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## ON THE STRUCTURE OF BEHAVIORAL SELF-REGULATION

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We are interested in the structure of human behavior, broadly conceived. This interest has taken us into several specific research domains, including test anxiety, social anxiety, and self-regulation of health-related behavior. But in some respects the specific explorations in diverse areas of work have been in the service of a more general interest in the structure of behavior.

The questions underlying this interest are very abstract: What is the most useful way to think about how people create actions from intentions and desires? Once people have decided to do something, how do they stay on course? What processes account for the existence of feelings, as people make their way through the world? At the fore of our thinking over the past two decades is the idea that behavior is a self-regulatory event. It is an attempt to make something happen in action that is already in mind. This general idea forms the basis of this chapter.

This chapter is organized in terms of a series of conceptual themes that we've found useful. Some of them have been central in our thinking for a long time; others have been taken up only more recently. We start simple, with basic ideas about the nature of behavior and the organization of some of the processes by which we believe behavior is regulated. We then turn to consideration of emotion—how we think it is created and how certain classes of affects differ from each other. This is followed by a discussion of

the fact that people sometimes are unable to do what they set out to do, and what follows from that problem. The next sections are more speculative. They deal with dynamic systems and catastrophe theory as models for understanding behavior and how these models may contribute to the ways in which people such as ourselves think about self-regulation.

### 1. BEHAVIOR IS GOAL DIRECTED AND FEEDBACK CONTROLLED

The view we take on behavior begins with the concept of goal and the process of feedback control. We see these ideas as intimately linked. Our focus on goals is very much in line with a growing reemergence of goal constructs (Austin & Vancouver, 1996; Elliott & Dweck, 1988; Miller & Read, 1987; Pervin, 1989). A variety of labels are used in this literature: for example, *current concern* (Klinger, 1975, 1977), *personal strings* (Emmons, 1986), *life task* (Cantor & Kihlstrom, 1987), and *personal project* (Little, 1983). In all these theories, there is room for individualization. That is, a life task can be achieved in many ways. People choose paths that are compatible with other aspects of their life situations (many current concerns must be managed simultaneously) and other aspects of their person-allies.

Two goal constructs that differ somewhat from those named thus far are the *possible self* (Markus & Nurius, 1986) and the *self-guide* (Higgins, 1987, 1996). These constructs are intended to bring a dynamic quality to conceptualization of the self-concept. In contrast to traditional views, but consistent with other goal frameworks, possible selves are future oriented. They concern how people think of their unrealized potential, the kind of person they might become. Self-guides similarly reflect dynamic aspects of the self-concept.

Theorists who use these various terms—and others—have their own emphases (for broader discussions, see Austin & Vancouver, 1996; Carver & Scheier, 1998), but many points are the same. All include the idea that goals energize and direct activities; these views implicitly (and sometimes explicitly) convey the sense that goals give meaning to people's lives (cf. Baumeister, 1989). In each theory there is an emphasis on the idea that understanding the person means understanding the person's goals. Indeed, in the view represented by these theories, it is often implicit that the self consists partly of the person's goals and the organization among them.

#### A. FEEDBACK LOOPS

How are goals used in behaving? Part of our answer is that goals serve as reference values for feedback loops. A feedback loop, the unit of cybernetic control, is a system of four elements in a particular organization

(cf. Miller, Galanter, & Pribram, 1960): an input function, a reference value, a comparator, and an output function (Figure 1).

An input function is a sensor. We will treat this function as equivalent to perception. The reference value is a second bit of information (i.e., in addition to the input function). We'll treat the reference values in the loops we're interested in as goals. A comparator is a device that makes comparisons between input and reference value. The comparison yields one of two outcomes: either the values being compared are discriminably different from one another or they're not. The comparison can vary in sensitivity. Sometimes very small discrepancies are detected; sometimes only quite large ones.

Following the comparison is an output function. We will treat this as equivalent to behavior, although sometimes the behavior is internal. If the comparison yields a "no difference," the output function remains whatever it was. If the comparison yields "discrepancy," the output changes.

There are two kinds of feedback loops, corresponding to two kinds of goals (Figure 2). In a negative or discrepancy-reducing loop, the output function is aimed at diminishing or eliminating any detected discrepancy between input and reference value. It yields conformity of input to reference. This conformity is seen in the attempt to approach or attain a valued goal.

In this view, behavior isn't for the sake of behavior, but occurs in the service of creating and maintaining conformity of input to standard. Behavior can create conformity, but disturbances from outside also can create conformity. Although disturbances often change conditions ad-

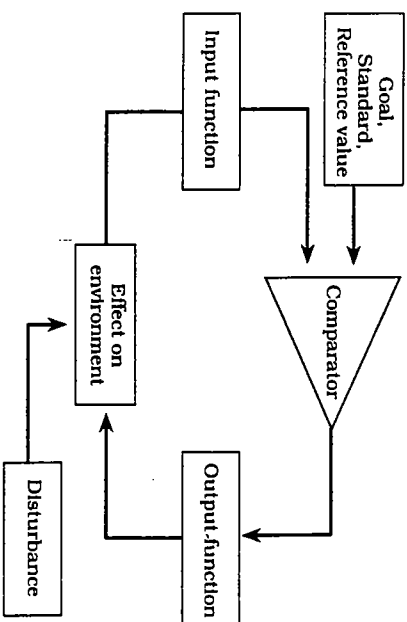
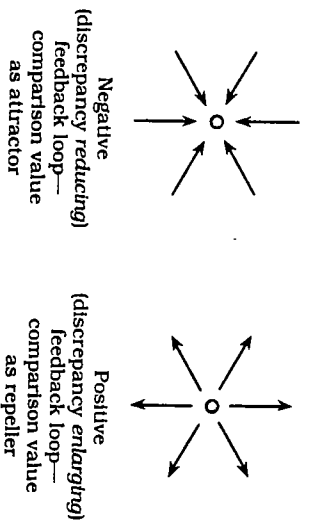


FIGURE 1 Schematic depiction of a feedback loop, the basic unit of cybernetic control. In such a loop, a sensed value is compared to a reference value or standard, and adjustments are made in an output function (if necessary) to shift the sensed value in the direction of the standard.



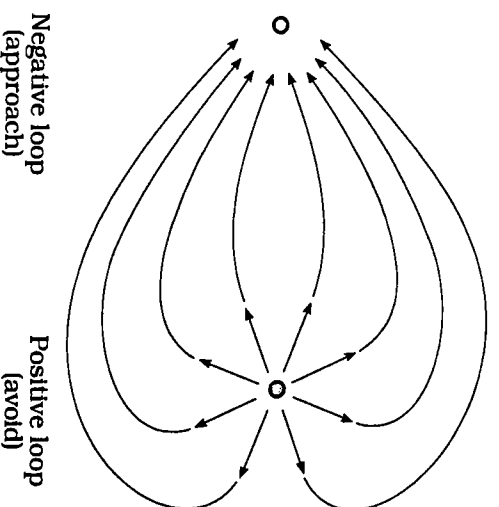
**FIGURE 2** Negative feedback loops cause sensed qualities to shift *toward* positively valenced reference points. Positive feedback loops cause sensed qualities to shift *away from* negatively valenced reference points. *Note:* From *On the self-regulation of Behavior*, by C. S. Carver and M. F. Scheier, 1998, New York: Cambridge University Press; Copyright 1998 by Cambridge University Press. Reprinted with permission.

versely (enlarging a discrepancy with the reference value), they also can change conditions favorably (diminishing a discrepancy). In the first case, recognition of a discrepancy prompts a change in output, as always. In the second case, the disturbance preempts the need for an output adjustment, because the system sees no discrepancy. Thus no output adjustment occurs.

The second kind of feedback loop is a positive or discrepancy-enlarging loop (Figure 2). The reference value here is not one to approach, but one to avoid. Think of this as an “anti-goal.” A psychological high-level example is a feared possible self. Other, more concrete examples would be traffic tickets, public ridicule, and being fired from your job. A positive loop senses present conditions, compares them to the anti-goal, and tries to enlarge the discrepancy. For example, a rebellious adolescent who wants to be different from his parents senses his own behavior, compares it to his parents’ behavior, and tries to make his own behavior as different from theirs as possible.

The action of discrepancy-enlarging processes in living systems is typically constrained in some way by discrepancy reducing loops (Figure 3). To put it differently, avoidance behaviors often lead into approach behaviors. An avoidance loop creates pressure to increase distance from the anti-goal. The movement away occurs until the tendency to move away is captured by the influence of an approach loop. This loop then serves to pull the sensed input into its orbit. The rebellious adolescent, trying to be different from his parents, soon finds other adolescents to *conform* to, all of whom are deviating from their parents.

Our use of the word orbit in the last paragraph suggests a metaphor that may be useful for anyone to whom these concepts do not feel terribly



**FIGURE 3** The effects of positive feedback systems are often bounded or constrained by negative feedback systems. A value moves away from an undesired condition in a positive loop and then comes under the influence of a negative loop, moving toward its desired condition. *Note:* From *On the Self-Regulation of Behavior*, by C. S. Carver and M. F. Scheier, 1998, New York: Cambridge University Press; Copyright 1998 by Cambridge University Press. Reprinted with permission.

intuitive. You might think of feedback processes as metaphorically equivalent to gravity and anti-gravity. The negative feedback loop exerts a kind of gravitational pull on the input it is controlling, pulling that input closer to its ground zero. The positive loop has a kind of anti-gravitational push, moving sensed values ever farther away. Don’t forget, though, that this is a metaphor. More is involved here than a force field.

It’s worth noting that the situations people confront are often more complex than the one shown in Figure 3. Often there are several potential values to move toward. For this reason, one positive value won’t always capture or constrain all the avoidance attempts. Thus, if several people are trying to deviate from a mutually disliked reference point, they may diverge from one another. For example, one adolescent trying to escape from his parents’ values may gravitate to membership in a rock band, whereas another may gravitate to the army. Presumably the choice of what direction to approach will depend, in part, on the fit between the available reference values and the person’s preexisting values and, in part, on the direction the person took initially to escape from the anti-goal.

Some years ago we argued that the comparator of a psychological feedback loop is engaged by increases in self-focused attention (Carver,

1979; Carver & Scheier, 1981, 1990). Indeed, the similarity in function between manipulations of self-focus and the elements of the feedback loop was one thing that attracted us to the feedback model in the first place. Self-focused attention leads to more comparisons with salient standards (Scheier & Carver, 1983), and it enhances behavioral conformity to salient standards. The standards have ranged from instructions to personal attitudes to subjective norms (for reviews, see Carver & Scheier, 1981, 1998). On the avoidance side, self-focus has led to more rejection of attitudinal positions held by a negative reference group (Carver & Humphries, 1981) and to stronger reactance effects (Carver & Scheier, 1981).

The literature of self-awareness is not the only one that fits the picture of feedback loops, however (Carver & Scheier, 1998). For example, social comparison processes can easily be viewed in these terms: People use upward comparisons to help them pull themselves toward desired goals; people use downward comparisons to help them force themselves farther away from (upward from) those who are worse off than they are.

## B. REEMERGENT INTEREST IN APPROACH AND AVOIDANCE

Our interest in the embodiment of these two different kinds of feedback processes in behavior is echoed in the recent reemergence of interest in two modes of regulation in several other literatures. One of these derives from a group of theories that are biological in focus. The research base of these theories ranges from animal conditioning and behavioral pharmacology (Gray, 1982, 1987b) to studies of human brain activity (Davidson, 1992a, 1992b; Tomarken, Davidson, Wheeler, & Doss, 1992). The theories incorporate the idea that two systems (sometimes more) are involved in regulation of behavior.

One system, handling approach behavior, is called the behavioral activation system (Cloninger, 1987; Fowles, 1980), behavioral approach system (Gray, 1987a, 1990), behavioral engagement system (Depue, Krauss, & Spont, 1987), or behavioral facilitation system (Depue & Iacono, 1989). The other, dealing with withdrawal or avoidance, is usually called the behavioral inhibition system (Cloninger, 1987; Gray, 1987a, 1990), although it is sometimes termed a withdrawal system (Davidson, 1992a, 1992b). The two systems are generally regarded as independent, because they're believed to be regulated by different brain mechanisms.

Another literature with a dual-motive theme derives from self-discrepancy theory (Higgins, 1987, 1996; Higgins, Bond, Klein, & Strauhan, 1986). This theory holds that people relate their perceptions of their actual selves to several self-guides, particularly ideals and oughts. Ideals are qualities the person desires to embody—aspirations, hopes, positive wishes for the self. Living up to an ideal means attaining something desired. An ideal is clearly an approach goal. We believe it is *purely* an approach goal.

Oughts, in contrast to ideals, are defined by a sense of duty, responsibility, or obligation. An ought is a self that one feels compelled to be, rather than intrinsically desires to be. The ought self is a positive value in the sense that people try to conform to it. However, living up to an ought also implies acting to *avoid a punishment*—self-disapproval or the disapproval of others. In our view, oughts are more complex structurally than ideals. Oughts intrinsically imply both an avoidance process and an approach process. Their structure thus resembles what was illustrated earlier in Figure 3. Recent work has demonstrated the avoidance aspect of the dynamics behind the ought self (Higgins & Tykocinski, 1992).

## II. HIERARCHICALITY AMONG GOALS

Another theme in the translation of goals into behavior reflects the obvious fact that some goals are broader in scope than others. How to think about the difference in breadth is not always easy to put your finger on. Sometimes it's a difference in temporal commitment. Sometimes, though, it's more than that. It's a difference in the goal's level of abstraction.

### A. PREMISE: GOALS CAN BE DIFFERENTIATED BY LEVELS OF ABSTRACTION

The notion that goals differ in their level of abstraction is easy to illustrate. You might have the goal of being an honorable person or a self-sufficient person. These goals are at a relatively high level of abstraction. You also may have the goal of avoiding a person at work who gossips or of making dinner for yourself. These are all at a lower level of abstraction. The first set concerns being a particular kind of *person*, the second set concerns completing a particular kind of *action*. You could also think of goals that are even more concrete than the latter set, such as the goal of walking quietly to your office and closing the door without being heard or the goal of cutting vegetables into a pan. These goals (which some would call plans or strategies instead of goals) are closer to specifications of individual acts than were the second set just described, which were more summary statements about the desired outcomes of intended action patterns.

How should we think about this difference in abstraction among goals? As you may have noticed, the examples used to illustrate concrete goals relate directly to the examples of abstract goals. We did this to point out that abstract goals are linked to concrete goals in a hierarchy of levels of abstraction. William Powers (1973) argued that a hierarchical organization of feedback loops underlies the self-regulation of behavior. Because

feedback loops imply goals, this argument also constituted a model of hierarchical structuring among the goals involved in creating action.

His general line of thinking ran as follows: In a hierarchical organization of feedback systems, the output of a high-level system consists of the resetting of reference values at the next lower level of abstraction. To put it differently, higher order or superordinate systems "behave" by providing goals to the systems just below them. The reference values specified are more concrete and restricted as one moves from higher to lower levels. Control at each level reflects regulation of a quality that contributes to the quality controlled at the next higher level. Each level monitors input at a level of abstraction appropriate to its own functioning, and each level adjusts output so as to minimize its discrepancies. It is not assumed that one processor handles functions at various levels of abstraction. Rather, structures at various levels handle their concerns simultaneously.

Powers focused particularly on low levels of abstraction. He said much less about the levels that are of most interest to us, except to suggest labels for several levels whose existence makes intuitive sense. Programs are activities involving conscious decisions at various points. Sequences, the next level down, run off directly once cued. The level above programs is principles, qualities that are abstracted from (or implemented by) programs. These are the kinds of qualities represented by trait labels. Powers gave the name "system concepts" to the highest level he considered. Goal representations there include the idealized overall sense of self, relationship, or group identity.

A simple way of portraying this hierarchy is in Figure 4. This diagram omits the loops of feedback processes, using lines to indicate only the links among goal values. The lines imply that moving toward a particular lower goal contributes to the attainment of some higher goal (or even several at once). Multiple lines to a given goal indicate that several lower-level action qualities can contribute to its attainment. As indicated previously, there are goals to "be" a particular way and goals to "do" certain things (and at lower levels, goals to create physical movement).

### B. ACTION IDENTIFICATION

Although the Powers hierarchy per se has not been studied empirically, another theory that strongly resembles it—Vallacher and Wegner's (1985) action identification theory—has been. This model is framed in terms of how people think about their actions, but it also conveys the sense that how people think about their actions is informative about the goals by which they are guiding their actions.

People can identify a given action in many different ways, and the act identifications can vary in level of abstraction. High-level identifications

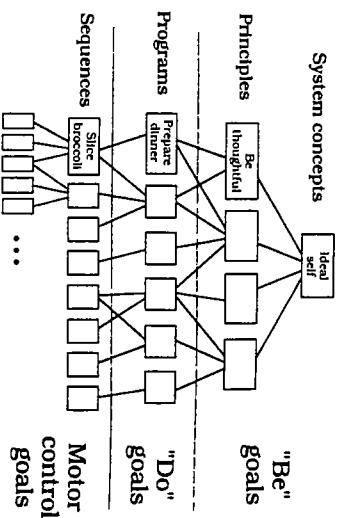


FIGURE 4 A hierarchy of goals (or of feedback loops). Lines indicate the contribution of lower level goals to specific higher-level goals. They also can be read in the opposite direction, indicating that a given higher order goal specifies more concrete goals at the next lower level. The hierarchy described in text involves goals of "being" particular ways, which are attained by "doing" particular actions. *Note:* From *On the Self-Regulation of Behavior*, by C. S. Carver and M. F. Scheier, 1998. New York: Cambridge University Press. Copyright 1998 by Cambridge University Press. Reprinted with permission.

are abstract (e.g., becoming more cultured), lower-level identifications get more and more concrete (e.g., attending a ballet, listening to sounds, and watching people move while you sit quiet and still). Low-level identifications tend to convey a sense of "how" an activity is done; high-level identifications tend to convey a sense of "why."

Although the Vallacher and Wegner (1985) model is hierarchical, it doesn't specify what qualities define various levels: It simply assumes that where there is a potential emergent property there is the potential for differing levels of identification. On the other hand, the examples used to illustrate the theory tend to map onto the levels of the Powers hierarchy: sequences of acts, programs of actions (with variations of smaller-scale and larger-scale programs), and principles of being. Thus, work on action identification tends to suggest the reasonableness of these particular levels of abstraction in thinking about behavior.

### C. MULTIPLE PATHS TO HIGH-LEVEL GOALS, MULTIPLE MEANINGS IN CONCRETE ACTION

Although the hierarchy we are discussing is in some ways very simple, it has implications for several issues in thinking about behavior (for a broader treatment, see Carver & Scheier, 1998). It is implicit here that goals at any given level can often be achieved by a variety of means at

lower levels. This flexibility is particularly apparent at upper levels of the hierarchy, where the goals are abstract. This permits one to address the fact that people sometimes shift radically the manner in which they try to reach a goal when the goal itself has not changed. This happens commonly when the emergent quality that is the higher order goal is implied in several lower order activities. For example, a person can be helpful by writing a donation check, picking up discarded for a recycling center, volunteering for a charity, or holding a door open for someone else.

Just as a given goal can be obtained via multiple pathways, so can a specific act be performed in the service of diverse goals. For example, you could buy someone a gift to make him or her feel good, to repay a kindness, to put him or her in your debt, or to satisfy a perceived holiday-season role. Thus, a given act can have strikingly different meanings, depending on the purpose it's intended to serve. This is an important subtheme of this view on behavior: Behavior can be understood only by identifying the goals to which behavior is addressed. This isn't always easy to do, either from an observer's point of view (cf. Read, Druiian, & Miller, 1989) or from the actor's point of view.

#### D. GOAL IMPORTANCE: GOALS AND THE SELF

Another point made by the notion of hierarchical organization concerns the fact that goals are not equivalent in their importance. The higher you go into the organization, the more fundamental to the overriding sense of self are the qualities encountered. Thus, goal qualities at higher levels would appear to be intrinsically more important than those at lower levels.

Goals at lower levels are not necessarily equivalent to one another in importance, however. Just as it's sometimes hard to tell what goal underlies a given behavior, it can also be hard to tell from a behavior how important is the goal that lies behind it. In a hierarchical system there are at least two ways in which importance accrues to a concrete goal. The more directly a concrete action contributes to attainment of some highly valued goal at a more abstract level, the more important is that concrete action. Second, an act that contributes to the attainment of several goals at once is more important than an act that contributes to the attainment of only one goal.

Relative importance of goals returns us to the concept of self. In contemporary theories the self-concept has several aspects: one is the structure of knowledge about your history; another is knowledge about who you are now; another is the self-guides or images of potential selves used to guide movement from the present into the future (which may also be working models). A broad implication of this sort of theory is that the self is partly the person's goals.

### III. FEEDBACK CONTROL AND CREATION OF AFFECT

We shift now to another aspect of human self-regulation: emotion. Here we add a layer of complexity to the feedback model which differs greatly from the complexity represented by hierarchicality. Again the fundamental organizing principle is feedback control, but now the control is over a different quality.

What are feelings and what makes them exist? Many have analyzed the information that feelings provide and situations in which affect arises (see, e.g., Frijda, 1986; Lazarus, 1991; Ortony, Clore, & Collins, 1988; Roseman, 1984; Scherer & Ekman, 1984). The question we address here is slightly different: What is the internal mechanism by which feelings arise?

#### A. THEORY

We have suggested that feelings arise as a consequence of a feedback process (Carver & Scheier, 1990). This process operates simultaneously with the behavior-guiding function and in parallel to it. One way to describe this second function is to say it's checking on how well the behavior loop is doing at reducing its discrepancies. Thus, the input for this second loop is a representation of the *rate of discrepancy reduction in the action system over time*. (We focus first on discrepancy-reducing loops, turning later to enlarging loops.)

We find an analogy useful here: Because action implies change between states, consider behavior analogous to distance. If the action loop deals with distance, and if the affect-relevant loop assesses the progress of the action loop, then the latter loop is dealing with the psychological equivalent of velocity, the first derivative of distance over time. To the extent this analogy is meaningful, the perceptual input to this loop should be the first derivative over time of the input used by the action loop.

We don't believe this input creates affect by itself, because a given rate of progress has different affective consequences under different circumstances. As in any feedback system, this input is compared against a reference value (cf. Frijda, 1986, 1988). In this case, the reference is an acceptable or desired rate of behavioral discrepancy reduction. As in other feedback loops, the comparison checks for a deviation from the standard. If there is one, the output function changes.

We suggest that the result of the comparison process at the heart of this loop (the error signal generated by the comparator) is manifest phenomenologically in two forms: one is a hazy and nonverbal sense of expectancy—confidence or doubt; the other is affect, feeling—a sense of positiveness or negativness.

### H. RESEARCH EVIDENCE

At least a little evidence has accumulated to support the idea that affect originates in a velocity function. Hsue and Abelson (1991), who came independently to this idea, reported two studies of velocity and satisfaction. In one, subjects read descriptions of paired hypothetical scenarios and indicated which one they would find more satisfying. For example, they chose whether they would be more satisfied if their class standing had gone from the 30th percentile to the 70th over the past 6 weeks or if it had done so over the past 3 weeks.

Some comparisons were of positive outcomes; some negative. Given positive outcomes, subjects preferred *improving* to a high outcome over a *constant* high outcome; they preferred a fast velocity over a slow one; and they preferred fast brief changes to slower larger changes. When the change was negative (e.g., salaries got worse), subjects preferred a constant low salary to a salary that started high and fell to the same low level; they preferred slow falls to fast falls; and they preferred large slow falls to small fast falls.

We conducted a study that conceptually replicates aspects of these findings, but with an event that was personally experienced rather than hypothetical (Lawrence, Carver, & Scheier, 1999). We manipulated success feedback on an ambiguous task over an extended period. The patterns of feedback converged such that block 6 was identical for all subjects at 50% correct. Subjects in a neutral condition had 50% on the first and last block, and 50% average across all blocks. Others had positive change in performance, starting poorly and gradually improving. Others had negative change, starting well and gradually worsening. All rated their mood before starting and again after block 6 (which they did not know ended the session). Those whose performances were improving reported better moods; those whose performances were deteriorating reported worse moods, compared to those with a constant performance.

Another study that appears to bear on this view of affect, although not having this purpose in mind, was reported by Brunstein (1993). It examined subjective well being among college students over the course of an academic term as a function of several perceptions, including perception of progress toward goals. Of particular interest at present, progress at each measurement point was strongly correlated with concurrent well being.

### C. CRUISE CONTROL MODEL

Ours is essentially a "cruise control" model of affect. That is, the system we've postulated functions much the same as the cruise control on a car. If you're going too slowly toward some goal in your behavior, negative affect arises. You respond by putting more effort into your action, trying to speed

up. If you're going faster than you need to, positive affect arises and you coast. A car's cruise control is very similar. You come to a hill, which slows you down. Your cruise control responds by feeding the engine more gas to bring the speed back up. If you come across the crest of a hill and roll downhill too fast, the system pulls back on the gas and drags the speed back down.

The analogy is intriguing in part because it concerns an electromechanical regulation of the very quality we believe the affect system is regulating: velocity. It is also intriguing to realize that this analogy incorporates a similar asymmetry in the consequences of deviating from the set point. That is, both in your car's cruise control system and in your behavior, going too slow requires investment of greater effort and resources. Going too fast does not. It requires only pulling back on resources. That is, your cruise control doesn't apply your brakes; it just cuts back on the gasoline. In this way it permits you to coast back to your velocity set point. In the same fashion, you don't respond to positive affect by trying to make it go away, but just by easing off.

Does positive affect lead people to withdraw effort? There is a little information on this, but not much. Melton (1995) found that people in a good mood performed worse than control subjects on syllogisms. A variety of ancillary data led him to the conclusion that the people in good moods did worse because they were expending less effort. To us, this looks like coasting.

### D. AFFECT FROM DISCREPANCY-ENLARGING LOOPS

When we began this section we said we would restrict ourselves at first to discrepancy-reducing loops. Thus far we've done that, dealing only with issues that arise in the context of approach. Now we turn to attempts to distance oneself from a point of comparison, attempts to not be or not do, discrepancy-enlarging loops.

It should be apparent from our earlier discussion that behavior toward avoidance goals is just as intelligible as behavior toward approach goals. But what about the affective accompaniments to avoidance loops? The affect theory described here rests on the idea that positive affect results when a behavioral system is making rapid progress in *doing what it is organized to do*. The systems considered thus far are organized to close discrepancies. There's no obvious reason, however, why the principle shouldn't apply just as well to systems with the opposite purpose. If the system is making rapid progress doing what it's organized to do, the result should be positive affect. If the system is doing poorly at what it's organized to do, the result should be negative affect.

That much would seem to be fully comparable across the two types of systems. We see, however, a difference in the affect qualities involved (see