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# An Evolving View of the Structure of Self-Regulation

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## 2.1 Introduction

This chapter begins by describing a viewpoint on behavior that has been identified with the term *self-regulation* for nearly four decades (Carver and Scheier 1981, 1998). The term was chosen because this viewpoint depends heavily on the principles of feedback control (Powers 1973). The broad outlines of this view remain much the same today as they were then. However, the state of knowledge in genetics and neuroscience, as well as in behavioral science itself, has changed dramatically since that time. Accordingly, this picture of self-regulatory phenomena has also evolved, and a subsequent part of the chapter describes some of that evolution. The picture remains a work in progress, a set of conceptual

guidelines rather than a finished statement, but we think it provides a useful complement to other theories.

This chapter is mostly about the occurrence of normal behavior, but it also addresses problems in behavior. The idea that normal and problem behaviors represent different locations on a multidimensional matrix of basic functions—self-regulation that is functional versus self-regulation that has gone awry for some reason—is becoming more prominent in today’s views of psychopathology. Reflecting that development, this chapter also includes some discussion of behavioral problems and how they might be interpreted within a self-regulatory framework.

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## 2.2 Behavior as Goal Directed and Feedback Controlled

We begin by briefly describing a feedback-based view of action control, starting with the goal concept. This construct is prominent in today’s psychology, under a wide variety of labels (Austin and Vancouver 1996; Elliot 2008; Johnson et al. 2006). It is broad enough to cover long-term aspirations (e.g., creating and maintaining a good impression among colleagues) as well as the endpoints of very short-term acts (e.g., reaching to pick up a water glass without knocking it over). Goals generally can be reached in diverse ways, and a given action often can be done in the service of diverse goals (Carver and Scheier 1998;

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Kruglanski et al. 2002). This results in potentially vast complexity in the organization of action.

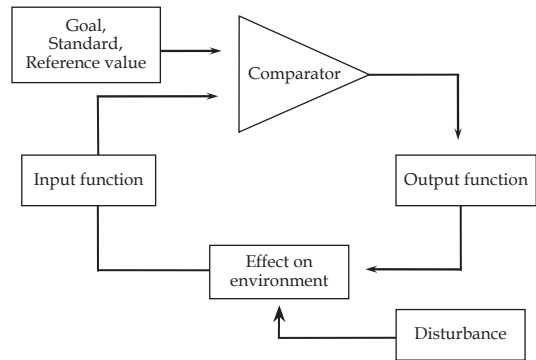
The goal concept has a strong foothold in psychology. People who treat goals as an organizing construct tend to assume that understanding who a person is means understanding that person's goals—indeed, that the substance of the self consists partly of the person's goals and the organization among them (cf. Mischel and Shoda 1995).

### 2.2.1 Feedback Loops

The main point of this section, though, is actually less about the content of goals than the process of attaining them. Long ago, two of us (Carver and Scheier 1981) adopted the view that movement toward a goal reflects the occurrence of a discrepancy reducing (thus, negative) feedback loop (MacKay 1966; Miller et al. 1960; Powers 1973; Wiener 1948). Such a loop (Fig. 2.1) entails the sensing of some present condition and comparing it to a desired or intended condition. If a discrepancy between the two is detected, it is countered by action that changes the sensed condition. The overall effect is to bring the sensed condition into conformity with the intended one (Powers 1973). If one thinks of the intended condition as a goal, the overall effect is to bring behavior into conformity to the goal—thus, goal attainment.

There also exist discrepancy-enlarging loops, which increase deviations from the comparison point rather than decrease them. The comparison point in this case is a threat, an “anti-goal.” Effects of discrepancy enlargement in living systems are typically constrained by discrepancy reducing processes. Thus, for example, people often are able to avoid something aversive by the very act of approaching something else. Such dual influence defines active avoidance: organism fleeing a threat spots a relatively safe location and approaches it.

People sometimes infer from descriptions such as this that feedback loops act only to create and maintain steady states and are therefore irrelevant to behavior. Some reference values (and goals) *are* static, but others are dynamic (e.g., taking a vacation trip across Europe, raising children



**Fig. 2.1** 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 appropriate direction

to be good citizens). In the latter cases, the goal is the process of traversing the changing trajectory of the activity, not just the arrival at the end point. Thus, the principle of feedback control can be applied easily to moving targets (Beer 1995).

Why this emphasis on feedback control? Many think of feedback as an engineering concept (yes, engineers do use it), but the concept also has roots in physiology and other fields. Homeostasis, the processes by which the body self-regulates parameters, such as temperature, blood sugar, and heart rate, is a feedback process (Canon 1932). The concept has been useful enough in many fields that it is sometimes suggested that feedback processes are some of the fundamental building blocks of all complex systems.

Some believe there is merit in recognizing functional similarities between the processes underlying various kinds of complex systems (cf. Ford 1987; von Bertalanffy 1968). It seems likely that an abstract organizational property that emerges in one may emerge in others. In the same way, it seems likely that principles underlying physical movement control (which also rely in part on principles of feedback) have something in common with principles embodied in higher mental functions (Rosenbaum et al. 2001a). For these reasons, the principle of feedback control seems useful as a conceptual heuristic.

Nonetheless, there certainly are many contexts in which the superstructure of feedback

processes is quite unnecessary. Although we believe the ideas just described are important in principle, the global functions performed by discrepancy-reducing and discrepancy-enlarging loops are captured in the simpler terms *approach* and *avoidance*. These are concepts that also have a very long history in the analysis of behavior. Incentives draw behavior toward them and threats inhibit or even reverse such actions. Most of the rest of the chapter focuses on approach and avoidance processes.

### 2.2.2 Levels of Abstraction

Goals exist at many levels of abstraction. You can have the goal of being socially responsible; you can also have the goal of saving resources—a more restricted goal that contributes to being socially responsible. One way to save resources is to recycle. Recycling decomposes into other, more-concrete goals, such as placing empty bottles into containers and moving them to a pick-up location. All of these entail goals, values to be approached, but they exist at varying levels of abstraction.

It is often said that people's goals form a hierarchy (Powers 1973; Vallacher and Wegner 1987), in which abstract goals are achieved by attaining the concrete goals that help define them. Lower-level goals are attained by relatively brief *sequences* of action (formed from even more primitive subcomponents of motor control, e.g., Rosenbaum et al. 2001b). Sequences often have a self-contained quality, in that they run off fairly autonomously once triggered.

Viewed from the other direction, sequences of automatic acts can be organized into *programs* of action (Powers 1973). Programs are more planful than sequences, and require choices at various points. Programs, in turn, are sometimes (though not always) enacted in the service of *principles*—more abstract points of reference that provide a value basis for making decisions within programs or suggest that certain programs be undertaken or refrained from. What Powers (1973) called principles are roughly equivalent to what others call *values* (Schwartz and Bilsky 1990; Schwartz and

Rubel 2005). The potential complexity does not stop even with values, however. Sets of values can coalesce to form a very abstract sense of desired (and undesired) self, or a sense of desired (and undesired) community.

All these classes of goals, from very concrete to very abstract, can in principle serve as reference points for self-regulation. When self-regulation is undertaken regarding a goal at one level, control presumably is simultaneously being invoked at all levels of abstraction below that one. Control is not necessarily being exerted at higher levels, however. Indeed, it is fully possible for a person to knowingly undertake an action that turns out to conflict with a higher-level goal. This creates problems when the person later attends to that higher goal.

### 2.2.3 Feedback Processes and Affect

The use of feedback control principles has also been extended to conceptualizing affect (Carver and Scheier 1990, 1998, 1999a, b). This extension applied the feedback concept somewhat differently. The argument was that the feeling properties that represent affect emerge from a feedback loop that runs in parallel to the behavior-guiding process, tracking how well the latter is doing its task. Thus, the input for the affect loop is some representation of the *rate of discrepancy reduction in the action system over time*.

This input is not sufficient to create affect, because a given rate of progress has different implications in different circumstances. Carver and Scheier (1998) argued that this input is compared to a reference value, as in any feedback system (cf. Frijda 1986, 1988). In this case, the reference is an acceptable or desired or intended rate of behavioral discrepancy reduction. As in other feedback loops, the comparison checks for deviation from the standard. If there is one, the output function changes.

The error signal in this loop (a representation of the discrepancy) is manifested subjectively as affect—positive or negative valence. If the sensed rate of progress is below the criterion, affect is negative. If the rate is high enough to

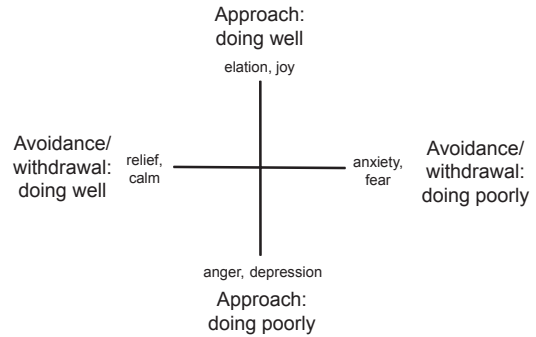
exceed the criterion, affect is positive. If the rate is not distinguishable from the criterion, affect is neutral. Thus, feelings with a positive valence mean you are doing better at something than you need to or expect to, and feelings with a negative valence mean you are doing worse than you need to or expect to (for details, see Carver and Scheier 1998, Chaps. 8 and 9; 2013).

This two-layered viewpoint implies a natural link between affect and action. The affect loop has a direct influence on what occurs in the action loop. The idea of two feedback systems functioning in concert turns out to be common in control engineering (e.g., Clark 1996), where it permits devices to respond in a way that is both quick and stable, without undesired overshoots and oscillations (Carver and Scheier 1998, pp. 144–145). These properties seem similarly desirable in human experience.

The affect portion of Carver and Scheier's (1998, 1999a, b) viewpoint has a great many implications that are beyond the scope of this chapter (see Carver and Scheier 2013, for more complete treatment). We note a few here briefly.

The idea that affects of both valences can occur would seem true of both approach and avoidance systems. That is, both approach and avoidance have the potential to induce positive feelings (by doing well), and the potential to induce negative feelings (by doing poorly). But doing well at *approaching an incentive* is not quite the same experience as doing well at moving *away from a threat*. Thus, the two positives may not be quite the same, nor the two negatives.

Given this line of thought, and drawing as well on insights from Higgins (e.g., 1987, 1996) and his collaborators, Carver and Scheier (1998) posited two sets of affects, one relating to approach, the other to avoidance. The former arise from doing well versus poorly at gaining an incentive, the latter from doing well versus poorly at avoiding a threat. Thus, approach can lead to such positive affects as eagerness, excitement, and elation, and to such negative affects as frustration, anger, and sadness (Carver 2004; Carver and Harmon-Jones 2009). Avoidance can lead to such positive affects as relief and contentment (Carver 2009) and such negative affects as fear, guilt, and anxiety (Fig. 2.2)



**Fig. 2.2** Carver and Scheier's (1998) view of two orthogonal dimensions of self-regulatory function and examples of the affects that can emerge from them

A second issue is that the changes in behavior associated with negative and positive affect have an asymmetry: Negative affect implies a need for greater effort, whereas positive affect implies less need for effort than there had been. It has been argued that this asymmetry contributes to a system of priority management: the shifting from one goal to another as focal in behavior (Carver 2003; Dreisbach and Goschke 2004; Shallice 1978; Shin and Rosenbaum 2002; Simon 1967). Specifically, negative affect acts as a demand for higher priority (Simon 1967), and positive affect indicates that priority could be temporarily downgraded.

Another aspect of priority management concerns the idea that goals sometimes are not attainable and are better abandoned. Sufficient doubt about success in goal attainment creates reduction in effort and even giving up the goal itself (Carver and Scheier 1998, 1999a, b). This sense of doubt is accompanied by sadness or dysphoria. This issue comes up again later.

## 2.3 Impulse and Constraint

As we said at the outset, the view presented in the opening section has had adjustments and elaborations over the years. We turn now to an issue that induced some of those adjustments. A theme that has become prominent in many areas of psychology in recent years is the tension between impulse and constraint. This issue is by no means new.

It has been framed over many years in terms of concepts such as delay of gratification, planfulness, socialization, and id versus ego. The concept of impulsiveness is itself quite broad (e.g., Parker et al. 1993; Smith et al. 2007; Whiteside and Lynam, 2001), and the word is used in diverse ways in different contexts. But the core of the concept is that people often confront situations in which they can immediately follow an impulse or desire or they can overrule that impulse and evaluate more fully before acting.

Both impulse and constraint have valuable characteristics in the appropriate contexts (Block and Block 1980). When it is manifested as spontaneity, impulsiveness brings a sense of vigor and freedom to the human experience (e.g., Dickman 1990; Hansen and Breivik 2001). However, impulses can also create problems. Impulses can interfere with attainment of longer-term goals (e.g., spending for today rather than saving for the future). Impulses can lead to violation of social norms (Cooper et al. 2003; Lynam 1996) and thereby to interpersonal conflict. Being able to control impulsive reactivity thus is crucial to successful self-management (Vohs and Baumeister 2011).

What tips the balance between impulse and constraint? At least two mechanisms exist. One account of variability in impulsiveness rests entirely on the basic processes of approach and avoidance. The stronger the tendency to approach cues of incentives, the greater the likelihood of impulsive approach. If there are threat cues, though, the threat system becomes active, stifling ongoing approach. One might think of this stifling of approach as being an overruling of the approach motive by the avoidance motive, and thus representing constraint.

The competition between approach and avoidance is one starting point in thinking about impulse and constraint. But there are reasons to suspect that the competition between approach and avoidance is not the entire story. For example, in today's trait models of personality, the trait that is generally seen as reflecting approach—extraversion—and the trait that is generally seen as reflecting avoidance—neuroticism—are both distinct from the trait that reflects constraint—disinhibition versus constraint in Clark and Watson's

(1999) three-factor model, or conscientiousness in the five-factor model (see also Depue and Collins 1999; Zelenski and Larsen 1999).

### 2.3.1 Dual-Process Models

A different response to constraint follows from what are often termed dual-process models of functioning. These models start with the idea that people process information in two somewhat distinct ways simultaneously. The two processing modes appear to use different aspects of the available information (Rudman et al. 2007). There is evidence that the two modes learn in different ways, and that the two patterns of learning create parallel influences on action that potentially compete with one another, thus requiring continuous arbitration (Daw et al. 2005; Otto et al. 2013).

What is often characterized as the more primitive mode of processing (sometimes called reflexive) is often (but not always) said to operate largely outside consciousness. The other mode (sometimes called reflective) is the symbolic processor of the rational mind. Some theorists stress the idea that the reflexive mode is best suited to contexts that are relatively unpredictable (e.g., Tops et al. 2010), because what it learns is actuarial patterns of associations which accumulate slowly but thoroughly (what some call model-free learning, e.g., Daw et al. 2005). In contrast, the reflective system is optimal in contexts that are relatively predictable, because what it learns is rules (what some call model-based learning), which can be realized suddenly and then be applied freely.

The idea of dual systems is by no means without controversy (e.g., Keren and Schul 2009; Evans and Stanovich 2013), and the many variations on this idea that have been posed by different theorists sometimes differ substantially from each other. For example, Braver (2012) discusses proactive and reactive control, and assumes that both modes use similar brain regions but in different patterns depending on task demands. Tops et al. (2010) also use the terms proactive and reactive, but instead tie these systems to different brain regions. For discussion of how two modes



of processing can be instantiated within a single architecture, see Dayan (2008).

By now, this idea and variations on it have been taken up as a useful conceptual tool in many areas of psychology (Barrett et al. 2004; Kahneman 2011; MacDonald 2008; Rothbart et al. 2001, 2003; Evans and Stanovich 2013). A version of this viewpoint that has been particularly useful to us is from developmental psychology (Kochanska and Knaack 2003; Nigg 2000, 2003; Rothbart et al. 2001, 2003). This version posits basic approach and avoidance temperaments that act reflexively in the presence of incentive and threat cues, respectively. In acting reflexively, they are said to exert reactive control. Later to develop is a third temperament, often termed effortful control.

The label “effortful” conveys the sense that this is an executive, planful activity, entailing the use of cognitive resources to deter the tendency to react impulsively, though it is not intended to imply that the subjective experience necessarily feels like exerting effort. Effortful control relies on development of prefrontal brain areas (e.g., Durston et al. 2002a, b; Kochanska and Knaack 2003; Nigg 2003; Rothbart and Bates 1998). It is superordinate to approach and avoidance temperaments (e.g., Ahadi and Rothbart 1994; Clark 2005) and thus can countermand them (cf. Evans and Stanovich 2013). In that way, it permits control over reactive behavior.

Although restraint of approach impulses is the most obvious manifestation of this process, there are other potential manifestations that are equally important. Effortful control can also override what might be thought of as a reflexive tendency toward avoidance if the avoidance temperament is especially active. Thus, for example, with sufficient effortful control resources, a person can remain in a tension-inducing social situation rather than flee from it. If a person’s approach temperament is weak or inactive, effortful control can override a reflexive tendency toward *inaction*. For example, it can get you to go exercise when you do not really want to. Thus, exerting effortful control can move a person toward either restraint or action, depending on what reactive response is being overcome.

This argument casts a somewhat different light on the concept of impulsiveness. In this view, what is impulsive is what is *reactive*, whether the outward display is of action or inaction. Impulsiveness as a concept has always been hard to pin down (Block 2002; Dickman 1990; Eisenberg 2002; Nigg 2000; Solanto et al. 2001; Stanford and Barratt 1992; White et al. 1994; Whiteside and Lynam 2001, 2003). It can take many forms, including jumping toward an incentive, being easily distracted by opportunities that arise while a current pursuit is ongoing, and reacting quickly to emotions. The aspect of impulsiveness that is emphasized here is that impulses are reactive: relatively reflexive responses to some stimulus in disregard of other considerations. The key, in this view, is that the action property represents a reactive, automatic association to the stimulus.

### 2.3.2 Dual-Process Models and Hierarchicality of Behavior

These kinds of ideas suggest a different way to think about the hierarchy of control that was first proposed by Powers (1973). We said earlier that programs of action entail decisions. They seem to be managed top-down, using planful, effortful processing. Planfulness is also a common characterization of behavior managed by the reflective system. It seems reasonable to map what Powers (1973) called program-level control (and even higher levels) onto the deliberative, reflective mode of functioning.

In contrast to this deliberative quality, what Powers (1973) termed sequences are well-learned action combinations that occur in a relatively automatic stream once they are triggered. Sequences (along with yet lower levels of control) are necessarily called up during the execution of programs. However, it seems reasonable to suggest that sequences can also be triggered more autonomously, without their being a subroutine of effort toward a higher goal (examples might include reaching to pick up a \$10 bill you spotted on the ground and putting it into your pocket, or frowning and turning away when you see someone you dislike). Sequences may be triggered by

the activation of strong associations in memory (the appearance of money as positive, the appearance of the other person as negative). In such cases, the operating characteristics would seem akin to those of the reactive mode of functioning.

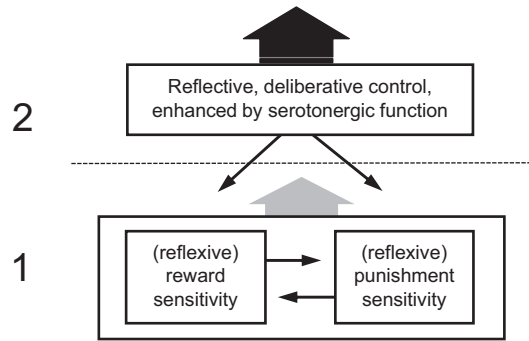
In the past, it has often been noted that the level of control that is functionally superordinate can vary by situations and persons (e.g., Carver and Scheier 1998, 1999a). As we said earlier, it is easy to imagine cases in which a person is behaving according to a principle (e.g., a moral or ethical value), and it is easy to imagine cases in which the person is behaving according to a plan (what Powers, 1973, termed a program, because of its if-then properties). It is also easy, however, to imagine cases in which the person is acting impulsively and spontaneously, without regard to either principle or plan.

In making this case in the past, Carver and Scheier's emphasis generally focused simply on how sequences and plans differ. The literature of dual-process models raises the question of whether this differentiation is perhaps more important than had been realized. Perhaps Carver and Scheier (and others) underappreciated the extent to which lower self-regulatory structures can be triggered autonomously and their outputs enter the stream of ongoing action, without oversight from higher levels, and potentially even in conflict with values at higher levels.

This is one way the emergence of dual-process models has influenced our thinking. Another influence, which itself has a wide variety of implications, consists of an investigation of some of the biological underpinnings of the dual-process model.

### 2.3.3 Serotonergic Function and Dual-Process Models

A number of researchers have tried to understand roles played by different neurotransmitter systems in the management of behavior. One system that has been the subject of much investigation is the serotonergic system. In this section, we consider a potential role for serotonergic function in impulse and constraint.



**Fig. 2.3** Simplified description of dual-process model of behavior. The reflexive process (layer 1) entails competition between reflexive approach and avoidance tendencies, yielding a resultant behavior tendency (*grey arrow*). The reflective process (layer 2) may countermand that resultant, exerting its own influence on behavior (*black arrow*). We suggest that one effect of greater serotonergic function is to enhance the influence of the reflective system. (Adapted from Carver et al. 2008)

Human research on serotonergic function uses several methods, including acute tryptophan depletion and relating behavior to genetic polymorphisms that have independently been linked to serotonergic function (Manuck et al. 2006). A full review of the literature using these (and other) techniques to study serotonergic function in humans is well beyond the scope of this chapter. We will point to only a few select examples (for a broader, though dated, review, see Carver et al. 2008). This evidence appears to suggest that the serotonergic system functions (partly) to decrease reactivity and to increase constraint (Figure 2.3).

Some of the evidence comes from laboratory studies, in which tryptophan depletion, which temporarily reduces serotonin, appears to impair constraint over automatic emotional responses. As an example, consider a task in which specific cues are rewarded, and for which the response thus becomes habitual. Then the rules change such that this response is no longer rewarded. Tryptophan depletion impairs the ability to inhibit those responses after the rule changes (Cools et al. 2005; Park et al. 1994; Rogers et al. 2003).

Many studies have examined effects of tryptophan depletion on aggression. A study by

Cleare and Bond (1995) made a very important conceptual point in that regard. Participants were pre-assessed as being either high or low in aggression. Those high in aggressive tendencies became more aggressive after tryptophan depletion, but there was no effect for those low in aggressive tendencies. Similar results were reported by Finn et al. (1998). This suggests that effects of low serotonergic function on aggression are less about aggression per se and more about the release of existing habitual tendencies to be aggressive (see also Manuck et al. 2006; Spont 1992). A later study (Bjork et al. 2000) further reinforced this point: In this case, tryptophan depletion led to greater aggressive response to provocation among men high in aggressiveness but had an opposite effect among those low in aggressiveness.

A good deal of research has also examined serotonin in adults with clinical conditions reflecting impulsive aggression (see Manuck et al. 2006). Lower serotonergic function has long been linked to history of fighting and assault (Coccaro et al. 1997), domestic violence (George et al. 2001), and impulsive aggression more generally (Coccaro et al. 1998; Cleare and Bond 1997).

The pattern of these findings (and others) appears consistent with the view that serotonergic pathways are involved in impulse control (Depue 1995; Depue and Collins 1999; Depue and Spont 1986; Manuck et al. 2003; Soubrié 1986; Spont 1992; Zuckerman 2005), particularly impulses that reflect strong emotions.

This pattern was characterized by Carver et al. (2008) in terms of the dual-process viewpoint described previously. Recall that the basic, reactive mode of functioning is said to be impulsive and highly responsive to strong emotions. The reflective mode is said to be planful and less reactive to immediate emotional cues. Joining these descriptions with the findings just described, it seems plausible that serotonergic function may shift the balance of influence between these two modes of functioning. That is, lower serotonergic function may increase the influence of the reactive system or decrease the influence of the reflective system.

### 2.3.4 Depression and Serotonergic Function

Now consider depression (see also Brinkmann and Franzen this volume). Depression is very different from the phenomena we have just been discussing, but depression is also linked to low serotonergic function. The facet scale called depression from trait neuroticism has been linked repeatedly to the serotonin transporter gene, the short allele being associated with higher scores. There is also evidence linking serotonergic function to clinically meaningful depression (for review, see Carver et al. 2008). Outcomes of meta-analyses of this literature have varied as a function of selection criteria. However, Uher and McGuffin (2010) found that the serotonin transporter polymorphism interacted with early maltreatment to predict vulnerability to depression in each of the 11 studies that used objective or interview measures of maltreatment (see also Caspi et al. 2010).

An earlier section linked low serotonergic function to impulsive reactions to emotional cues. The idea that high reactivity to emotions underlies impulsive violence, sensation seeking, and other externalizing problems is both intuitive and supported by a great deal of data (Cyders et al. 2009; Dick et al. 2010; Whiteside and Lynam 2003). Now, we are saying that low serotonergic function also implies vulnerability to depression, which is associated with lethargy and an absence of behavioral engagement (Sobin and Sackeim 1997). What could account for this very substantial difference in presentation?

To address this question we return to dual-process models, and to our working definition of impulsiveness. Dual-process models suggest that the reactive mode acts reflexively and is highly responsive to emotions. But these are “operating characteristics” of that mode of function. How the operating characteristics are manifested overtly depends on what emotions the person is experiencing and what reactive action impulse thereby is being triggered.

In most cases, emotions call for outward action of some sort. Eagerness promotes approach. Fear promotes avoidance. But intense sadness—the affective core of depression—calls for passiv-



ity (Frijda 1986). It is a *deactivating* emotion, a signal of failure. An over-responsiveness to emotion, applied to sadness, would promote behaviors that sadness ordinarily triggers. The behavior triggered by intense sadness is *in* action. Thus, depressed behavior often reflects passivity and apparent difficulty in initiating action.

Consistent with this, there is evidence that people in a sad mood evaluate tasks as requiring more effort than they are rated in the absence of the sad mood (Gendolla 2012). If success still seems possible despite the greater demand, people in sad moods actually mobilize more effort (reflected in stronger blood pressure responses) than those without a sad mood. But if demand is seen as being great enough to threaten success, sad people exert less effort than happy people, displaying a pattern much like fatigue (Brinkmann and Gendolla 2008; Gendolla 2012; see also Brinkmann and Franzen this volume).

Paradoxically, then, a single functional property—behavioral reactivity to emotion—can not only help release bursts of violence or acting out but may also help create essentially the opposite profile of behavior, in response to a different emotion.

This leaves two issues dangling. First, if people who are sensation seekers and people who are vulnerable to depression both have low serotonergic function, they must differ from each other in some other fundamental way. Second, the case that depression should be viewed as similar in this way to overtly impulsive behavior is thus far circumstantial. It depends entirely on findings concerning correlates of the serotonergic system. Is there any further evidence that this argument is tenable? We consider these questions in turn.

### 2.3.5 What Differentiates Impulsive Aggression and Sensation Seeking from Depression?

First, what other variable might underlie the great divergence between sensation seeking and depression? The most obvious candidate is the sensitivity of the approach system. When poor reflective oversight is combined with a very

reactive approach system, the result is overt approach-related impulsiveness. When poor reflective oversight is combined with an unreactive approach system, the result is impulsive inaction: lack of effort toward potential rewards. In both cases, the effects of variation in level of basic incentive sensitivity (high and low, respectively) are amplified by the absence of effortful override.

Enhanced versus blunted approach motivation may be rooted in differences in dopaminergic function in certain brain areas. Dopaminergic pathways are believed to be critical in the engagement of goal-directed effort (Farrar et al. 2007; Salamone et al. 2007, 2005, 2006). A weakly functioning dopaminergic system yields less “wanting” for appetitive outcomes (Berridge 2007) and less engagement of effort in pursuit of them (Salamone et al. 2005, 2006, 2007). A range of evidence implicates deficits in dopaminergic function in depression (Dunlop and Nemeroff 2007).

### 2.3.6 Does Depression Relate to Impulsive Reactivity?

The second question is whether there is any direct evidence linking depression to over-reactivity to emotions or any other aspect of impulsiveness. There is. Three studies (Ekinci et al. 2011; Henna et al. 2013; Peluso et al. 2007) have associated a diagnosis of major depressive disorder (MDD) with self-reports of motor impulsivity on the Barratt Impulsiveness Scale (BIS; Barratt 1965); two of them (Ekinci et al. 2011; Henna et al. 2013) found a similar effect for attentional impulsivity.

The item content of the BIS makes it difficult to attribute impulsiveness to emotional versus nonemotional sources. But another recent study explored more explicitly the possibility that depression would be associated with reactivity to emotions (Carver et al. 2013). It employed a variety of questionnaires bearing on impulsiveness, and a subsample also completed a diagnostic interview for lifetime episode of MDD.

Of the scales administered, some were chosen to pertain to reflexive reactivity to emotions. Recall that the dual-process view does not distinguish emotional valences. People who are vulnerable

to depression should have a general reactivity to emotion of diverse sorts, not just negative emotions. To ensure a test of this reasoning, the study included one scale that addressed impulsive behavioral reactions to emotions “in general,” and another that assessed impulsive reactions to *positive* emotions in particular (the Positive Urgency Measure, PUM; Cyders et al. 2007).

The impulse-related questionnaires had previously been distilled to three underlying factors. Factor 1 (pervasive influence of feelings) reflects a broad tendency for emotions to reflexively shape the person’s orientation to the world. Factor 2 (lack of follow-through) centers on the tendency to complete tasks versus being distracted and letting things go, with no obvious involvement of reacting to emotion. Factor 3 (feelings trigger action) centers on impulsive overt behavioral reactivity to emotions, including positive emotions. Persons diagnosed with MDD had higher scores on factors 1 and 3 than did persons with negative diagnoses, but there was no difference between groups on factor 2 (Carver et al. 2013). Importantly, these differences between groups were robust to several kinds of controls for current depressive symptoms and externalizing symptoms. Conceptually consistent with this finding is evidence that brain regions involved in emotions are over-responsive to positive social evaluations in depressed compared to nondepressed persons (Davey et al. 2011).

Longitudinal evidence also supports the importance of emotion-relevant impulsivity to depression. Smith et al. (2013) followed a group of fifth graders for a year, assessing diverse markers of psychopathology over time. They found that a measure of urgency (reflecting impulsive reactions to both negative and positive emotions) predicted increase in relative depression over that year, after controlling for a wide range of externalizing symptoms.

### 2.3.7 Transdiagnostic Vulnerability

The possibility that the broad spectrum of psychopathologies may be characterized by a more limited number of features that are actually trans-

diagnostic has been raised in a number of places in recent years (e.g., Harvey et al. 2004; Johnson-Laird et al. 2006). It seems worth asking whether an impulsive over-reactivity to emotions may be one such transdiagnostic feature (see also an argument made by Johnson-Laird et al. 2006, about the role of emotional over-responsiveness in psychopathology).

Some additional information is available on this question. The three factors described above have also been studied in other psychopathology-related contexts, albeit with nonclinical levels of symptoms. One of these studies (Johnson et al. 2013b) found that manic temperament, measured by the Hypomanic Personality Scale, correlated significantly with factor 3 after controlling for comorbid syndromes, but not to the other factors. Similar associations have been found between the PUM (a key contributor to factor 3) and both mania vulnerability (Giovannelli et al. 2013) and bipolar I diagnostic status (Muhtadie et al. 2014). Thus, reports of an over-responsiveness to positive emotions and emotions in general relates to mania vulnerability as well as to depression vulnerability.

Yet another set of analyses found associations between both emotion-reactivity factors and a wider range of problem behavioral tendencies, including anxiety, depression, suicidality, alcohol problems, aggressive tendencies, and borderline personality traits (Johnson et al. 2013a). As a group, these findings are consistent with the notion that an impulsive over-reactivity to emotions represents a feature common to a great many psychopathologies.

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## 2.4 Summary and Conclusion

This chapter sketched the outlines of a view of the structure of self-regulation, based on the organizing principle of feedback control processes, as applied to goal striving and affective experience. We then considered this viewpoint in light of some more recent developments in psychology and related disciplines. In particular, the emerging salience of dual-process models of self-regulation provides an interesting tool to use

in reexamining the difference between actions that are planful and deliberative and actions that are more spontaneous and seem to be triggered by cues of the moment, often cues that take the form of emotional reactions to stimuli. Earlier views recognized that such spontaneous executions of sequences of acts could take place if a higher level of control was not presently operative, but said little more than that about it. The dual-process view provides a more elaborated picture, at least providing some hints about why the autonomous triggering of spontaneous actions might occur.

In later sections of the chapter, we expanded on this idea to discuss one viewpoint on some of the biological underpinnings of the reflective–reflexive distinction. We suggested there that one role played by the serotonergic system (one role among many, we hasten to add) is to influence the balance between reflective and reflexive. This is an idea that is not without its controversies, but it is an idea we think worth exploring further.

The chapter then turned to an implication of this view of the serotonergic system which follows from the fact that low serotonergic function has been tied to depression vulnerability as well as vulnerability to externalizing problems. The position was put forward there that both of these classes of problems, and perhaps others as well, may be grounded partly in tendencies to overreact to situational emotional states, displaying the actions that follow from those emotions. Evidence that this tendency was related to diverse problematic tendencies was briefly reviewed. Although this is far from establishing the case, we think this idea, as well, is worth exploring further.

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