CHAPTER 6

Energy, Arousal, and Action

I will do such things—
What they are, yet I know not;
but they shall be
The terrors of the earth.
—SHAKESPEARE, *King Lear*,
Act II, Scene IV

Nothing happens, nobody
comes, nobody goes, it's awful!
—SAMUEL BECKETT,
Waiting for Godot

Think of a car running along a road. Why does it do what it does? What makes it go at all, and what makes it go where it goes rather than somewhere else? What makes it go is the engine. And what makes it go in one direction rather than another is the steering apparatus.

Now some writers have suggested that we might break up the causation of behavior in a similar way. One set of influences, analogous to the steering mechanism, affects *what* a creature does if he does anything. It *selects* actions. The other, analogous to the engine, affects whether he does do anything and, if so, how vigorously and persistently he does it. It is a kind of behavioral gas pedal, making the difference between vigorous, persistent action and slow, sluggish, feeble action or no action at all. Finally, it seems natural to think of this latter set of influences as *motivational.*

Our everyday use of the term *motivation* often suggests an image like this one. There are days when we feel, well, *motivated*—just motivated in general. We are aroused, alert, ready to take action. Then there are those other days when we are unresponsive, sluggish, not inclined to do much of anything. Then we may say that we are *unmotivated*, and we often wish we could summon up the energy to do something about it!

In this chapter, we will look at how this conception—motivation as the energizer, the engine, of behavior—developed. One form of the idea arose primarily in the psychological laboratory. A second, Freud's theory of drives, emerged in the first instance from the clinic. A third, the *arousal* concept, originated in the physiological laboratory, but found psychologists eager to join forces with physiologists in exploring it. We will see that despite their very different origins, the three ideas have much in common.

HULL'S DRIVE THEORY

The experimental psychologist Clark L. Hull made an early and influential attempt to specify how drive, conceived as an "engine" of behavior, could fit into its causation. Hull envisioned nothing less than a mathematical theory of behavior, analogous to Newtonian physics as a model of the "behavior" of nonliving objects. He sought, in other words, to specify quantitative relations between behavior and its causes.[1]

Now in a natural environment, where many such causes operate all at once, the mathematics would be horrendously complicated. (They get pretty hairy in Newtonian mechanics too, once we get beyond simple two-body problems!) So Hull's strategy was to observe behavior under laboratory conditions in "simple" animals, where a few important causal influences could be systematically varied and their effects specified. That done, one could work up to more complex cases—and more complex species.

Drive, Habit, and Reaction Potential

Take a look at Figure 6-1. Each of the data points represents the average "score" of a separate group of rats, all trained to press a lever for food reward (or, as we say, food *reinforcement*). Some groups received only a few reinforcements during this training (the data points to the left); others received many (the points to the right). Finally, when tested, some groups of rats were only mildly hungry (lower curve), others were quite hungry (upper curve). The rats were tested under extinction conditions; lever-presses were no longer reinforced with food, and the measure, or "score," was how many times each rat would press the lever before quitting. This was assumed to be a measure of the "strength" of the lever-pressing tendency.

We see that the average score is higher, the more reinforcements the rats had received (the scores rise as we read from left to right). In addition, scores are higher under high hunger than low. Finally, the two curves diverge; the *difference between* the two sets of circles increases from left to right.

Now any theory of what is going on must account for this pattern of data. Hull's thinking went something like this:

Suppose that persistence of lever-pressing does reflect the "strength" of the rat's tendency to press the lever. It reflects, in other words, an underlying theoretical variable that *energizes* the response itself. Modifying Hull's notation, let's call it E (for *energy*).

Now E must increase with number of reinforcements, and also with level of drive. Suppose that successive reinforcements increase the value of another

1. Hull, 1943.

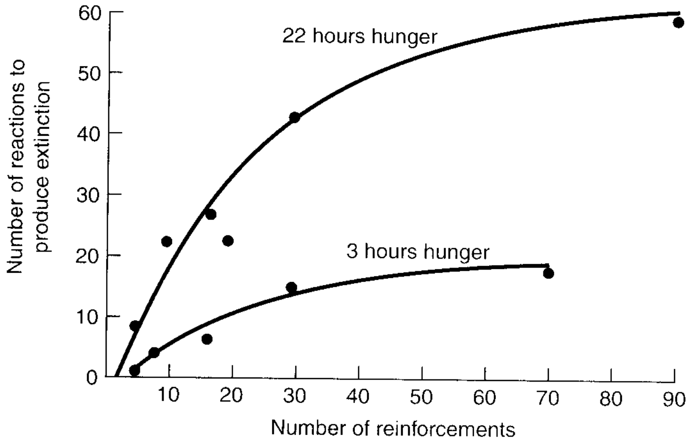


Figure 6-1 Resistance to extinction as affected jointly by number of prior reinforcements (contributing to habit strength, or *H*), and severity of food deprivation (contributing to drive, or *D*). (From Perin, 1942.)

theoretical variable, *H* (for *habit*). This represents the *strength of an association* between the situation and the response in question, for Hull, like Thorndike (pp. 37–38), saw the learning process as a matter of strengthening stimulus-response associations. The concave-downward shape of the curves then suggests that that association grows rapidly at first, then more slowly, with successive reinforcements.

Notice that the strength of the association, *H*, is not the same as the tendency to make the response here and now, *E*. In a well-trained rat, *H* (the association) may be very strong; but if the rat is not hungry, he will not bother to lever-press (see later). *H*, in other words, reflects what the rat has learned. But to show what he has learned, the rat must be—what else?—*motivated* to do so.

This takes us to a third theoretical variable, the motivational factor *D* (for *drive*), which increases as food deprivation does. Persistence of bar-pressing is higher in hungrier animals because *D* is higher.

Finally, the divergence between the two curves suggests a *multiplicative* relation between *H* and *D*. So we get Hull's basic equation:

$$E = H \times D.$$

Thus *E* will be higher as *H* increases (left to right), or as *D* increases (upper versus lower curves). As for the divergence, it follows directly from the algebra. If we multiply any two numbers, then increase one of them and multiply again, we will also increase the *difference between* the two products; that is, the products will diverge.

The whole idea was attractive to many psychological theorists, not only because one could account for a lot with just a little simple algebra, but because the theory made a great deal of sense, and made contact with other ideas as well.

Consider: It follows from Hull's equations that if either *D* or *H* is zero, then *E* should also be zero. That makes good sense. As noted earlier, an animal may be very well trained in lever-pressing (*H* is high); but if it is not hungry (*D* is zero), why should it bother to lever-press now? It won't; *E* will be zero. Conversely, an animal might be very hungry indeed (*D* is high), but if it has had no training at lever-pressing (*H* is zero), then *E* will be zero and the animal will do no lever-pressing (except occasionally by accident, which is what makes training possible). Here then are more data to fit the simple model! (But see later.)

Again: If Hull was right, then a very hungry animal would work hard for food, and so (under most conditions) obtain more food and get less hungry (*negative feedback,* though the term was not current in Hull's time). Thus behavior was used to regulate energy reserves—behavior in the service of *homeostasis.*

[illegible]

Now that could be a good thing or a bad thing. It all depends on whether it is the stronger or the weaker habit that best fits the occasion.

Let us look at the exam situation. Suppose an exam question for this course asks you, "Who was Watson?" Now, you of course will have mastered this book thoroughly. You will have a strong habit of responding to that question, "He was the scientist who . . . ," and you can fill in the rest. Other possible responses, that might intrude as wrong answers, have less strength. Therefore, you will do well in any case, but you will likely do even better if you are a bit anxious and eager and "up" for the quiz—that is, if drive is high. If your drive is high, the appropriate response will not only be the strongest one, but it will be strongest by a wider margin.

But think about the poor student who hasn't studied. Asked "Who was Watson?" his strongest habit is the reply, "He was Sherlock Holmes's biographer." Now the poor guy has to *suppress* that dominant habit before any other response, including the correct one, has any chance of being expressed in actual behavior. And *the more anxious he is, the harder that will be*—again, because anxiety will increase the difference between strong response tendencies and weaker ones.

Spence and his colleagues had their experimental subjects learn a list of word pairs—so-called paired-associate learning, in which, given the stimulus word, one learns to say the response word that goes with it. One such list was made up of easy items in which the stimulus-response connection was already strong, like the "Watson–Sherlock Holmes" connection (though that was not one of their items). Another list was made up of difficult items, like the "Watson–founder-of-behaviorism" connection (which would be weak for a student who has not studied the history of psychology, though of course it would not be weak for *you*).

For the easy list, high anxiety (high D) should make the correct response tendency all the stronger, so anxious subjects should do better than non-anxious ones. But for the difficult list, where existing habits interfered with good performance, high anxiety should make the incorrect habits all the stronger, hence harder to suppress; so anxious subjects should do more poorly than non-anxious ones at this task.

So Spence's group also varied anxiety. This was done by selecting subjects who were high (for one group) or low (for another) in chronic or "resting level" of anxiety as measured by a paper-and-pencil test.*

The results are shown in Figure 6-2. Sure enough: When the list was easy, the high-anxious subjects did better than the low-anxious ones. But when the list was hard, high-anxious subjects did slightly *less* well than their low-anxious counterparts.

*The test was the Manifest Anxiety Scale, developed by Janet Taylor (later Janet Taylor Spence) for this research project. A high score reflected "yes" answers to items like (1) "I cry easily," or (2) "I work under a great deal of tension."

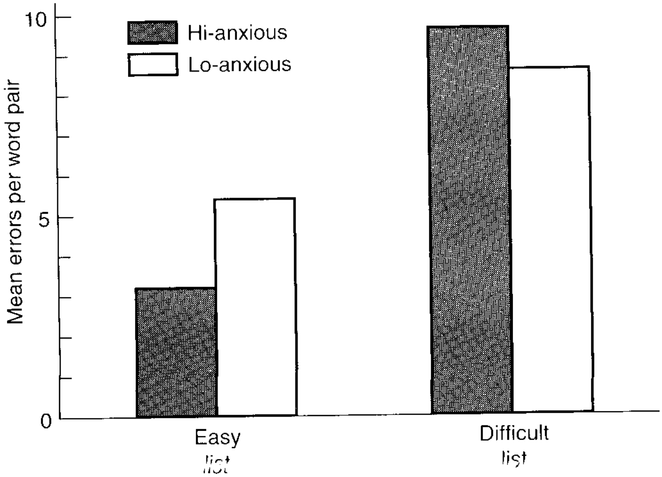


Figure 6-2 How anxiety (*D*) interacts with *H* in human learning. With easy pairs of words, high-anxious subjects make fewer errors than low-anxious ones. With difficult pairs, the difference disappears or is even slightly reversed. (Data from Spence, Taylor, and Ketchel, 1956.)

This example shows how the Hullian algebra can indeed be applied to complex human behavior, to lead to testable predictions. It also shows, by the way, how personality variables (here, high versus low chronic anxiety) can make contact with experimentally derived concepts (*D* and *E*) within a single theory. And it shows how a theory can lead to questions that would not occur to us, and findings that would be very puzzling, without it. Why should subjects' chronic anxiety level have *any* effect on their rate of learning a list of word pairs? The theory tells us why.

Some Problems with Hullian Theory

There was much more to Hull's theory than we have considered, but we have enough to see the guiding ideas and to have some feel for what such a theory can do. We also have enough to see why, as research continued, the theory has shown itself to be inadequate.

First, it is now clear that learning is not a matter of strenthening stimulus-response connections. As we will see in Chapter 8, animals learn not just *what to do*, but also *where things are* ("cognitive maps" and "search images," pp. 329–32). So an animal may make its way to a goal by means of a response that has never been reinforced in that setting.

Also too simple was the idea that reaction potential will be zero whenever drive is. It turned out that animals will learn quite complex tasks, such as taking a mechanical puzzle apart (Fig. 6-3) for no reward except, perhaps, satisfaction of curiosity (pp. 234–37); and they will do so when non-hungry, non-thirsty, and presumably non-lecherous.[3] Non-hungry, non-thirsty rats will drink copious quantities of a sweet solution, with no need to drive them to do so.[4] It

3. Harlow, 1953.
4. Sheffield and Roby, 1950; Ernits and Corbit, 1973.

Figure 6-3 Hasps, hooks, and hinges: Baby rhesus monkeys work busily to take apart a mechanical puzzle. If the experimenter then reassembles the puzzle, they will take it apart again. Persistent as it is, this activity is not motivated by any homeostatic drive.

simply is not true that a non-deprived animal (*D* zero) will just sit there doing nothing.

Finally, Hull's "generalized-drive" idea has not held up. Hull treated *D* as a non-specific multiplier, something to which *all* drive states contributed, and which activated *all* S-R connections (all *H*'s) indiscriminately.

Attempts to test this idea involved such things as, for example, adding an "irrelevant" thirst drive to hunger in experiments like the one in Figure 6-1 above. If Hull were right, then the added thirst should increase *D*, just as an increase in hunger would, and so increase the vigor or persistence of food-getting activity.

It did not. And later research discovered that there was good reason for this: Water deprivation, which enhances thirst, may actually suppress or *inhibit* hunger and feeding.* These findings came later and Hull had no way of knowing about this. But the fact remains that different drives are not necessarily additive; they may inhibit each other instead.

A Look Backward: Hull's Legacy

You may well ask why, if the theory hasn't held up, have I spent so much time working through it with you? For four reasons. First, it is an instructive example of behavioristic theorizing. And its research logic—simplify the situation so that only a few key variables operate, rather than try to study everything at once—was then, and is now, a cornerstone of the experimental method in psychology.

*Some of the inhibition may simply reflect the mechanical difficulty of swallowing dry food with a dry mouth (for example, Kissileff, 1969). But there is also evidence that the activation of brain systems involved in thirst may have inhibitory effects on food-getting and feeding behavior (see for example Grossman, 1962).

Second, the idea that behavior is controlled jointly by a motivational factor (like *D*) and an associative, cognitive, or learning-based factor (like *H*) crops up again and again—as does the notion of a multiplicative relation between them. In modern decision theory (Chap. 10), for example, the tendency to choose a given alternative reflects the values of its possible outcomes (motivational), *times* what we judge the probabilities of those outcomes to be (cognitive). Variants of this idea have been proposed by many modern psychologists. So in working through a bit of Hull, we are previewing some important contemporary ideas.

Third, whereas the notion of "generalized drive" has been greatly modified since Hull's day, it has not disappeared entirely. Hull was surely wrong in this: It is not the case that *any* drive state will automatically enhance *all* behaviors in a generalized, non-specific way. But this much of it may be true: There are certain influences that affect, not just this or that action, but a variety of actions, raising or lowering the vigor or persistence of all of them at once. Such influences could make the difference between an active, alert, vigorous creature and a sluggish, unresponsive, or comatose one. That latter idea is still with us, as we will see later when we discuss *arousal*.

There is one further reason. In seeing how certain findings raise problems for Hull's theory, we see a good example of how we check our ideas by testing the predictions they make (pp. 5–6). That way, when we are wrong, we will know it. In science, the failure of a theory is not a step backward but a step forward. Every failed prediction says to us: Here is a place where our ideas do not square with the facts, and need to be revised.

We will see how important this process is when we contrast Hull's theory with another "engine model" of motivation—Sigmund Freud's.

FREUD'S THEORY OF DRIVES

A few weeks ago (as this is written), a certain Chuck Jones went to jail for theft. He had had dozens of stolen shoes, boots, slippers, and sandals, most of them belonging to Ms. Marla Trump (wife of the high-profile real estate developer Donald Trump), for whom he had worked as public-relations representative. Most of these had high heels; and this, according to a clinical psychologist who testified, is quite characteristic, because such shoes are more feminine and also because the heel is a phallic symbol. (He doesn't say how he knows this, and there is trouble ahead on that point, as we will see.) Mr. Jones himself had told a friend: "I don't know why I like shoes." He could not explain his own actions.

As a clinical neurologist of the late nineteenth century, Sigmund Freud faced, from very early on, the problem of symptoms that made no sense. These included physical symptoms with no reasonable organic basis, but also actions, fears, and preoccupations (as with shoes, for instance) that could not be explained—least of all by the patient himself.

Yet Freud insisted that these symptoms occurred for a reason. They were, in a word, *motivated*. Their study led him to a theory that was, right or wrong, the most influential theory of human motivation our society has yet produced.

Freud's Theory of Motivation

Freud regarded mental events as ultimately biological ones, reflecting operations of the brain. Like any other biological events, they take energy—biological energy, that comes from the food we eat. Therefore, some biological events motivate action, whether mental action or physical.

Freud's word for these, the German word *trieb*, is usually translated as "instinct;" but as many writers have pointed out, the word *drive* is a more accurate translation, and probably closer to Freud's intention. A drive is a source of tension and discomfort, which the actor will seek to remove. That is what gives it its motivating, energizing force.

Every man has reminiscences which he would not tell to everyone . . . He has other matters in his mind which he would not reveal even to his friends . . . But there are other things which a man is afraid to tell even to himself, and every decent man has a number of such things stored away in his mind.
—FYODOR DOSTOYEVSKI, *Notes from the Underground*

It's sexual energy, this energy that you control and channel into your performance. Without it, you can have the best technique in the world and sing beautifully, but you'll just be singing notes, and your audience will go to sleep.
—OPERATIC BARITONE GEORGE MALDONADO

DRIVES **Every drive has a *source*, an *object*, and an *aim*. The *aim* of all the drives is ultimately the same—the reduction of discomfort.** It is the sources from which various drives arise, and the objects by which they are satisfied, that distinguish them.

Thus the source of hunger might be the discomfort of stomach pangs (pp. 63–64). Its object is food.

The source of elimination drives is pressure in bowel or bladder. As to their object—well, in this society (unless one can tolerate a lot of anxiety-arousing disapproval), their expression usually requires that one find a suitable enclosure. (The elimination drives have been neglected by psychologists, but if these drives are present in strength and no suitable object is around, we see—do we not?—why Freud thought of drives as sources of unpleasurable tension!)

The sexual drive also is experienced as tension. Its object is sexual contact broadly conceived—sexual intercourse perhaps, but also the pleasure of intimate touching, of and by another, or of and by oneself. Its aim, as always, is pleasurable reduction of tension.

As Freud saw it, all actions (physical and mental) are motivated by this small handful of biological drives. Of them, the sexual drive is much the most important. Freud was roundly criticized for this assertion, even by his associates. Yet, if one tries to reduce human motivation to biological drives at all, it makes good sense. Hunger, thirst, and elimination drives *must* be regularly satisfied if we are to survive; but sexual gratification can be postponed indefinitely. And in Western society, said Freud, that drive is in fact systematically frustrated. This, plus the great flexibility of our ways of expressing drives (see below), makes the sex drive a plausible candidate for a source of "general-purpose" motivational energy.

THE PLEASURE PRINCIPLE Since the aim of all drives is the same—the reduction of tension—we could say for Freud, as for Hull, that ultimately there is only one motivator. For Hull it is the sum D of all drive states. For Freud, it is discomfort, which is unpleasant; and the aim of behavior is the pleasure of reducing that discomfort. Hence, at bottom, the organism seeks pleasure, and *nothing else*. That is the *pleasure principle*.

A LOOK BACKWARD Even this brief preview shows that Freud's ideas mesh closely with those of other writers. His pleasure principle recalls the *hedonism* of Thomas Hobbes (pp. 32–33). His theory is a *homeostatic* one: a state of quiescence, or non-tension, is maintained as much as possible; and it is regulated, in the sense that deviations from it will be corrected if they can. Thus we could say that Freud, like Hull, saw behavior as an adjunct to homeostasis. And, here once again, homeostasis is defended by *negative-feedback* loops. Tension or disturbance (input) calls forth action (output) to make the tension go away (negative feedback).

Dynamics of Mind: Conflict, Redirection, and Disguise

The instincts or drives are biologically based and primitive. If we are to think of them as the wellsprings of motivation, then we face the same problem Hullian theory faces: How, from these few and simple building blocks, can we generate the richness and complexity of human behavior?

Freud's answer is as follows: Complex mental phenomena result from the complexities of the *interactions among* drives and urges and their respective strivings. They are perceived as "brought about by the play of forces in the mind, as expressions of tendencies striving toward a goal, which work together or against one another. We are endeavoring to attain a dynamic conception of mental phenomena."[4]

Thus we saw earlier (pp. 41–42) that Freud saw patients as at war with themselves: a tendency to express a thought or wish could be blocked by a countervailing tendency *not* to express it (Fig. 6-4A). We should remember, however, that both these mental forces had the same origin—the pool of mental energy, coming from the food we eat. We can elaborate Figure 6-4A so as to represent this (Fig. 6-4B).

The relation among forces in the mind can be more complex than this. Rather than simply blocking each other, conflicting forces can result in a *redirection* of energy in some third direction (Fig. 6-4C). Thus the outcome in thought or action can be a redirected, distorted, or *disguised* expression of the original forces. Or the forces may be directed toward a substitute *object*—like shoes!—if the more direct object is blocked, unavailable, or dangerous. The outcome may make no sense on the face of it; but penetrate the disguise, said Freud, and we will see that it does make sense after all.

4. Freud, 1977.

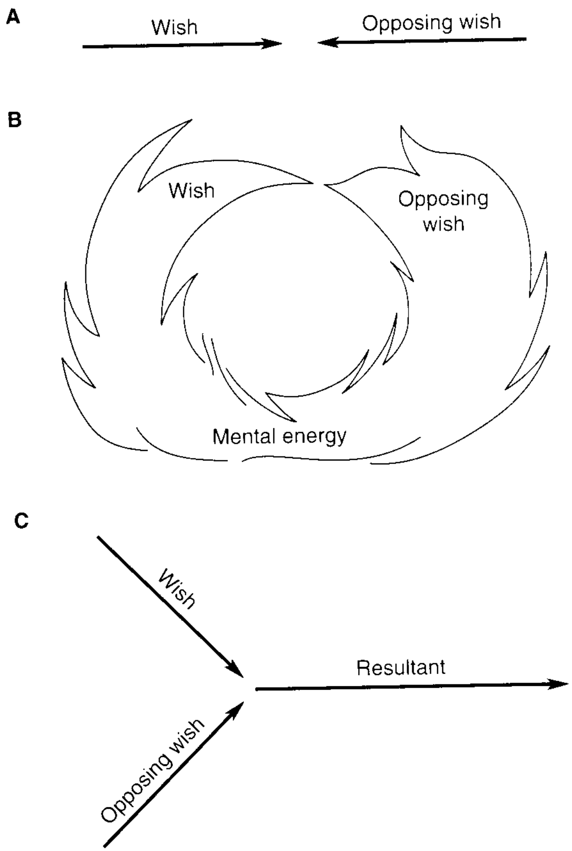


Figure 6-4 In Freud's theory, opposing wishes may block each other (A), though they both draw on the same pool of psychic energy (B). The resultant thought or action may represent a compromise between two wishes or impulses (C).

Freud's Theory of Dreams

This is a fundamental principle in Freud's thinking. Neurotic symptoms, fears, fetishes—but also quite normal actions, and even acts of creative genius—can be seen as disguised expressions of primitive impulses. If we want examples close to home, said Freud, we can look within ourselves. We all do irrational, apparently senseless things—at night, when we dream. In perhaps his most influential book, *The Interpretation of Dreams*, Freud applied his developing theory to the act of dreaming.

Think about the *act* of dreaming. We *do* irrational things in our sleep. Thinking and dreaming are actions. If you have a senseless, irrational, childish dream—well, you *did* it. You made it happen; it is, after all, your dream. So we can ask our motivational question: When you dreamed that dream, why did you do it?

Freud saw dreams as coming about in either of two ways. First, a strong unconscious impulse may by itself break through into consciousness while one sleeps, because the defenses that otherwise keep it from consciousness are weakened during sleep (Fig. 6-5A).* Second, an event of the day might be *associated with* a deeper, more long-lasting, and unconscious idea (Fig. 6-5B). It may then "borrow" energy from that idea by fusing with it, so that what comes into the sleeper's consciousness is a fusion of the two (Fig. 6-5C).

An analogy may help. The event of the day may be compared to a human

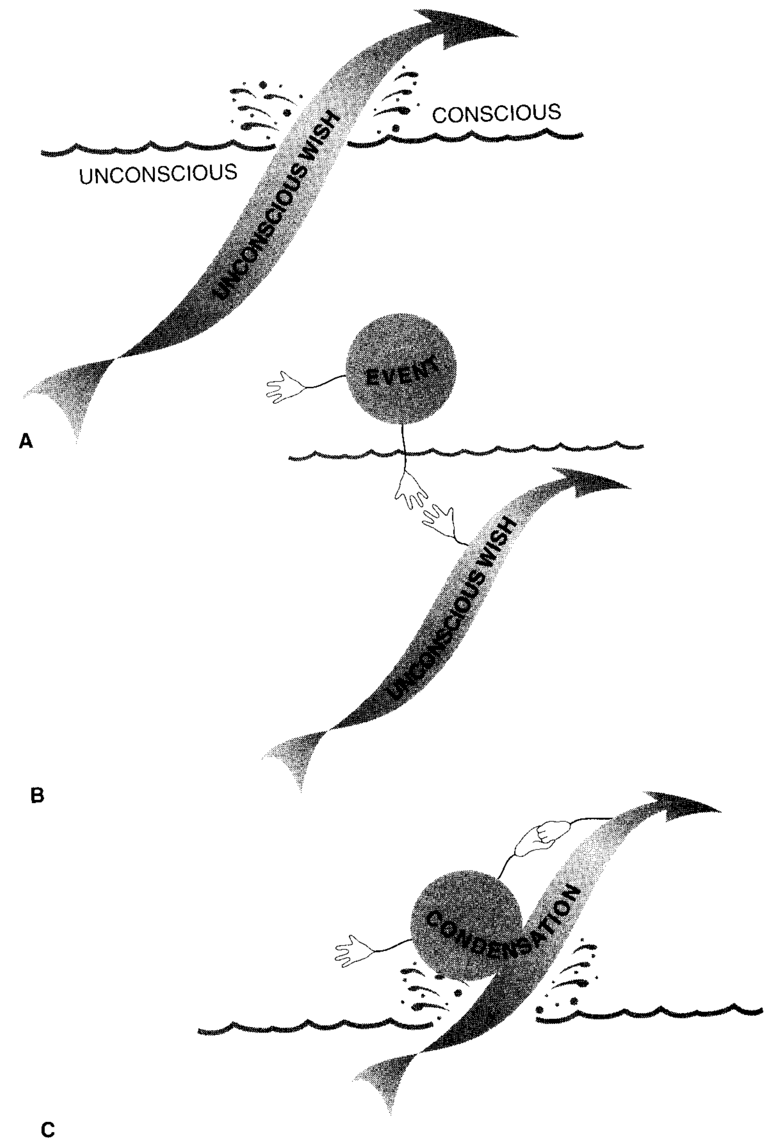


Figure 6-5 Two ways in which unconscious wishes may appear in consciousness as dreams. (A) The wish may be strong enough to break through directly. Or (B) a recent event may be *associated with* an unconscious wish, represented by the joining hands. Then a fusion or "condensation" of the two may have enough total energy to break through.

*The defenses are weaker, Freud suggested, because it is safer to think forbidden thoughts while one is asleep. It is safer because we cannot act on the thoughts; the dreaming brain turns the motor system off, so that movement is inhibited. Modern research on the physiology of sleep finds that Freud was quite right about this.

rider, a smallish jockey perhaps. It makes contact, through association, with a strong unconscious drive—the jockey mounts a big, powerful horse. Then he can use its great strength and speed to get somewhere—into the land of consciousness perhaps, as a dream.

As long as we're about it, let's take another step. Maybe the dream work will fuse together the horse and the jockey, so that we get a centaur—a human head and torso emerging from the shoulders of a horse. There are no such creatures, but so what? Our minds can combine these parts to create a new whole, which can symbolize in one image both the intelligence and skill of the jockey and the enormous power of the horse. Dream work, Freud believed, involved a great deal of such *condensation*—combining ideas or their fragments into an imaginary synthesis that expressed all of them at once.

And we can do one more thing with this metaphor (of which the author is becoming quite fond, as you see). Suppose the idea of riding a horse were threatening—a powerful and potentially uncontrollable animal between one's legs. What if the thought gave rise to troublesome anxiety? We might suppress the thought—generating a counterforce, borrowing some energy to oppose the horse image and thrust it out of mind.

Then the centaur, an image that *modifies and thus disguises* the horse, could be thought about (and dreamed about) with less discomfort. Thus the energy of the original thought could find indirect release, and no additional energy need be tied up in its suppression. As Freud saw it, very many dream images—and daydream images, and neurotic symptoms, and everyday activities too—are just such disguises. They mask the uncomfortable instinctive drives, the objects of these, or both, and thus they reduce the displeasure of anxiety.

How then do we interpret a dream? In essence, we follow the dream work in reverse. By the technique of *free association* to each element of the dream (pp. 41–42), we work backward—perhaps against great resistance—to discover what urges those elements represent in the patient's mind. We can sooner or later uncover an intelligible pattern, and see what interplay of tensions has expressed, distorted, condensed, or otherwise shaped those urges into the content of the dream itself.

To see this idea in action, let's take one of Freud's examples:[5]

> "You're always saying to me," began a clever woman patient of mine, "that a dream is a fulfilled wish, Well, I'll tell you a dream whose subject is the exact opposite—a dream in which one of my wishes was *not* fulfilled. How do you fit that in with your theory? This was the dream:
> *I wanted to give a supper-party, but I had nothing in the house but a little smoked salmon. I thought I would go out and buy something, but remembered then that it was Sunday afternoon and all the shops would be shut. Next I tried to ring up some caterers, but the telephone was out of order. So I had to abandon my wish to give a supper-party."*
> Analysis.—My patient's husband . . . had remarked to her the day before that he was getting too stout and therefore intended to start on a course of weight-reduction . . . [He would] above all accept no more invitations to supper. —She laughingly added that her husband, at the place where he regularly lunched, had made

5. From Freud, 1980, pp. 180–182.

> the acquaintance of a painter who had pressed him to be allowed to paint his portrait . . . [The husband replied that] he was sure the painter would prefer a piece of a pretty young girl's behind to the whole of his face . . .

Notice how it is the woman, not Freud, whose thoughts flow from topic to topic: from the dream to her husband's diet to the place where he eats lunch, and then by way of the painter to a woman's figure. The relevance of that last will be apparent shortly.

> After a short pause, such as would correspond to the overcoming of a resistance, she went on to tell me that the day before, she had visited a woman friend of whom . . . she felt jealous because her (my patient's) husband was constantly singing her praises.
>
> Fortunately this friend of hers is very skinny and thin and her husband admires a plumper figure. I asked her what she had talked about to her thin friend. Naturally, she replied, of that lady's wish to grow a little stouter. Her friend had enquired, too: "When are you going to ask us to another meal? You always feed one so well."
>
> The meaning of the dream was now clear, and I was able to say to my patient: "It is just as though when she made this suggestion you said to yourself: 'A likely thing! I'm to ask you to come and eat in my house so that you may get stout and attract my husband still more! I'd rather never give another supper-party.' [The dream] was thus fulfilling your wish not to help your friend to grow plumper. The fact that what people eat at parties makes them stout had been brought home to you by your husband's decision not to accept any more invitations to supper." . . . [But why did smoked salmon appear in the dream?] "Oh," [the patient] replied, "smoked salmon is my friend's favourite dish."

Thus, by letting the patient tell us what ideas are connected with each other in her own mind (by seeing how her mind flows by *association* from one to another), we see the underlying pattern that the dream expresses. In a similar way, we can trace neurotic symptoms—or the foibles of our daily mental lives—back to their sources in unconscious motives.

The Structure of the Mind

It is worth emphasizing once again that the dream work, and the primitive urges on which the work is done, are largely unconscious. This takes us to Freud's conception of how the mind is organized. Figure 6-6 shows his famous sketch. Most of what goes on in the mind, Freud believed, is unconscious; we may be aware of its results, but not of its operations. These unconscious processes include the collection of instinctive drives (the *id*, the source of motivation) and some, though not all, of the information-gathering and decision-making parts of our minds (the *ego*, the source of cognition).

It also includes some, though not all, of the internalized sets of approvals and disapprovals that we pick up from our culture by way of our parents and other caretakers. These *superego* processes lead to our feelings of anxiety ("moral

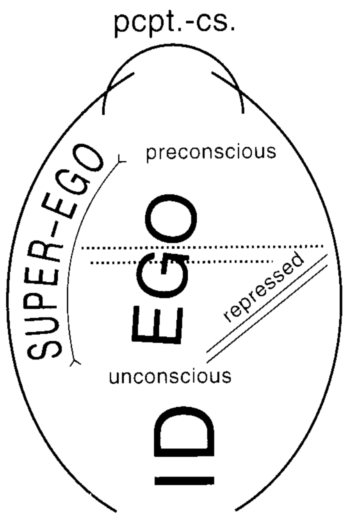


Figure 6-6 Freud's sketch of the organization of the mind. The "percept-conscious" includes material that one is conscious of at the moment; the much larger "preconscious" contains material that is not conscious but could be, such as your memory of what you had for breakfast or your knowledge that Rome is in Italy. Much of the mind, however, is unconscious, and much material is unconscious because it is *repressed*—forced out of consciousness and kept out by forces opposing its entry into consciousness. Both the *superego* and the *ego* are represented as in part unconscious; the *id*, as totally so. (From S. Freud, 1977.)

anxiety" or guilt) when we violate society's standards or contemplate doing so, and our feelings of pride or satisfaction at "doing the right thing" in society's eyes, at being the kind of person society says we ought to be. (Freud spoke of the latter as the "ego ideal.") However, since superego processes *are* in part unconscious, the sources of our anxiety or guilt may not be apparent to us. Many of our problems in living result from this.

PSYCHOANALYSIS IN ANOTHER CULTURE

Freud developed his ideas over the years into a detailed theory of human development: the oral, anal, and phallic stages, and the famous *Oedipus complex*—the growing boy's wish for sexual comfort from his mother and his terror of his powerful rival, the father. We will not review these ideas here, first because any good text in personality theory will do that, and second because one may reject these specific ideas—as many psychoanalysts do—while still holding onto the more general Freudian concepts of symbolism, association, the persistence of primitive urges, and, above all, unconscious motivation.

A Case Fragment

So let us look at a case in which both analyst and patient are from a different culture from ours. This example shows both similarities with, and differences from, a strictly Freudian interpretation of clinical material.

The therapist is a psychoanalyst in India, Dr. Sudhir Kakar. And the patient is a 26-year-old Indian man, M., who had been in analysis for 3 years.

Most of M.'s early memories about his female relatives were images of their sleeping together, in

> the crowded, public living arrangements of the Indian family . . . Sleeping in the heat with little or no clothes next to one of his caretakers, an arm or a leg thrown across the maternal body, there is one disturbing memory that stands out clearly. This is of M.'s penis erect against the buttocks of his sleeping mother and his reluctance to move away, struggling against the feelings of shame and embarrassment that she may wake up and notice the forbidden touch. . . . Embedded in this blissful abundance of maternal flesh . . . however, is a nightmare. Ever since childhood . . . M. would often scream in his sleep while a vague, dark shape threatened to envelop him. At these times only his father's awakening him with the reassurance that everything was all right helped M. compose himself for renewed slumber.[6]

That was then. Compare now:

> In the very first sessions of the analysis, M. talked about a sexual compulsion that he found embarrassing to acknowledge. The compulsion consisted of traveling in a crowded bus and seeking to press close to the hips of any plump, middle-aged woman standing in the aisle. It was vital for his ensuing excitement that the woman gave her back to him. If she ever turned to face M. with the knowledge of his desire in her eyes, his erection immediately subsided and he would hurriedly move away with intense feelings of shame. After marriage, too, the edge of his desire was often at its sharpest when his wife slept on her side with her back to him. In mounting excitement, M. would rub against her and want to make love when she was still not quite awake. If, however, the wife gave intimations of becoming an enthusiastic partner in the exercise, M sometimes . . . found his erection precipitately shrivel.[7]

A Freudian would immediately suspect that M. was reliving, as an adult, the childhood closeness to his mother. One would also suspect that the desire for such closeness triggered intense fear of the jealous father—hence the "discovery" of his actions by the woman would lead at once to impotence, as if to prevent any possible justification for that jealousy.

Kakar, while agreeing that there is unconscious conflict here, sees the terms of the conflict differently. It seems that the boundaries between genders are more fluid in India than in the West, and that in India it is not uncommon for a man to feel, and express, the wish to be a woman:

6. Kakar, 1991, pp. 437–438.
7. Ibid.

> [W]hen Gandhi publicly proclaims that he has mentally become a woman or . . . talks of man's envy for the woman's procreative capacities, saying "There is as much reason for a man to wish he was born a woman as for woman to do otherwise," he is sure of a sympathetic and receptive audience."[8]

M., too, had fantasies—undisturbing ones—of being a woman.

The conflict faced by a growing boy in India, Kakar suggests, is not between desire for the mother and fear of the father (a conflict that Freud held to be universal), but between, on the one hand, the desire to be an independent, autonomous man and, on the other, the wish to merge again with the mother, to become one with the mother symbolically. If he did that, he would gain closeness to the mother, her nurturance and protection; but he would would also cease to be an independent, autonomous male. Hence the dark, threatening figure in the dream was not the father but the potentially devouring, all-consuming mother. It "has as its roots the fear of the mother's sexuality."[9] So, we might guess, did his impotence when his sexuality was acknowledged by a woman.

Symbolism in Myth and Folklore

Freud insisted that our literature and folklore, as well as our symptoms, expressed unconscious urges and conflict. His "Oedipus complex" is named after the Greek legend of Oedipus, who, unknowingly, murdered his father and married his mother. The story moves us, said Freud, because it expresses a conflict every boy feels. He wishes his father were out of the way (or expressing it childishly, as the unconscious often does, that his father were dead), so that his mother would be all his. But this wish in turn triggers fear of his father's jealousy, and so the wish must be punished, as was the act in the tragic myth.

In a similar way, Kakar sees the ubiquitous conflict of the Indian boy symbolized in folklore. Consider a folk story, which concerns two young gods. One is Ganesha, "god of all beginnings" represented as a pot-bellied toddler having the head of an elephant with one tusk missing. His brother Skanda is a handsome child, a youth of slender body and heroic exploits.

> Ganesha, in many myths, is solely his mother Parvati's creation. Desirous of a child . . . she created him out of the dirt and sweat of her body mixed with unguents . . . Skanda . . . is the son of more than one mother: his father Shiva's seed, being too powerful, could not be borne by one woman and wandered from womb to womb before Skanda took birth.[10]

It should come as no surprise that Skanda's sexual appetites were literally legendary.

8. Ibid., p. 439.
9. Ibid., p. 438.
10. Ibid., p. 440.

Now, the folk tale:

> A mango was floating down the stream and Parvati, the mother, said that whoever rides around the universe first will get the mango . . . Skanda impulsively got on his golden peacock and went around the universe. But Ganesha, who rode the rat, had more wisdom. He . . . [rode around] his mother, worshipped her and said, "I have gone around my universe." Since Ganesha was right his mother gave him the mango. Skanda was furious when he arrived and demanded the mango. But before he could get it Ganesha bit the mango and broke one of his tusks.[11]

Kakar sees this myth as expressing the conflict that the growing Indian boy confronts. He can be an autonomous, sexual male, and ride around the universe. But then he cannot rejoin, or become, the nurturing mother figure. Or he can rejoin the mother; he can nurse at her breast (the mango, we are told, is often compared to the breast) and be protected and comforted. But then he loses some of his masculinity (one tusk breaks off) and he does not get to explore the universe.

A Look Backward

Kakar's interpretation of M.'s case material obviously keeps the basics of Freudian theory: the persistence into adulthood of unconscious childhood conflicts which are expressed symbolically. It also suggests, however, that the exact nature of the conflict may vary, depending on the culture in which one lives. Fear of a father's jealousy need not be universal, as Freud had held it to be.

In a similar way, Kakar, like Freud, sees legend and folklore as expressive of deep-lying, persisting concerns (analogous to the horse in our earlier image). Just what these concerns are, however, may vary considerably in different societies.

WHAT SHOULD WE SAY ABOUT FREUD?

For just about a century now, the debate has continued: Is Freudian psychology a set of fundamental insights into the mind, or is it a century-long wild-goose chase? Do his ideas give us deep understanding of the human mind, both normal and pathological—or do they only allow us to spin ingenious stories that give us the *illusion* of understanding? The question is still before us.

Freud as Cognitive Psychologist

Many of the things Freud said about the mind are not, from a modern perspective, really controversial at all.[12] The ideas he dealt with include ones with

11. Ibid.
12. Erdelyi, 1985.

which modern cognitive psychologists are quite comfortable. That material can be distorted in memory to fit long-standing ideas, or that two episodes can fuse together in memory is well known. And clearly there can be associative links between ideas; this is only to say that one idea can remind us of another.

Can we be "reminded" of sexual material in this way? Of course; why not? Matthew Erdelyi gives a marvelous example. This took place on a television quiz show, hosted by comedian Groucho Marx. Groucho, a virtuoso of the unrehearsed "one-liner," would interview his contestants before playing the quiz game with them. On one such interview, the following exchange took place:

> Groucho: How are you?
> Man: Fine.
> G. Well, tell me, are you married?
> M. Yes, I've been married for nine years.
> G: Gee, that's swell. Do you have any kids?
> M. Yes, nine already and the tenth is on the way.
> G. Wait a minute! Ten kids in nine years?
> M. Well, I happen to love my wife very much.
> G. Well, I love my cigar too, but I take it out of my mouth once in a while![13]

Can we be in any doubt as to the sexual reference here? Television audiences were not. Audience members who were offended by sexual innuendos (and there were more of these in the 1950s than there are now) called their stations in large numbers to complain.

Two questions arise, however. One is how far we can push such interpretations and still be on firm ground. What about Figure 6-7? Here we see a man and a woman at a tender moment. The ring is shown edge-on, but there is also a faint reflection that could remind us of the roundness and the *openness* of

Figure 6-7 Is this a sexy picture? (From Gleitman, 1995.)

13. Ibid.

the ring. And directly between the two people there is a silhouette of a very erect flower arrangement. We could easily see sexual symbolism in all this (the details are left as an exercise for the reader). But the question is: would we react to these symbols unconsciously in any case, with increased interest in the figure as a result? Or are we *reading them in* now, because we have psychoanalytic theory specifically in mind? And if the latter, might not a psychoanalyst, who also has the theory in mind, read symbolism into what she hears her patient say? Keep that question in mind; we'll return to it.

The "Dynamic Unconscious"

The second question is this: If we do accept such interpretations, do we need an energy metaphor to explain them?

Freud, as we have seen, regarded mental (and behavioral) events as reflecting the resolution of dynamic forces. Ideas and wishes are active, striving processes. If many of these are unconscious, it is because they are *made* unconscious; they are forced out of consciousness, or *repressed*, by other dynamic processes.

It has been pointed out that most people will tell us, if asked, that they do actively thrust ideas out of mind if these are unpleasant or anxiety-arousing. Yes, but in these cases, the ideas are preconscious; they remain accessible to consciousness and may still come to mind, all too easily it often seems. Freud is talking about ideas that are thrust so violently out of consciousness that the person *cannot* get to them, at least not without the patient help of a psychoanalyst.*

The idea of repression has become so commonplace that many of us are inclined to take it for granted. It is worth emphasizing, therefore, that such a process has *never been demonstrated* under controlled conditions—that is, under conditions where we know what is going on.

In other cases too, modern writers wonder whether unconscious mechanisms need reflect the clash of "hot" instinctual energies. Maybe they reflect instead some ways in which our minds process information, "coolly" as it were. Are we, as one team of writers happily put it, dealing with "psychodynamics" or with "psychologic"?**

Freud's Interpretations

All this takes us to what many writers regard as the key question about Freudian psychology: In whose head(s) are these associations, symbols, and disguises? Are they in all our heads, or only in the heads of psychoanalysts? To

*For this reason, the Groucho Marx joke, delicious as it is, is only superficially Freudian. The sexual reference was fully apparent to the radio listeners and, surely, to Groucho himself.

**Nisbett and Ross, 1980. Their book includes a very readable discussion of this issue, which we also will touch on again in later chapters.

what extent do psychoanalysts (Freud included) "read into" a patient's material what they expect to find there?

Take the case of M.'s problems on buses. The symptoms cry out, we might say, for interpretation as a reliving of childhood experiences. Perhaps so (since we have the theory specifically in mind), but that still doesn't mean the interpretation is right. For all we know, M. might have the same problems even if he had slept alone from earliest childhood. That is what an experimenter means when he points out that "real life doesn't run the control condition."*

Looking over this example, we begin to see the problem more clearly. *Freud's theory cannot be tested.* It is so flexible that it could be made to "explain" anything whatever—after the fact. But that means that if it is wrong, it gives us no way of discovering that it is wrong (see pp. 207–8). We must take it on faith or not at all.

There is obviously a problem of bias here—of reading into material what one expects to find there. This is frequently a problem with case studies, as we saw in Chapter 1. And in Freud's case, letters and documents recently made public have suggested that Freud's biases intruded blatantly into his work. He may have been, quite simply, a poor scientist, by the standards of our day and of his own.**

Freud was nothing if not confident of his own theories. And it now seems that he was capable of jumping to a conclusion based on his theories and forcing it on his patients. He might continue to insist that such and such must have happened in the patient's childhood, even if the patient never could recall any such event. And if the patient did recall it, what then? We now know that it is possible for a person to *create* false memories, of things that we *know* did not happen, in response to the insistence of an experimenter (or a well-meaning therapist). We'll discuss this "false-memory syndrome" in Chapter 11.

One other thing should be made very clear in all this: *A patient's assent to a Freudian interpretation is no guarantee of its correctness.* The patient, too, is puzzled by his own thoughts and actions. He would like to understand them. A story

*It does not help matters that many of Freud's followers—and, on occasion, Freud himself—have been ready to give quick and confident pronouncements about this or that action, based on no evidence at all. Here is an example of the sort of thing that makes scientists cringe:

In a letter, Freud speaks of Shakespeare's Hamlet, "who is positively hasty in murdering Laertes." A commentator writes of this: "[Freud's] slip about Laertes is an interesting commentary on the conflict he had stumbled upon in himself . . . Hamlet, of course, murders the father, Polonius, rather than Laertes, the son. It is as though, caught up in his self-analysis, Freud could not quite face the enormity of the son's homicidal oedipal hostility directed against his father." (Gay, 1990, p. 8.)

This bald assertion is true to the spirit of Freud's thinking. But we have no way of knowing whether or not it is correct. Was Freud's slip really an indication of "homicidal hostility" toward his own father? Suppose Freud had got it right, and written correctly of Polonius as the murderee—would that count against the theory? No, for then the commentator could as easily have said this: Since the fictional victim was someone else's father, not his own, Freud could express his hostility symbolically, hence safely, by writing of Hamlet's murder of a father. The theory wins, either way!

**For discussion and references, see Crews, 1993.

that gives him the *feeling* that he understands them may, right or wrong, be avidly accepted.

One may well wonder: If Freud's methods were so bad, why did his theory have such impact on the popular culture? There are a number of possible answers. Freud's case studies do spin intriguing stories. He wrote about sex, always a topic of interest. And there is a certain *fittingness* to the theories: If we do dark, mysterious, sometimes violent things, it seems natural to look for dark, mysterious, sometimes violent mechanisms to account for them.* None of this, however, argues for the rightness of the theory. It may instead only help to explain its seductiveness, in offering us the illusion of understanding in place of the real thing.

A Look Backward

Looking back over the chapter thus far, we can see several points of similarity between Freud's theory and Hull's. (1) Both writers saw motivation as springing ultimately from a handful of biological, homeostatic, energizing drives that reduce ultimately to one: Hull's *D*, and Freud's *pleasure principle.* (2) Both failed to make their case convincingly. In Hull's case, the theory was tested and found wanting; in Freud's, it could not be tested at all, and the invitation to bias in Freud's methods increases our suspicions of it. As a result, although (3) some recognizably Hullian and Freudian ideas are still with us, (4) neither theory in its original form is widely held by students of motivation today.

That said, we should note on the other hand, first, that some recognizably Freudian ideas *are* still with us: that one idea can symbolize another and that memories can fuse and condense with each other. And that our minds can process information *unconsciously* is about as well established anything in psychology could be. (Did you even notice, Reader, the missing word in the last sentence? Or did you fill it in—unconsciously?)

Above all, it is clear that any theory of motivation must face up to a simple but vital fact: *We do things without knowing why.* Mr. Jones doesn't know why he has his thing about shoes. I don't know why I doodled that owl. We are, as a modern writer put it, "strangers to ourselves" in very many ways.[15] We need to understand why this is so. Did Freud solve that problem? Probably not. Is the problem real and important? Definitely.

AROUSAL

At about the time when interest in Hull's theory was waning among psychologists, another non-specific, engine-like concept was gaining ground. This was the concept of *arousal.*

*Remember this when we discuss the *representativeness heuristic*, pp. 408–9.
15. Wilson, 1985.

We can look at the underlying idea in several ways. One is to consider that an organism may act in various ways—it may do this, that, or the other—depending on the situation. That action, however, occurs with more or less vigor or persistence depending on the state of arousal. High arousal, vigorous action; low arousal, feeble action (Fig. 6-8A).

Another way of looking at it is to consider not just how vigorous the action is, but how effective it is likely to be. If arousal level is too low, little or no effective action will occur, as before. If it is too high, action may be very intense, but it may also be frenzied and frantic and disorganized, so that nothing useful gets accomplished (Fig. 6-8B). This looks forward to the idea that there is an optimal, or best, level of arousal for behaving effectively (pp. 234–39).

Non-Specific Effects on Behavior

The first line of evidence for such ideas came from the study of reflex action (p. 165). It turns out that stimuli can have not only specific effects, calling forth just this or that reaction, but also *non-specific* effects, enhancing or priming a variety of reactions.

THE "CENTRAL EXCITATORY STATE" At around the turn of the century, the English physiologist Sir Charles Sherrington noticed that the elicitation of a simple reflex in dogs would elicit not only a specific reaction (e.g., leg flexion in response to a pin-prick on the foot), but also a momentary

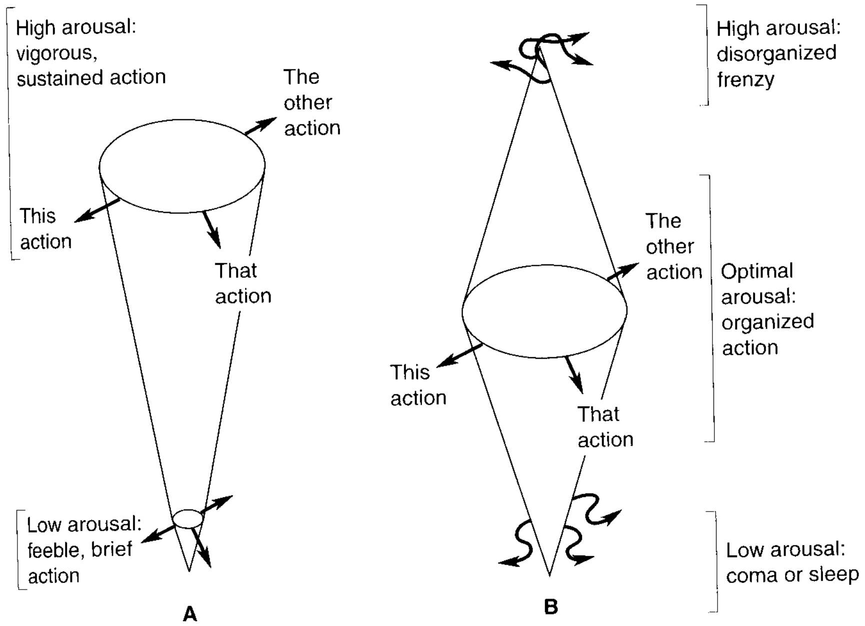


Figure 6-8 Two conceptions of the effects of non-specific arousal on behavior. In A, arousal enhances the vigor or energy level of whatever action occurs; the higher the arousal, the more vigorous the action. In B, there is an optimal, intermediate level of arousal for well-organized action. Action becomes less effective as arousal level moves away from the optimum, up or down.

state in which other reflexes, even unrelated ones, became more sensitive and vigorous. Besides eliciting leg flexion, then, the pinprick evoked what Sherrington called a *central excitatory state,* in which the whole family of reflex actions was made more excitable.

Something of the sort could easily be demonstrated in humans, too. In one classic study, subjects used one hand to squeeze a hand dynamometer—the gadget that measures the strength of one's squeeze. It was found that squeezing this instrument with one hand actually increased the speed with which one could react to a signal, where that reaction used the other hand—an entirely different set of muscles.

PAIN- AND STRESS-INDUCED BEHAVIORS More recently, researchers have identified yet more examples of non-specific effects. Suppose a male rat is subjected to mild pain, produced by electric shock or a clamp attached to the tail. This of course will produce attempts to escape and expressions of annoyance; but if a receptive female is present, then the male rat may court and mate. Or if food is present in the situation, the rat may eat.[16]

Stressors of these kinds can also counteract the effects of interference with the brain. Certain forms of brain damage can reduce responsiveness in experimental animals, producing, for example, rats or cats that are unwilling to mate or eat or explore (pp. 177–78). David Wolgin and Philip Teitelbaum found that many of these deficits could be reversed, as if by magic, if the animal were stressed or aroused. After being picked up, pinched, or dipped in cold water, an otherwise sluggish and unresponsive cat would walk briskly around for a while, or lunge at a mouse, or eat a bit of food. Arousal by quite another means, injection of the stimulant drug *amphetamine,* had similar effects.[17]

Wolgin and Teitelbaum suggest that the directing and eliciting properties of stimuli are superimposed on a general arousal that makes the actor responsive to them. Conversely, arousal can be enhanced by stimuli, such as a pinch or a cold bath. In other words, stimuli coming in from outside can have two effects. They can trigger specific responses such as feeding or mating, and they can also arouse the animal, making it responsive to other, perhaps quite unrelated, stimuli. Drugs or handling can also produce that arousal.

In humans as well as animals, non-specific effects have been observed. For example, many people in our society report that they eat in response to stress (pp. 188–89). Again, both women and men have been found to be more sexually aroused by an erotic film if, prior to that film, they have watched a vivid and gory movie dealing with automobile accidents.[18] Perhaps relevant too is that in many cultures, bites and scratches that draw blood are a routine part of sexual foreplay.

16. Antelman and Szechtman, 1975.
17. Wolgin and Teitelbaum, 1978.
18. Hoon et al., 1977; Wolchik et al., 1980.

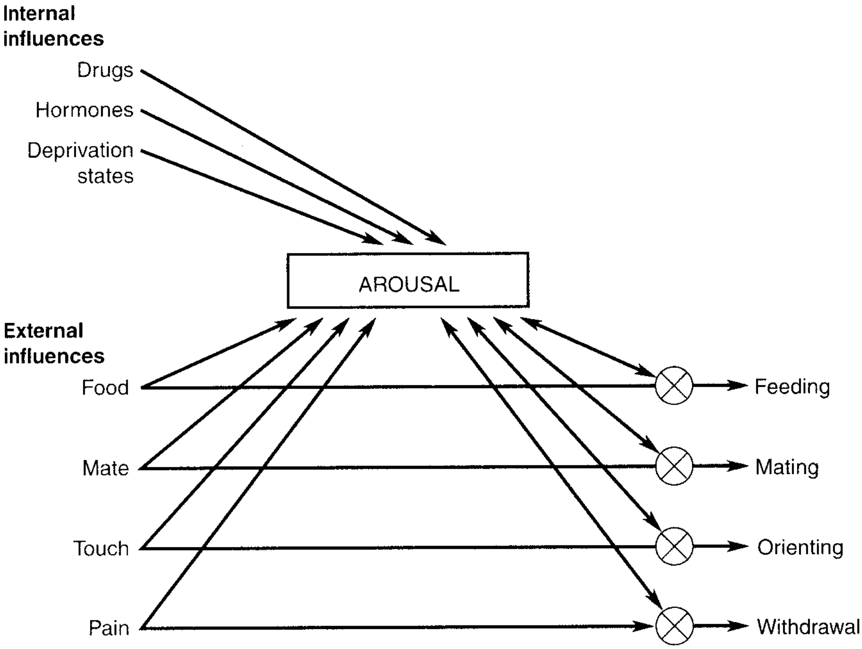


Figure 6-9 A possible role of arousal in behavior. Various stimulus situations elicit specific responses, but they also contribute to a generalized arousal state that enhances the effects of *all* stimuli. Internal influences also can contribute to that arousal state.

A Look Backward: Specific and Non-Specific Influences

What is underscored by these findings is this: A variety of manipulations can affect a variety of behaviors. Thus tail pinch, stimulant drugs, or prominent environmental stimuli can affect feeding, or mating, or attacking—among other things. We can represent these relations as in Figure 6-9, which shows some of the relations between non-specific arousal and some of its determinants and consequences.

The figure emphasizes several important ideas. First, specific stimulus factors, besides promoting and directing specific actions, can contribute to the generalized arousal state. So, presumably, can the occurrences of the responses themselves. Finally, there can be trade-offs among different influences. If food by itself is not an adequate stimulus for feeding just now, it might become so if pain-induced arousal is added to prime the feeding response. That is one way in which a pinch to the tail could elicit feeding.

THE PHYSIOLOGY OF AROUSAL

Yet another line of support for the arousal concept came from the study of organisms' reactions, physiological and behavioral, to emergencies. The physiologist Walter Cannon, who coined the term *homeostasis* (pp. 60–61), also pointed out that the body has a certain "emergency mode," in which it is prepared for vigorous action—"fight or flight," in Cannon's phrase—to deal with the emergency. Let us look more closely at this emergency state, and bring its investigation to modern times.

As with specific drive states, what happens inside and outside the body must be registered and translated into action by the nervous system. In complex creatures, this means integration in the spinal cord and the brain.

The Autonomic Nervous System

The **autonomic nervous system** is a part of the nervous system that has a specific role to play. Rather than producing behavior on the part of the creature—limb movements, for instance—it regulates the rate of the physiological processes that keep the body going. These include the processes of respiration, digestion, circulation of the blood, and the like.

The autonomic nervous system breaks down into two divisions, the **sympathetic** and the **parasympathetic** (Fig. 6-10). These systems place the body in different modes, depending on circumstances. We can think of this as a balance between a business-as-usual mode, controlled by the parasympathetic nervous system, and an emergency mode, mobilized by the sympathetic nervous system. In the latter function, the sympathetic system is reinforced by the **adrenal medulla,** an endocrine gland so closely related to sympathetic functioning that we might as well consider it as part of the package.

THE SYMPATHETIC-ADRENAL SYSTEM When emergencies arise and we must take vigorous action, our whole bodies go into emergency mode. Rate of breathing increases, to supply more oxygen; blood glucose increases, to supply more fuel. Heart rate increases, to keep the glucose and the oxygen coming to the cells; blood pressure therefore rises sharply. Not only that, but the blood vessels in the muscles expand, while vessels supplying the digestive organs constrict; the effect is to divert more blood to the muscles, to fuel the effort that may be required of them.

This global preparation for **fight or flight** is mobilized as a unit by a system well designed to change a number of things at once. Figure 6-10 shows a schematic diagram of the sympathetic nervous system. Motor nerve cells run from the spinal cord into a chain of nodes running up and down the cord, the **sympathetic chain ganglia**. There they synapse with other nerve cells that in turn run out to the organs—the blood vessels, heart, and others.

The synapses in the chain ganglia use the neurotransmitter **acetylcholine**. But at the target organs, the transmitter is **norepinephrine**, or noradrenalin, as it is also called. It is this chemical that affects the organs, exciting some and inhibiting others, so that the emergency state is brought into being.

Chemically, the adrenal medulla, a part of the adrenal gland, is very much like the nerve fibers running out from the chain ganglia. It too is stimulated by nerve cells that release acetylcholine, and it too releases a chemical transmitter, in this case **epinephrine**, or adrenalin. The difference is that the epinephrine is released into the bloodstream, which then carries it throughout the

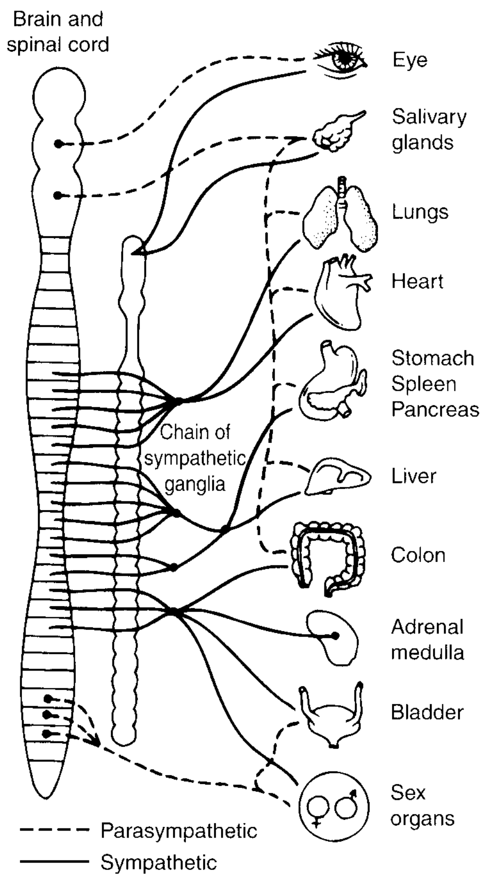


Figure 6-10 The autonomic nervous system, with its sympathetic division (solid lines) and parasympathetic division (dashed lines). The parasympathetic division has the following effects on its target organs: constriction of the pupils, stimulation of tears, stimulation of salivation, slowing of the heart, constriction of respiratory passages, promotion of movements in the stomach and intestine and the secretion of digestive fluids, contraction of the bladder, and flow of blood into the genital organs, producing erection in males and swelling of the vaginal walls in females. The sympathetic system has the opposite effects: dilation of the pupils, inhibition of tears, inhibition of salivation, acceleration of the heart, opening of the respiratory passages, inhibition of stomach and intestinal movements and digestive secretions, relaxation of the bladder, and inhibition of blood flow to the genitals. (After Cannon, 1929.)

body. It too inhibits some organs while exciting others, so that its effects closely resemble those of norepinephrine. It also has the important function of elevating blood-sugar level, supplying the cells with extra fuel.

The important thing to see is that this system is designed to function *as a unit.* The chain ganglia are closely connected with each other, so that an excitatory input anywhere in the system is likely to spread all up and down the chain, activating the whole system and thus mobilizing the entire body. The secretions of the adrenal medulla will have similar diffuse effects, for they are carried to all organs by the blood. In a word: *Input to the system from anywhere has effects everywhere.* Here we see again the important role of *divergence* in nervous system function.

Although the executive part of the system is organized at the level of the spinal cord, its effective inputs may of course come from elsewhere. Electrical stimulation of our old friend the hypothalamus may provoke a storm of sympathetic activity in an animal's body; if the animal is awake, signs of violent rage or fear may be evoked as well.[19]

THE PARASYMPATHETIC SYSTEM The housekeeping, business-as-usual system, the parasympathetic, is quite different. Here, nerve cells run from the spinal cord and from certain areas of the brain, to synapse with clusters of cell bodies close to the individual target organs. Other nerve cells go to those organs. These cells, like the sympathetic cells, are stimulated by acetylcholine, but unlike those cells they also release acetylcholine at the target organs. By and large, the effects of acetylcholine on the organs are opposite to those of epinephrine and norepinephrine. Acetylcholine slows down the heart, and it promotes activity of the digestive system, emptying of the bladder and rectum, and other housekeeping chores.

There is no interconnected chain of ganglia here, and there is no parasympathetic hormone corresponding to the sympathetic hormone, epinephrine, released by the adrenal medulla into the blood. As a result, the parasympathetic system is much less a unit than the sympathetic; its various parts can act more or less independently of one another. This makes good sense. The body's business-as-usual mode involves independent action of different systems, each in response to local conditions. If too much light enters the eye, the pupil must constrict; if the bladder is full, it must empty. There is no particular reason why these reactions should be coupled together so that if one occurs the other does. On the other hand, an increase in heart rate, constriction of blood vessels in the interior of the body, and a rise in blood sugar all act to make emergency fuel available to the muscles. These responses *should* be coupled with each other, so that if any one occurs they all do. And they are so coupled, through the sympathetic system.

Arousal and the Brain

The brain is a communication network. It is made up in large part of billions of nerve cells, or *neurons,* whose job it is to transmit messages from source to destination. Once called into action by an event or *stimulus,* arising from inside or outside the brain, such a cell, we recall, will send a series of electrochemical blips—nerve impulses—along its thread-like *axon* to affect the next cell in the chain.

19. For example, Hess, 1957.

In much of the brain, these axons are gathered together in bundles, reminding us of telephone cables. These cell bundles, again like a cable that connects, say, Pittsburg with New York City, transmit information from just one location in the brain to another—from right *here* to right *there*.

But not all of the brain is organized that way. Gathered around the central core of the brain stem are networks of cells that connect to multiple output locations (Fig. 6-11). Networks of cells like these remind us of military warning systems: an emergency signal that originates at one base will be sent, not just to some one other base, but to all other bases in the network.

This system, then, has effects that are widespread and diffuse, rather than localized and specific. The parallel with the sympathetic nervous system is apparent: input from any of a number of sources will have effects that spread throughout the system. And because the system does seem to be involved in a generalized arousal or alerting reaction within the brain, we will refer to it as the *brainstem arousal system,* or BAS.

There are several lines of evidence that this system does have an arousing, alerting effect when it is called into play. One kind of evidence is obtained by "listening in" on the brain's internal conversations by the recording of brain waves. Such a recording is an *electroencephalogram,* or EEG.

THE EEG To record an EEG, we simply paste electrodes to the scalp with conducting paste and attach the electrodes to a voltage-measuring device. We can then record the electrical fields that the activity of nerve cells generates.

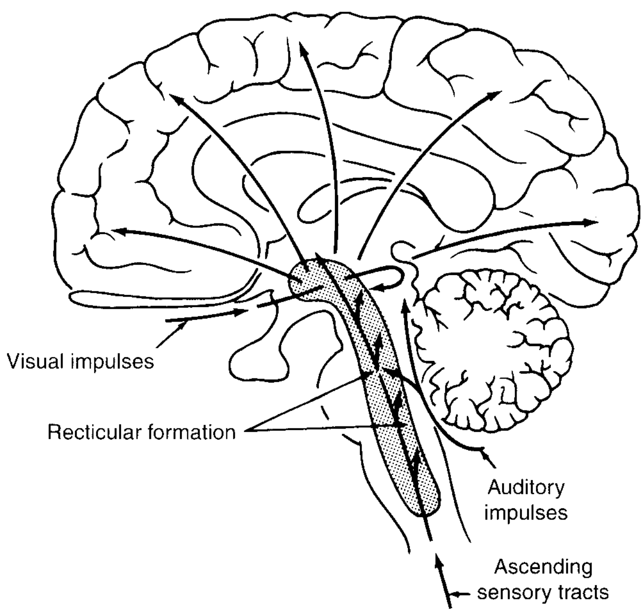


Figure 6-11 The reticular activating system. The reticular formation (shaded area), an important part of the brainstem arousal system, receives input from all the sensory systems. In turn it activates cells (see arrows) that deliver their messages throughout the cerebral cortex. (After Netter, 1958.)

We are measuring a kind of summed, or average, activity of many millions of brain cells (Fig. 6-12A).

If we do that in a subject who is sitting at rest with eyes closed, we would see a tracing of the kind shown in Figure 6-12B. There would be a rhythmic up-and-down trace. This is the **alpha rhythm**, also called a **synchronized EEG** (see below). The pattern is characteristic of low arousal level.

If the subject opens his eyes, or if we ask him a question or otherwise alert him, the tracing will change to the kind shown in the middle part of Figure 6-12C. The wiggles are faster and of lower amplitude. This is a **desynchronized EEG**, one showing arousal.

Why does this happen? Maybe an analogy will help here. Suppose we are at a party, where many conversations are in progress. A great deal of information is being transmitted within the room as a whole; many different arguments, stories, and flirtations are going on. If we simply record the overall sound level, our recording will not change very much over time, because the peaks and valleys of individual conversations will cancel each other out. The recording will look like the middle part of Figure 6-12C.

On the other hand, suppose all the people are saying the same thing at the same time—"DEE-fence! DEE-fence!" Now the peaks and valleys of the sound level are in phase with each other. Our record will make bigger swings back and forth in the rhythm of the chant—as in Figure 6-12B. But, let's face it, not much information is being transmitted. The chant may be fun, but it simply is not terribly informative. Just so, if many of the brain cells are doing the same thing at the same time, what they are doing is unlikely to be very interesting. The cells cannot be processing complex information if they are all chanting in unison.

Perhaps one effect of the impulses coming in from the BAS is to break up this synchrony. The BAS may say to the cortical cells, "Hey, listen. Something important is happening, and we may all have to do our different jobs to deal with it." If the task of saying that is entrusted to messengers—the cells of the BAS—who must spread the alert throughout the room, then we would expect the chant to break up. Various different out-of-phase conversations—What's up? Who are you? What's happening?—will ensue as the message gets around. Our sound recording will then show rapid but low-amplitude fluctuations, again as in the middle part of Figure 6-12C. Something like that may happen when our subject opens his eyes, or hears our question, or otherwise prepares to deal with information.

What is the role of sensory input in this system? Inasmuch as our subject's EEG switches to an aroused, desynchronized pattern when we ask a question, it seems that incoming sensory messages can arouse the brain. And it turns out that the specific sensory systems do give off branches into the BAS as they ascend in the brain. The result is that sensory inputs can have two effects. They convey specific sensory information, and they arouse the brain so that it can deal with that information.

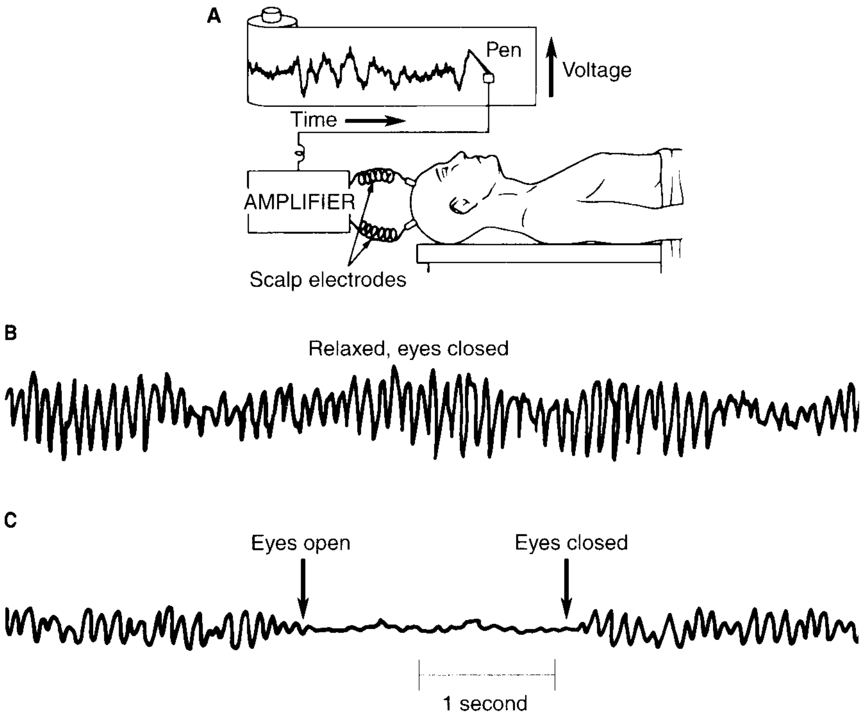


Figure 6-12 Procedure for recording EEG (A), and two typical records (B, C). (A) Scalp electrodes placed on the subject's head pick up the electrical fields generated by the activity of brain cells. These small electrical signals are magnified by an amplifier and are then used to drive a recording pen. Since the electrical signal fluctuates, the pen goes up and down, tracing a wavy line on the moving paper. The number of such waves per second is the EEG *frequency*. (From Gleitman, 1981.) (B) When the subject is relaxed with eyes closed, the record is of high amplitude (large electrical changes) and of relatively low frequency. This suggests that the many cells generating the electrical field are in *synchrony;* that is, they are all in the same state at the same time. (C) When the subject's eyes open, the wave breaks up and the record is at low amplitude and at a higher frequency, this suggests *desynchrony* of the cells' activities. (B, C: After Guyton, 1966.)

STIMULATION OF THE BRAIN Artificial stimulation of the brain gives us further evidence for an arousing or alerting function of the BAS. When the BAS was stimulated electrically in a sleeping animal, the synchronized EEG shifted at once to the desynchronized, aroused pattern. Behavioral arousal occurred too; the animal would raise its head, open its eyes, and look around alertly.[20] Strong stimuli can waken a sleeping animal, of course, but it seems

20. Lindsley, 1960.

we can bypass the sensory system and produce the same awakening directly, by stimulating the BAS.

DAMAGE TO THE BRAIN Another set of findings shows the effects of damage to this diffuse system.[21] In a classic series of experiments, knife cuts were made through the tissue of the BAS in cats. These cuts interrupted the ascending BAS, but avoided the sensory freeways that carry sensory information up into the brain. Presumably, therefore, the cats could hear, see, and feel, but they were drowsy, lethargic, and unresponsive after the operation. They simply did not react to sensory information. The messages got through, but the brain's bureaucracy did nothing about them. And this state of somnolent unresponsiveness was accompanied by a synchronized, high-voltage, low-arousal EEG.

All this is further evidence that it is not enough for sensory messages to get to the forebrain. The forebrain must be prepared to do something about them. And that preparation can be disrupted by BAS damage.

The reference to "somnolent unresponsiveness" reminds us of another kind of unresponsiveness—the akinesia and sensory neglect produced by lateral hypothalamic damage. We looked earlier (pp. 182–84) at the evidence that a non-specific system may run up through that area of the brain, one that says, "Isn't that interesting!" to incoming stimuli. As we have described it, damage to the BAS seems to interfere with an "Isn't that interesting!" reaction.

AROUSAL AND EXTERNAL STIMULI When we say that the system is aroused, what exactly do we mean? An aroused brain might be one in which response systems—movements—are primed directly. Or its aroused activity could be a *response to* movements, rather than a cause of them.

Or, yet another possibility, an aroused brain might be one in which the effect of *external* inputs is increased. In one experiment, tiny wires were implanted in the brainstem while the rats were anesthetized. These made it possible to record the electrical activity of single neurons in the BAS, later when the animal was awake and freely moving. It was found that some cells showed very *low* activity when the rat was eating or grooming, even though these are very vigorous actions. But when the animals were attending to *external* stimuli rather than (as it seemed) focusing on what they were doing, these cells became very active indeed. The researchers suggest that *vigilance* might be a better term than *arousal* to describe the latter state.[22]

In yet other experiments, the effect of BAS activity on response to external signals has been shown directly. In Figure 6-13, we see that electrical stimulation of the visual pathway, in an anesthetized cat, caused a small electrical response in the visual receiving area of the forebrain (A). But when the BAS

21. Moruzzi and Magoun, 1949.
22. Aston-Jones, 1985.

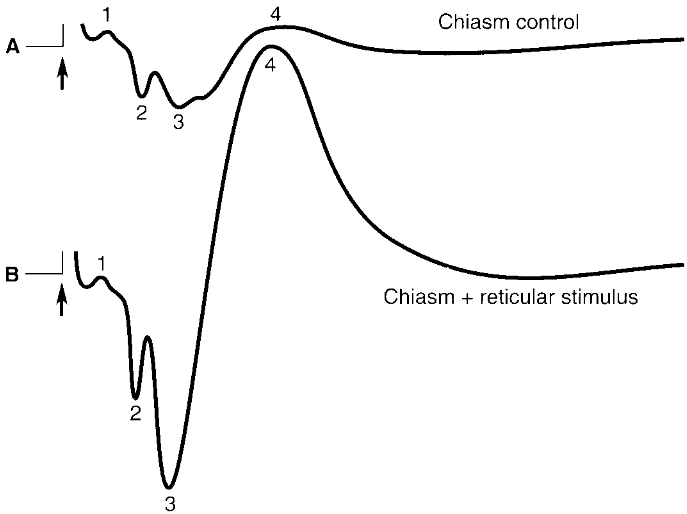


Figure 6-13 In an anesthetized cat, electrical stimulation of the optic tract—the bundle of nerve fibers running from the eye into the brain—causes an electrical response in the visual receiving area of the cerebral cortex. As with the EEG, this "evoked response" reflects the summed activity of many thousands of cortical cells. Note the much greater response in the lower tracing, especially at 2, 3, and 4. The difference is that in the lower tracing, the brainstem arousal system was stimulated as well as the optic tract. (From Singer, 1979.)

was stimulated along with the visual pathway, the effect was very much greater (B). In all this, it seems as if the BAS is acting, not so much as an "engine" of behavior, but as a "volume control" for inputs from the environment.

Finally, these operations—priming responses, or registering responses that have already occurred, or vigilance for sensory inputs—are not incompatible. They may all be going on when the brain is aroused. What we have been calling the BAS is actually a very complex collection of subsystems, and different subsystems may well have different jobs.

A Look Backward—and Forward

As we have seen, the sympathetic nervous system is designed to arouse the body. The BAS and related systems are designed to arouse the brain, to make it vigilant and responsive.

Sensory input may have two different effects on the brain. It may go to its specific sensory receiving areas in the brain to convey specific information and call forth specific reactions. But in addition, it may arouse the whole brain by way of the diffuse BAS. In this way an incoming report from the sensory systems could say two things to the brain: (1) "Here is the specific information I have to convey," and (2) "Something is happening! Isn't that interesting! Pay attention! Prepare to investigate and perhaps do something about it!" The latter is the arousal reaction.

All this looks backward once again to the very important notion that we saw earlier when we talked about hunger and sex. Internal and external influences on motivation and behavior are not independent; they interact with each other. An external event can contribute to internal changes—in blood chemistry for example or, as here, in an internal state of arousal. Conversely, internal states can affect how external signals are reacted to. In the last section, we saw that internal changes in BAS activity can affect the sensory pathways that register external events.

OPTIMAL AROUSAL THEORY

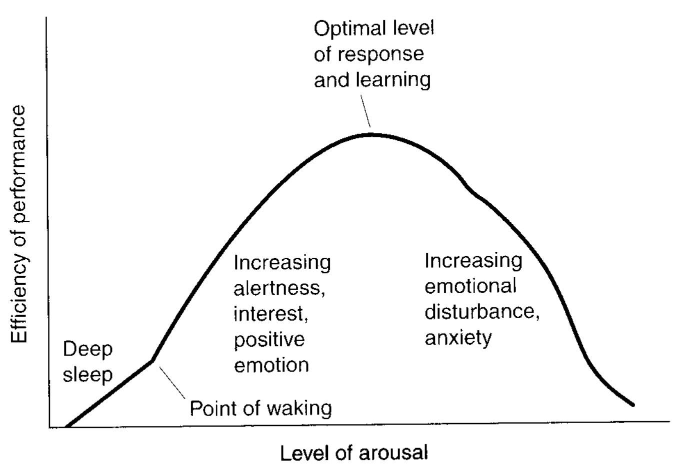
For Hull, some state of need or deprivation—drive, or *D*—is necessary for any behavior at all to occur. Total absence of drive should produce an organism that does nothing whatever—like a car with the engine switched off.

Very different is the notion of *optimal arousal,* to which we now turn. It says this: The ideal state is one in which there is an *intermediate* level of arousal—not too much, not too little. That state is best for effective behavior, it is most pleasant, and it is the state that organisms seek to attain or maintain (Fig. 6-14).

Sources of Optimal Arousal Theory

Various ideas converge to support this theory. First, there are the results of introspective studies of pleasantness and unpleasantness. For a variety of sensory modalities, pleasure tends to be evoked by stimuli of low or medium intensity; high-intensity stimuli tend to be unpleasant. Thus there is an inverted U-shaped relationship between the intensity of a stimulus and its pleasantness.[23] We can easily think of examples. Almost any stimulus can actually be painful if it is strong enough. Short of that, consider salt in scrambled eggs. A little is good. A lot is not so good!

Figure 6-14 Optimal arousal theory. Action, learning, and information processing are most efficient at an intermediate level of arousal, neither too high nor too low. (From Hebb, 1955.)



23. See for example Wundt, 1910.

Second, there are the results of some early experiments from the animal learning laboratory. One study looked at the efficiency of maze learning in mice, varying two things: the difficulty of the task, and the strength of the drive.[24] Briefly, there is an optimal level of drive for a task of given difficulty. Again there is an inverted U-shaped function, this time relating efficiency of learning to drive level. This relationship is often referred to as the **Yerkes-Dodson law.**

Finally, a number of writers have wondered how the biasing mechanisms of the brain, that push it toward negative or positive responses to stimuli, fit into the picture. Recall again the non-specific systems running up through the hypothalamus. One says, "Isn't that nice!" and one says, "That's awful!"—to a variety of inputs. Daniel Berlyne, among others, has pointed out that the inverted U-shaped curve could result from the joint action of a positive "Isn't that nice!" system and a negative "That's awful!" system if we assume three things: (1) that the "nice" system is the more sensitive one, but (2) that it quickly saturates, so that it can be activated just so much and no more, and (3) that awfulness subtracts from niceness.[25] That would mean that low-intensity stimuli activate only the sensitive "nice" system. But as stimulation gets more intense, it becomes intense enough to bring the "awful" system into play. And the more intense it is, the more the balance shifts away from niceness and toward awfulness (Figure 6-15).

Seeking Optimal Arousal

The notion of an optimal arousal level has been a popular one. Let us look at just a few of the many findings that fit within it.

TOO MUCH AROUSAL First, this theory would agree with Freud's theory, and Hull's, that too much is too much—of anything. In both animals and humans, loud noises are aversive, and will support escape or avoidance almost as effectively as electric shock. They can also affect physiological functioning and disrupt performance.[26] For example, children whose school was in the flight path of a Los Angeles airport were found to have higher blood pressure than children from quieter but otherwise comparable schools.[27] They were also more likely to fail on problems or to give them up.

Crowding, too, can cause increased blood pressure and feelings of discomfort,[28] and it is likely to disrupt performance on complex tasks.[29] Here is the Yerkes-Dodson law in human performance.

24. Yerkes and Dodson, 1908.
25. Berlyne, 1970, 1971; see also Schneirla, 1959.
26. Cohen et al., 1981.
27. Paulus, McCain, and Cox, 1978.
28. Epstein, 1981.
29. McClelland, 1974; cited by Worschel and Shebilske, 1983.

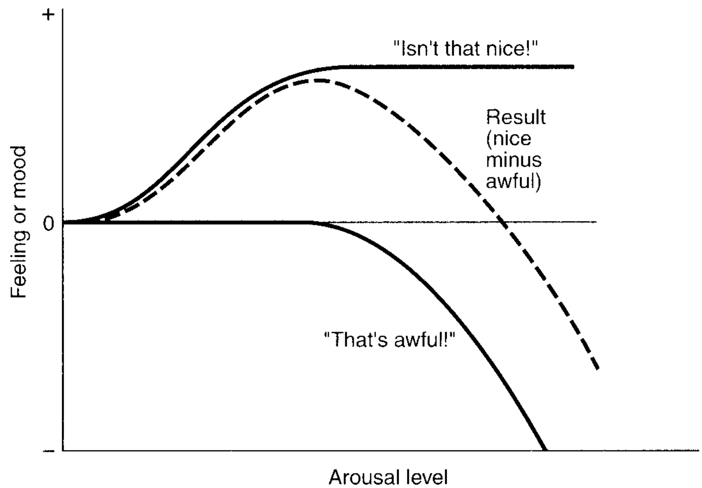


Figure 6-15 How two systems, one positive ("Isn't that nice!") and one negative ("That's awful!"), could give rise to an optimal arousal level. Feeling or mood reflects the difference between the two systems (dashed line), that is, the extent to which positive exceeds negative. Mood would be most positive at an intermediate arousal level that excites the positive system, without exciting the less sensitive negative one.

Finally, a state of too much arousal is not just aversive and disruptive. It can be life-threatening:

> Twice in the past eight months . . . the Montreal newspapers reported the behavior of a human being who, suddenly finding himself in extreme danger but with time to escape, simply made no move whatever. One of the two was killed; the other was not, but only because a truck driver chose to wreck his truck and another car instead.[30]

In such cases, one might suppose that the people simply froze in terror. Not necessarily. Hebb cites records of behavior during emergencies in which people displayed not freezing, but "a clear impairment of intelligent behavior, often with aimless and irrelevant movement." And he makes explicit the parallel with Hull's ideas: "a high [drive] arouses conflicting [habits]?"

Too Little Arousal On the other hand, optimal arousal theory breaks sharply with Freud and Hull at the other end of the spectrum. Too little going on can be as bad as too much.

Consider an experiment like this:

> [The] subjects were paid handsomely to do nothing, see nothing, hear or touch very little, for 24 hours a day. Primary needs were met, on the whole, very well. The subjects suffered no pain, and were fed on request. It is true that they could not copulate, but at the risk of impugning the virility of Canadian college students I point out that most of them would not have been copulating anyway. . . . The secondary reward, on the other hand, was high: $20 a day plus room and board.[31]

30. Hebb, 1955.
31. Ibid., p. 245.

The subjects in these **sensory deprivation** experiments might lie on a cot, with opaque goggles over their eyes, earphones over their ears, and mailing tubes over their hands so that they could manipulate nothing and touch very little. Nothing bad happened to them. They were simply left there.

Notice that the subjects are in an ideal situation from either the Hullian or the Freudian point of view. Any homeostatic needs are quickly met; there are no tensions, drives, requirements, or hassles of any sort. The subjects should simply have been *unmotivated,* and they should have relaxed and enjoyed it.

> In fact, the subject was well motivated for perhaps four to eight hours, and then became increasingly unhappy. He developed a need for stimulation of almost any kind. . . . Some subjects were given [through the earphones] a talk for 6-year-old children on the dangers of alcohol. This might be requested, by a grown-up male college student, 15 to 20 times in a 30-hour period. Others were offered, and asked for repeatedly, a recording of an old stock-market report.[32]

The Regulation of Arousal

It appears then that there is something like an **optimal arousal level,** set not at zero (as for Freud) but at some moderate value. Moreover, we have seen evidence that organisms *seek* that optimal level. If arousal is too low, one seeks to raise it: If there is nothing else to see or hear, college students ask to have stock-market reports read to them. If arousal is too high, one seeks to lower it: A harassed city dweller seeks a quiet walk in the woods. That suggests that there are negative-feedback loops for arousal as there are for blood sugar level, so that we seek to decrease arousal if it is too high, or to increase it if it is too low.

Donald Hebb interprets many of our everyday behaviors as attempts to raise a too-low arousal level.[33] We read exciting stories; we go to scary movies; we ride roller coasters. And we make arbitrary responses to be able to do these things—transporting ourselves, shelling out money, and so on—so we are seeing the action of *motivational states* in these instances. We will go to considerable lengths, taking whatever action is available, to escape from boredom.

Conversely, we sometimes will escape from a situation in which too much is going on—even if it is not acutely threatening. Those are the times when we will seek peace and quiet—again by whatever action is available.

But Is There One Optimal Arousal Level?

Optimal arousal theory has a certain surface plausibility. We don't like to be bored, but we also don't like to be bombarded with too much going on. Still, on second thought, we may wonder whether there is any *one, single* level of arousal that is optimal all the time, as the theory implies.

32. Ibid., p. 246.
33. Hebb, 1955.

Consider how our bodies feel after a roller-coaster ride. Our hearts pound, our knees shake, we are in a cold sweat—and we find it pleasant. If our bodies were in the *same* state after a visit to the dean's office, would we find that pleasant? And if not, how can we say that any given level of arousal is pleasant, or optimal, in itself? We can't.

Studies of physiological arousal raise similar questions. Experiments have shown that unpleasant situations, such as stress or crowding, increase the outpouring of epinephrine and norepinephrine. A stress reaction? Perhaps, but when an exciting game of Bingo is in progress, the measure of sympathetic activity can rise just as high.[34] If we say that a given amount of sympathetic activity is *too high* when produced by crowding or threats, how can the same activity level be *just right* when produced by a Bingo game?

Indeed, even the everyday examples that make the theory seem plausible can be less supportive when examined more closely. Jean is bored, and wants some excitement. James is hassled and harried, and wants some peace and quiet. Is it really the *same* final state that the two people are seeking, from opposite sides? It seems unlikely. My guess is that they would cross over if they could, that Jean, who wants excitement, will seek a somewhat higher level of arousal than will James, who wants some peace.

Optimal Arousal and the Task

Finally, let us look again at the Yerkes-Dodson law. What the law actually says is not that there is *one* optimal level of motivation, but rather an optimal level *for the task at hand.* And that optimal level varies with the task. It seems to be lower when the task is complex (where there are many possible *H*s to compete with each other?). It is higher when the task is simple (where only one *H* is clearly dominant?).

Athletes and performing artists, and their coaches, are familiar with this idea. For finely skilled activity, one wants to be excited and "up" for the occasion, but not too much so. "Tensing up" can be fatal to good singing, and "choking under pressure" can be disastrous for the skilled golfer or billiards player. Where finely skilled movement is less important than an explosion of strength or speed, as for the sprinter, then the level of tension can be considerably higher without endangering performance. There is some direct experimental evidence for this idea.[35] Because of this, athletes and performers often deliberately take steps to raise or lower their own arousal levels toward what is optimal for the upcoming test (see below, pp. 240–41).

Notice, however, that we have shifted ground here. We are now thinking of a given level of arousal, not as something that is currently present to affect our behavior, but as a *goal*—something that is not present now, but that we seek to bring about. And the *motive* involved is not an existing state of arousal,

34. Frankenhaeuser, 1976.

35. For review see LeUnes and Nation, 1989.

but our desire to do well at the task. Achieving the right level of arousal is thus a stepping-stone toward that end.

All this moves away from the notion of arousal as the "engine" of behavior. Instead, it looks forward to the general problem of goal-directed behavior, to be considered in later chapters.

COGNITIVE FACTORS IN AROUSAL: DISCREPANCY AND SURPRISE

Thus far, we have spoken as if arousal were determined simply by the amount of sensory input an organism receives. If that were so, arousal could be seen as a direct physiological response to sensory inputs. But that is too simple, for we must also consider *cognitive* influences. We will see that arousal depends on what we *expect* to happen, and not just on what does happen.

Stimuli or Events?

If we put aside a boring novel and pick up a new and more interesting one, our eyes are not receiving any more light than they were before. Interesting conversation is not necessarily any louder than boring conversation. There is something important about the *content* of the input, not just the *amount* of it that we receive.

Further experiments with sensory deprivation make the same point. Instead of lying in darkness, a subject may wear translucent goggles which, like frosted glass, admit light but not *patterned* light. Instead of hearing only silence, he may hear continuous shooshing "white noise" through headphones. Then he is hearing sound, but not *patterned* sound.

Now if the simple *amount* of sensory input determines how much excitation is fed into the BAS, and therefore how aroused the forebrain is, then even unpatterned sensory input should prevent the disorganization of brain function and the distress associated with it. It does not.[36] Subjects find **pattern deprivation** just as intolerable as the original sensory deprivation of darkness and silence.

What Is an Event?

It appears that sensory deprivation is not just a matter of reduced physical input to the sense organs. It is deprivation of patterned sensory input, or events, or *happenings*. "Nothing happens, nobody comes, nobody goes, it's awful!" To understand this, we need to know what qualifies as an *event*, as opposed to a physical stimulus.

HABITUATION AND AROUSAL Part of the answer comes from some classic experiments by E. N. Sokoloff.[37] In human subjects, Sokoloff recorded

36. See Hinde, 1970, for discussion.
37. Sokoloff, 1960.

various physiological measures of arousal while his subjects were sitting in a quiet room. From time to time, a tone would suddenly come on. Sure enough, subjects were aroused by the tone—at first. But if the tone came on repeatedly, for fixed durations and at fixed intervals, the arousal response gradually weakened until it disappeared altogether.

This waning of responsiveness, with repeated or continuous presentation of a stimulus, is known as **habituation.** It is responsible for the fact that you are quite unaware of the pressure of your socks against your feet, until I call it to your attention. Notice that this is not a matter of sensory adaptation. When you attend to it, you feel it all right; the sensory input is getting through. But it is filtered out by the habituation mechanism, and is not an effective input until you and I make it so.

What Sokoloff did then was to introduce various changes in the time of onset or offset of the tone. If the tone occurred on schedule, the habituated subjects' bodies simply went on about their business; no arousal response occurred. But if the tone came on too early, the arousal response at once occurred. It also occurred if the tone stayed on too long, or ended too soon, or *failed* to appear when it was due. Notice in particular that the arousal response could occur with *no change at all* in the external input, as when the tone failed to appear, or to disappear, on schedule.

EVENTS AS SURPRISES What subjects find arousing, then, is not a physical input as such, but a *deviation* of the input from what was expected. If what happens is only what ought to happen, there is no discrepancy between the expected and the actual input—and no arousal. If there is a difference—the tone is too early, too late, or whatever—then that is an event. Arousal results.

In a word: to qualify as an event, an input must have some *surprise* value. Otherwise it is ignored.

Obviously there are limits to this habituation mechanism. An intense pain, even if expected, still hurts. And habituation applies primarily to *continuous* stimuli, like the socks on our feet, or *regularly repeated* ones, like the tones in Sokoloff's experiments. Distinct events, like the arrival of someone we have waited for, are still events when they occur even though we expect them.

The important fact remains, though, that relatively few of the stimulus inputs we receive are treated as events. And a good thing, too, or we would be swamped with information. The fact that the sun is up or down as it should be, that the chair under me is still solid—these are not events and can be ignored. Even an act that requires close attention, like the reading you are doing now, ignores most of what is going on. There are all sorts of things about this text that you are not aware of; but if I change one of them, dann sind Sie erstaunt, nicht wahr? It is very much an event if I start writing in German, but I'll bet you had no awareness at all of the fact that I was writing in English before.

In summary, arousal level is affected by *events*—by surprises—as distinct from sensory inputs. And if there is an optimal level of arousal, this may mean that there is an optimal level of surprises to deal with.

Finally, here is yet another point at which these ideas make contact with sports psychology and the performing arts. Skilled actors, at the moment when their skills are about to be tested, may perform a stereotyped series of movements, a kind of ritual. A baseball player about to bat, or an ice skater about to skate, may insist on taking a few seconds to do this. Such rituals may serve the purpose of warming up or shaking loose certain muscle groups; but it may also be important that the ritual, because it is stereotyped, is *utterly predictable*. There are no surprises in it. It may, for just that reason, be one way of lowering arousal or anxiety to a level that is closer to optimal for the task at hand (compare pp. 238–39).

AROUSAL: A LOOK BACKWARD

The concept of arousal, as we have elaborated it, can be schematized as in Figure 6-16. The basic idea is that specific effects of causal factors on behavior are superimposed on a background of higher or lower general arousal, produced by non-specific influences like the four Ss: stimuli, stimulant drugs, stresses, and surprises. This idea is still very much with us.

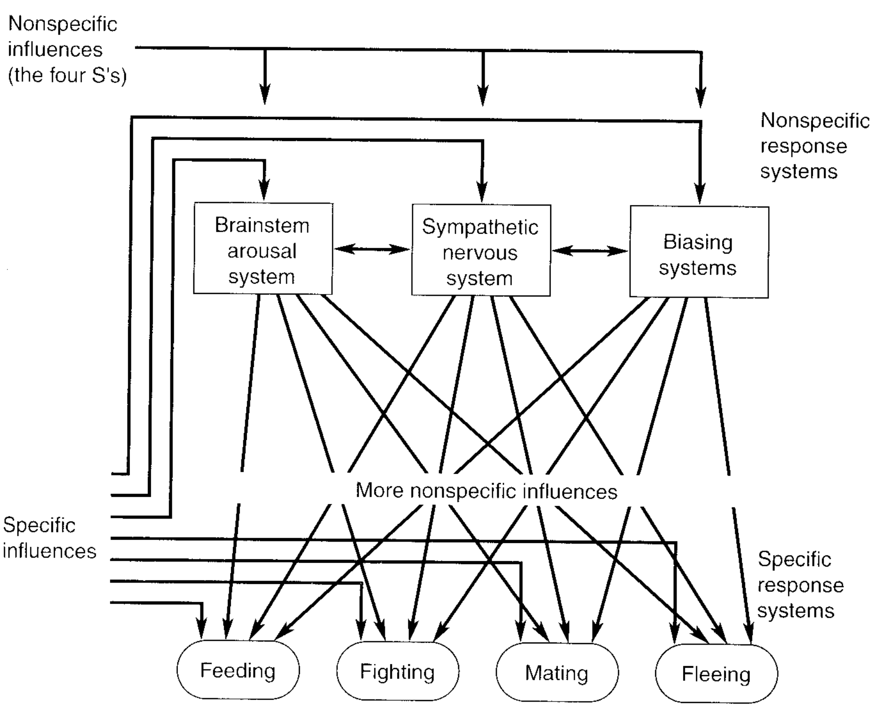


Figure 6-16 Hierarchical organization of specific and non-specific influences on action. See text for explanation.

Arousal versus Drive

Students of arousal have been interested in different problems from those that engaged Clark Hull, and they made little or no use of Hull's algebraic formulation. Still, the arousal concept has some points in common with Hull's generalized drive, or *D*.

First, as Hull saw it, tissue imbalances or needs arising from *any* source (food deprivation, water deprivation, sexual deprivation)—*all* converge to increase the motivational multiplier *D*. Similarly in the case of arousal. A creature may go into emergency or alertness mode for any of a number of reasons—the approach of a predator, or a rival, or a forest fire, or an experimenter, or the big long drop coming up on a roller-coaster ride. *Any* of these can throw the actor into the *same* emergency mode of operation.

On the output side, Hull saw *D* as multiplying, indiscriminately, *all* habits (*Hs*) that exist in a situation. Similarly, a state of arousal has multiple manifestations, all called into play at once. There are changes in the circulation, in the digestive system, in respiration—and in the brain, which becomes alert and engaged, ready to take in the situation and translate what it finds into action. Finally, a number of different actions—not all, as with Hull, but a number—may be primed together. An animal can be ready to fight *or* flee *or* freeze in fear—to do, that is, any of a number of specific things as the situation requires.

So arousal, like drive, may arise from any or all of a number of sources. And it may enhance any or all of a number of reactions or reaction tendencies, both physiological and behavioral.

Arousal and Motivation—Are They the Same?

Is this all there is to motivation, then? Will it help us to think of arousal as the motivating "engine" of behavior, and of other influences as non-motivational? Probably not.

In the first place, Figure 6-16 is drastically oversimplified in a number of ways, and one of these is that it omits *inhibitory* interactions among sub-systems. We saw earlier (pp. 207–8) that dehydration, which promotes drinking, can actually inhibit feeding. Stress can augment feeding behavior (pp. 224–25); but stress can also inhibit feeding under other circumstances.

By the same token, whereas an irrelevant stress (like mild pain) *can* enhance feeding or sexual activity, it doesn't follow that all influences have that generalized effect in all circumstances. We've seen that an especially tasty food can trigger a bout of eating that would otherwise not occur, without having any detectable effect on other motivational systems such as courting or mating. Perhaps we should think of the non-specific effects shown in Figure 6-16 as influences that *can* occur, not as ones that always and automatically do occur.

The same is true of physiological response systems. Heart rate can increase under some arousing circumstances, but it can decrease under others. It is affected by the sympathetic nervous system, but it is affected by more specific influences as well.

We might sum it up this way: Various response systems may all be driven in the same direction—upward—by non-specific arousal. But at the same time, they may be driven in *different* directions by *specific* influences, internal and external: thus dehydration may inhibit feeding, and a sexual gesture, in some species, may inhibit attack. Whether the end result is enhancement or depression of a given sub-system (like feeding or fighting) will depend on how strong these competing influences are, relative to each other. It surely is not true that everything automatically enhances everything else.

A FINAL LOOK BACKWARD

At the beginning of this chapter, we embarked on a search for the "engine" of behavior—the part that makes it go. Have we found our engine? No. Should we continue to search for it? I think not.

Hull's generalized-drive concept was certainly an idea worth checking out. But psychologists did check it out, and found it wanting. Not all drives promote all behaviors, and not all behaviors are evoked by drives.

Freud's theory, in attempting to reduce the engine of action to a handful of drives, faces some of the same problems as Hull's theory does. It is simply too limiting. Even many of Freud's early associates parted with him on this point. Few psychoanalysts, and fewer research psychologists, take this aspect of his theory seriously now.

More generally, modern researchers wonder whether Freudian phenomena, even if we grant their occurrence, really require the energy metaphor at all. Some of them at least may reflect "cold," dispassionate operations of our cognitive apparatus, rather than the "hot" passionate clash of opposing forces We will return to this matter in Chapter 11.

The notion of *arousal,* we have emphasized, is still very much with us. But we no longer think of it as an engine, with other influences relegated to a guidance or steering function. Activity in the arousal systems is simply one, among many, influences on behavior. As to its mode of action, recall that we changed the metaphor in our previous discussion (pp. 232–33), comparing arousal level to the setting of a volume control. There is something compelling about the notion that the engine is the "motivating" part of a car. It is much less compelling to think of the volume control as the "motivating" part of a hi-fi system!

The notion of *optimal arousal* again moves us away from the engine metaphor. There very likely is something to the idea that arousal may be too low, leading to sluggishness; too high, leading to tension or frenzy or disorganization; or just right for the problem we face. But in looking more closely, we saw (pp. 237–39) that there probably is not any one "optimal" level, that the system regulates in a homeostatic way. Rather, there may be a level that is optimal *for the task on hand;* and in such case, we may take action to raise or lower arousal as needed. But then the optimal level is not an engine but a destination; not a present state, but a goal or way station.

Finally, it is not clear that we gain anything by speaking of non-specific influences as "motivational" and calling other influences something else. If a yummy food calls forth a bout of feeding that would not otherwise occur—and does it without measurable effect on, say, sexual readiness—there seems no reason not to speak of that food, or the cues it provides, as *motivating* the feeding act. Similarly, if a situation promotes a drinking response but inhibits a feeding response, is there any point in calling the promoting influence "motivational" and the inhibiting one not? I do not think so.

All told, the attempt to make a hard-and-fast distinction between motivational and other influences was once a popular indoor game, but it has lost its popularity in recent years. Behavior is subject to many influences, and all of them need to be understood. Arousal level may be an important such influence, but it is only one, among many.

SUMMARY

Some early theories about behavior held that only one motivational concept, analogous to energy, was required. This would determine how vigorous or persistent behavior would be, whereas more specific influences determined what direction the behavior would take. By this account, motivation is like the engine of a car, whereas non-motivational factors are like the steering mechanism.

One such theory was Clark Hull's. His *generalized drive* (*D*), a kind of motivational energy, was assumed to energize all stimulus-response connections, or *habits* (*H*), indiscriminately. Thus actual behavior was assumed to reflect a multiplicative relationship between a motivational influence *D* and an associative or learning-based influence *H*.

This theory has some interesting implications. For example, it predicts that high drive should aid performance if the best response is the dominant one, but should hinder performance if an incorrect response is dominant; and there is some support for that prediction in learning experiments with human subjects.

Other experiments, however, do not fit the theory. Animals that are not deprived of anything (hence, presumably, in no drive state) can learn, and persist in, complex activities. And we cannot say that all drive states facilitate all responses; for example, thirst can inhibit feeding or food-getting responses. Nevertheless, the notion of a non-specific arousal mechanism is still with us, as is the notion of joint control by motivational factors on the one hand and learning-based and cognitive ones on the other. And the failure of the theory is a case study in how we test our ideas, and so learn when they are wrong.

Another energy-like concept was Freud's theory of drives or instincts. These were conceived as engine-like forces all having their origin in biological energy. Drives have different *sources* in different parts of the body, and different *objects* by which they may be satisfied, but all have the same *aim*—the reduction of discomfort, which reduction is felt as pleasurable. To Freud, all behavior is ultimately directed toward that aim. That is his *pleasure principle.*

Tendencies to think or act can come into conflict with each other; one may be opposed or blocked by another or redirected because of such opposition. Complexities can arise here, the more so because some person or object may come to represent, or symbolize, another. In this way, drive energy may be directed toward an object that is only a symbol of the object originally desired. Thus much of our behavior can be seen as disguised expressions of primitive impulses. Freud saw this principle as most clearly visible in dreams, where the disguises may be most easily seen through.

Much of this goes on below the level of consciousness, so that the disguised expression of wishes may be as incomprehensible to the person as to anyone else. Often the wishes, and the need to disguise them, date back to early childhood, so that adult behavior becomes a kind of re-enactment of childhood conflicts. Some writers believe, however, that the kinds of conflicts that arise can depend a great deal on the culture within which one is raised. Conflicts that are common within a culture may be reflected in its myths and legends as well as in the thoughts and actions of individuals.

Freud's work has been severely criticized. A cornerstone of his theory, that material may be actively thrust out of mind, or *repressed,* has never been demonstrated convincingly. How much was he reading into what his patients said? And how much of what they said was in response to the theoretical ideas that Freud forced upon them? Might they have *created* false "memories" in response to his insistence? Finally, because the theory is complex enough to give an after-the-fact explanation of anything that happens, it really cannot be tested. Despite all this, Freud was certainly addressing a vitally important question: Why do we so often do things, or think things, that we ourselves do not understand? Freud's answers are not widely accepted, but his question was fundamental.

Yet a third engine-like conception in motivational theory is the concept of ***arousal.*** Certain conditions can affect, not just this or that action, but a variety of actions; mild pain, for example, may induce an animal to feed or to mate. Such findings suggest a generalized arousal state, in which the organism's whole repertoire of actions is primed and energized or, perhaps, in which it is more vigilant and alert to incoming information.

Certain systems within the body also have widespread effects on a variety of systems all at once. Activation of the ***sympathetic nervous system*** affects a number of organs in preparing the body for "fight or flight." Within the brain, the ***brainstem arousal system,*** which includes the ***reticular formation*** of the brainstem, transmits its activity diffusely through the forebrain so that it, too, seems to activate a number of systems all at once. Damaging that system can produce a state of sluggishness, somnolence, and unresponsiveness to a variety of sensory inputs.

Much evidence suggests that there is something like an **optimal level** of arousal for the task at hand—not too high, not too low. Intermediate stimulus intensities tend to be judged pleasant; and the *Yerkes-Dodson law* states that an intermediate level of drive leads to most-effective functioning. At one extreme, intense arousal can lead to life-threatening panic. At the other, *sensory deprivation* is a severe stressor. Subjects may seek to regulate their arousal levels, reducing them if too high, augmenting them if too low. In such cases, however, optimal arousal becomes a goal that is sought, not something that is acting to cause the behavior now. Moreover, we must remember that different levels of arousal may be best for different tasks. There probably is no one single optimal level of arousal.

Level of arousal is affected, not just by internal and external sensory inputs, but by violations of expectations—in a word, by surprises. A stimulus to which we have become *habituated* may no longer arouse us. So cognitive factors (such as expectations) can affect arousal. This gives us four ways of arousing a subject: stress, stimuli, stimulant drugs, and surprises. We can remember these as the four Ss.

Like Hull's *D*, arousal can be augmented in a variety of ways, and can activate a variety of behaviors. But it is clearly not true (as Hull supposed) that *all* response systems, behavioral or physiological, are automatically and indiscriminately augmented by any increase in arousal. Different systems have their own, specific determinants as well as these more general ones like drive or arousal. All of these need to be understood. The attempt to divide these determinants into motivational and non-motivational ones has not proved very fruitful.