stimuli are rarely pure FAPs, we emphasize that an animal is never presented with single, idealized, and isolated releasing stimuli. Nor is there any disagreement that responses are modified by internal states. In fact, we have explicitly endorsed the concept that catecholamines and neuropeptides may modulate responses to environmental stimuli (Blackburn, Phillips, & Fibiger, 1987; Pfaus & Gorzalka, 1987).

However, we do not agree that motivation is a state in which responsiveness is modulated. In contrast to Wise, we hold that there can be no neutral, idealized state in which a "true" response to a releasing stimulus will occur. Instead of being a force, or thing, that is present in an organism, motivation is a construct imposed by the observer to give order to his or her observations. An animal without motivation is not a nonmotivated animal; it is a corpse.

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