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edited by **James J. Gross**

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Executive Function

MECHANISMS UNDERLYING EMOTION REGULATION

PHILIP DAVID ZELAZO
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Research on executive function (EF) is directed at understanding the conscious control of thought and action. Although EF can be understood as a domain-general construct at the most abstract functional level of analysis (i.e., as conscious goal-directed problem solving), more precise characterizations distinguish between the relatively "hot" motivationally significant aspects of EF and the more disinterested "cool" aspects (Zelazo & Müller, 2002). In this chapter, we propose a model of emotion regulation based on principles of EF (both "hot" and "cool") that spans Marr's (1982) three levels of analysis—computational (concerning what EF accomplishes), algorithmic (dealing in more detail with the way information is represented and how it is processed), and implementational (examining how the information processing is realized in the brain). This model highlights the roles of reflection (levels of consciousness) and rule use in the regulation of emotion and makes initial steps toward explaining how these processes contribute to the subjective experience of complex emotions. Presentation of this model is intended to serve as a concise summary of research on EF and as an exploration of its implications for emotion regulation.

DEFINING EMOTION AND EMOTION REGULATION

In agreement with a growing number of researchers (e.g., Barrett, Ochsner, & Gross, in press; Damasio, 1994), we suggest that a stark distinction between cognition and emotion reflects an outmoded adherence to a fundamentally moralistic world view (reason is angelic, passion beastly). Instead, we suggest that emotion corresponds to an aspect

of cognition—its motivational aspect. On this view, it is possible to have cognition that is more or less emotional, more or less motivated. Thus, we use the term "emotion" to refer to an aspect of human information processing that manifests itself in multiple dimensions: subjective experience, observable behavior, and physiological activity, among them. *Emotion regulation* refers to the modulation of motivated cognition and its many manifestations. Emotion regulation can occur in a variety of ways (Gross & Thompson, this volume), but one of the most obvious varieties is the deliberate self-regulation of emotion via conscious cognitive processing, and it is this variety of emotion regulation that we address in terms of EF. It is important to note that although we focus on the aspects of emotion regulation that are directly associated with processes of EF, we are not suggesting that this is the only route to emotion regulation (cf. Fitzsimons & Bargh, 2004). As with any complex psychological phenomenon, emotion regulation may well occur in a variety of ways (some of which may be quite automatic).

EXECUTIVE FUNCTION

EF is generally recognized as an important but ill-understood umbrella term for a iverse set of "higher cognitive processes," including (but not limited to) planning, working memory, set shifting, error detection and correction, and the inhibitory control of prepotent responses (e.g., Roberts, Robbins, & Weiskrantz, 1998; Stuss & Benson, 1986; Tranel, Anderson, & Benton, 1994). These processes are recruited for the deliberate self-regulation of emotion, and in this chapter, we will attempt to explain how. First, however, we need to provide a characterization of EF. In what follows, we describe EF at each of Marr's (1982) three levels of analysis—computational (concerning what EF accomplishes), algorithmic (dealing in more detail with the way information is represented and how it is processed), and implementational (examining how the information processing is realized in the brain)—and then show in more detail how EF plays a role in emotion regulation. A new model is outlined that relies on a distinction between hot and cool EF (see below), both of which are hypothesized to be involved in emotion regulation. This model highlights what we take to be the most important aspects of EF to be considered when seeking to understand emotion regulation.

Computational Level

One way to capture the diversity of the processes associated with EF without simply listing them and without hypostasizing homuncular abilities (e.g., a Central Executive [Baddeley, 1996], or a Supervisory Attentional System [Norman & Shallice, 1986]) is to treat EF as a complex hierarchical function (Zelazo, Carter, Reznick, & Frye, 1997). In this view, which has its origins in the work of Luria (e.g., 1966) and Goldberg (e.g., Goldberg & Bilder, 1987), the function of EF is seen to be deliberate, goal-directed problem solving and functionally distinct phases of problem solving can then be flexibly and dynamically organized around this function. Figure 7.1 illustrates how different aspects of EF contribute to the eventual outcome, as well as how EF unfolds as an iterative, essentially cybernetic (Weiner, 1948), process. Although this functional characterization does not, by itself, provide an adequate explanation of EF, it provides a framework within which one can understand the hierarchical structure of EF and consider the way in which more basic cognitive processes (e.g., working memory) contribute to particular aspects of EF (e.g., the role of working memory in intending).

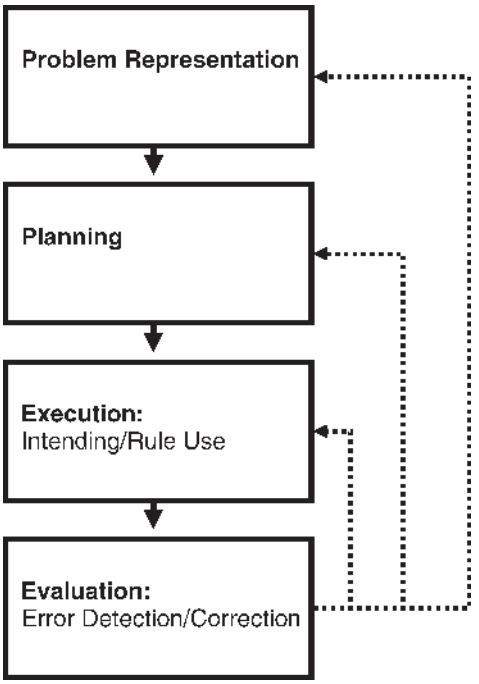

FIGURE 7.1. A problem-solving framework for understanding temporally and functionally distinct phases of executive function, considered as a functional construct. Dashed lines indicate optional recursive feedback loops. Adapted from Zelazo, Carter, Reznick, and Frye (1997). Copyright 1997 by the American Psychological Association. Adapted by permission.

To appreciate the utility of this abstract, functional characterization, consider how it applies to the Wisconsin Card Sorting Test (WCST; Grant & Berg, 1948), which is widely regarded as "the prototypical EF task in neuropsychology" (Pennington & Ozonoff, 1996, p. 55). In the WCST, participants are presented with four target cards that differ on three dimensions (number, color, and shape) and asked to sort a series of test cards that match different target cards on different dimensions. Participants must discover the sorting rule by trial and error, and after a certain number of consecutive correct responses, the sorting rule is changed. The WCST taps numerous aspects of EF, and, as a result, the origin of errors on this task is difficult to determine (but see Barceló & Knight, 2002; Delis, Squire, Bihrle, & Massman, 1992, for efforts to distinguish between different types of error). To perform correctly, one must first construct a representation of the problem space, which includes (1) one's current state, (2) one's goal state, and (3) options for reducing the discrepancy between (1) and (2). In the WCST, a key part of the problem consists in identifying the relevant dimensions. After representing the problem, one must choose a promising plan—for example, sorting according to shape. After selecting a plan, one must (1) keep the plan in mind long enough for it to guide one's thought or action, and (2) actually carry out the prescribed behavior. Keeping a plan in mind to control behavior is referred to as *intending*; translating a plan into action is *rule use*. Finally, after acting, one must evaluate the consequences of this action to determine whether one's goal state has been attained. This phase includes both error detection and, if necessary, error correction. Error correc-

tion entails revisiting earlier phases in the sequences, thereby initiating another iteration of the sequence—either in whole or in part. Failures of EF can occur at each problem-solving phase, so there are several possible explanations of poor performance on the WCST. For example, perseveration could occur after a rule change in the WCST either because a new plan was not formed or because the plan was formed but not carried out.

Notice that in this example, as in many situations, one needs to consider multiple goals simultaneously, at various levels of abstraction (Carver & Sheier, 1982). For example, one needs to pursue the relatively proximal subgoal of executing one's plan—sorting by shape—in the service of fulfilling the more distal, but still explicit, goal of performing well on the WCST. Thus, EF needs to be understood as a complex, hierarchical function at this level of analysis.

This computational characterization of EF also applies to situations involving emotion regulation. Consider, for example, a child who is hit accidentally by another child on a playground. Does the first child hit back, or does he diffuse the situation as he has been told to do by his teacher? The answer may depend on whether emotion regulation is successful, and emotion regulation may fail at any of the problem-solving phases.

1. The child may fail to represent the problem adequately. For example, he may be biased to represent such situations as threatening, and he may have difficulty flexibly reinterpreting the situation.
2. Alternatively or additionally, he may fail to plan or think ahead properly. For example, he may fail to anticipate the negative consequences of responding aggressively.
3. He may understand the rules that govern the situation (e.g., "I should not hit others" or "I should do as I am asked by my teacher") but fail to use these rules, just as people fail to use rules that they know on tests of rule use (e.g., Zelazo, Frye, & Rapus, 1996; Zelazo, Müller, Frye, & Marcovitch, 2003).
4. Finally, he may have difficulty learning from past experience.

Algorithmic Level

Research on EF has generated numerous proposals regarding the cognitive processes that help fulfill the higher-order function of EF. These processes include metacognition, selective attention, working memory, inhibitory control, and rule use, as well as combinations of these processes (e.g., see chapters in Roberts et al., 1998; Stuss & Knight, 2002). One approach that serves to integrate these processes has been motivated by research on the development of EF in childhood and across the lifespan. According to the Levels of Consciousness Model (e.g., Zelazo, 2004), EF (as defined here) is accomplished, in large part, by the ability to formulate, maintain in working memory, and then act on the basis of rule systems at different levels of complexity—from a single rule relating a stimulus to a response to a pair of rules to a hierarchical system of rules that allows one to select among incompatible pairs of rules. In this account, rules are formulated in an ad hoc fashion in potentially silent self-directed speech. These rules link antecedent conditions to consequences, as when we tell ourselves, "If I see a mailbox, then I need to mail this letter." When people reflect on the rules they represent, they are able to consider them in contradistinction to other rules and embed them under higher-order rules in the same way that we might say, "If it's before 5 P.M., then if I see a mailbox with a late pickup, then I need to mail this letter, otherwise, I'll

have find a mailbox with an early morning pickup." In this example, a simple conditional statement regarding the mailbox is made dependent on the satisfaction of yet another condition (namely, the time). More complex rule systems permit the more flexible selection of certain rules for acting when multiple conflicting rules are possible. This, in turn, changes the content of one's action-oriented representations (held in working memory), resulting in the amplification and diminution of attention to potential influences on thought (inferences) and action.

Increases in rule complexity are made possible by corresponding increases in the extent that one reflects on one's representations. Rather than taking rules for granted and simply assessing whether their antecedent conditions are satisfied, reflection involves making the rules themselves an object of consideration and considering them in contradistinction to other rules at that same level of complexity. Reflection, on this account, is taken to involve the recursive reprocessing of information. Each degree of recursion results in a new "level of consciousness," and each level of consciousness allows for the integration of more information into an experience before it is replaced by new intero- or exteroceptor stimulation. Moreover, each level of consciousness allows for the formulation and use of more complex rule systems. So, we might contrast relatively automatic action at a lower level of consciousness with relatively deliberate action at a higher level of consciousness. The former type of action is performed in response to the most salient, low-resolution aspects of a situation, and it is based on the formulation of a relatively simple rule system—likely a rule describing a stereotypical response to the situation. The more deliberate action occurs in response to a more carefully considered construal of the same situation, and it is based on the formulation of a more complex and more flexible system of rules or inferences. In general, reflection is engaged as needed in the service of problem-solving goals and in the flexible, iterative way described earlier in our treatment of EF at the computational level of analysis. Details of this model (showing, for example, the cognitive implications of each level of consciousness) are presented elsewhere (e.g., Zelazo, 2004; Zelazo, Gao, & Todd, in press).

The tree diagram in Figure 7.2 illustrates the way in which hierarchies of rules can be formed through reflection—the way in which one rule can first become an object of explicit consideration at a higher level of consciousness and then be embedded under another higher-order rule and controlled by it. Rule A, which indicates that response 1 (r_1) should follow stimulus 1 (s_1), is incompatible with rule C, which connects s_1 to r_2. Rule A is embedded under, and controlled by, a higher-order rule (rule E) that can be used to select rule A or rule B, and this, in turn, is embedded under a still higher-order rule (rule F) that can be used to select the discrimination between rules A and B as opposed to the discrimination between rules C and D. This higher-order rule makes reference to setting conditions or contexts (c_1 and c_2) that condition the selection of lower-order rules, and that would be taken for granted in the absence of reflection. Higher-order rules of this type (F) are required in order to use *bivalent* rules in which the same stimulus is linked to different responses (e.g., rules A and C). Simpler rules like E suffice to select between *univalent* stimulus–response associations—rules in which each stimulus is associated with a different response.

Consider, for example, the goal of getting a letter into the mail as soon as possible. Rule A may specify that you should deposit your envelope in the first mailbox you see that has a late (e.g., 5 P.M.) pickup time. Rule B may indicate that you should refrain from depositing your envelope in mailboxes that only have early morning pickups. Reflecting on rules A and B allows you to use rule E to discriminate between mailboxes

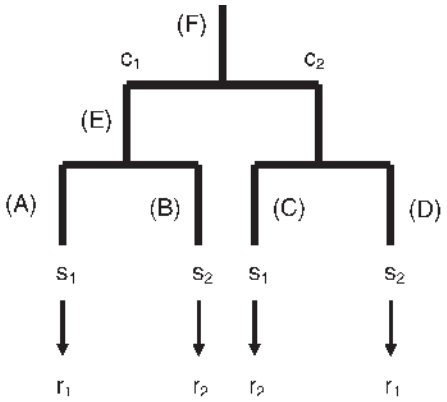

FIGURE 7.2. Hierarchical tree structure depicting formal relations among rules. c_1 and c_2 = contexts; s_1 and s_2 = stimuli; r_1 and r_2 = responses. Copyright 1995 by Elsevier. Adapted by permission.

that will help or hinder you in pursuit of your goal; A signifies approach, B avoidance. If, however, it is after 5 P.M., then you need to deposit your envelope in a mailbox with an early morning pickup and avoid mailboxes that only have late pickups. The time, therefore, is a context that needs to be considered. Reflection on this fact calls for formulation of another rule, rule F, for selecting between one context, *before 5 P.M.*, and another, *after 5 P.M.*. If it is after 5 P.M., you will want to avoid depositing your envelope in mailboxes with a 5 P.M. pickup (observing rule C instead of rule A) and proceed with another new rule, rule D: Deposit the envelope in a mailbox with an early-morning pickup.

Notice that in order to formulate a higher-order rule such as F and deliberate between rules C and D, on the one hand, and rules A and B, on the other, one has to be aware of the fact that one knows both pairs of lower order rules. Figuratively speaking, one has to view the two rule pairs from the perspective of (F). This shows how increases in reflection on lower-order rules are required for increases in embedding to occur. Each level of consciousness allows for the formulation and maintenance in working memory of a more complex rule system. A particular level of consciousness is required to use a single rule such as (A); a higher level of consciousness is required to select between two univalent rules using a rule such as (E); a still higher level is required to switch between two bivalent rules using a rule such as (F).

Implementational Level

The Levels of Consciousness Model (e.g., Zelazo, 2004) is a process model that describes the steps leading from the representation of a stimulus to the execution of a controlled response. In this model, reflection and rule use, which requires the maintenance of information in working memory, are the primary psychological processes involved in fulfilling the relatively abstract function of deliberate goal-directed problem solving (i.e., EF). The implementional level concerns how these psychological processes are realized in the brain. Considerable research remains to be conducted at this level of analysis, but there is now strong evidence that EF depends importantly on the integrity of neural systems involving the prefrontal cortex (PFC) (e.g., Luria, 1966; Miller, 1999; Stuss & Benson, 1986), although it is also clear that other brain regions are involved,

and that different regions of PFC are especially important for particular aspects of EF (e.g., Bunge, 2004). A great deal of current research in cognitive neuroscience is directed at identifying specific structure–function relations in regions of the PFC (e.g., Stuss & Knight, 2002).

Bunge and Zelazo (2006) summarized a growing body of evidence that the PFC plays a key role in rule use, and that different regions of the PFC are involved in representing rules at different levels of complexity—from a single rule for responding when stimulus–reward associations need to be reversed (orbitofrontal cortex [OFC]; Brodmann's area [BA] 11[1]), to sets of conditional rules (ventrolateral prefrontal cortex [vLPFC; BA 44, 45, 47] and dorsolateral prefrontal cortex [dLPFC; BA 9, 46]), to explicit consideration of task sets (frontopolar cortex or rostrolateral prefrontal cortex [rLPFC; BA 10]; see Figure 7.4). The role of OFC in rule use can be seen in object reversal, when one learns a simple discrimination between two objects and then the discrimination is reversed (the previously unrewarded object is rewarded and vice versa). To respond flexibly and rapidly on this task, it helps to represent the new stimulus–reward association explicitly, as a simple stimulus–reward rule maintained in working memory (Schoenbaum & Setlow, 2001); damage to OFC leads to perseverative responding in both human adults (Rolls, Hornak, Wade, & McGrath, 1994) and nonhuman primates (Dias, Robbins, & Roberts, 1996). In the absence of a simple stimulus–reward association maintained in working memory, one is likely to respond to the most salient association that one has to the situation—one is likely to respond to the previously rewarded stimulus.

In contrast to the OFC, both the vLPFC and dLPFC have been consistently implicated in the retrieval, maintenance, and use of more complex sets of conditional stimulus–response rules—in lesion studies and functional magnetic resonance imaging (fMRI) studies (e.g., Wallis & Miller, 2003; see Bunge, 2004, for review). For example, using fMRI, Crone, Wendelken, Donohue, and Bunge (2006) found that both vLPFC and dLPFC are active during the maintenance of sets of conditional rules, and that they are sensitive to rule complexity, showing more activation for bivalent rules than for univalent rules. Bunge, Kahn, Wallis, Miller, and Wagner (2003) observed that these two regions are also more active for more abstract conditional rules ("match" or "nonmatch" rules, whereby different actions are required depending on whether two objects match or not) than for specific stimulus–response associations. However, fMRI data suggest that dLPFC may be especially important when participants must switch from one bivalent rule to another, and hence suppress the previously relevant rule (Crone et al., 2006). That is, whereas vLPFC may be necessary for representing pairs of conditional rules, dLPFC may be recruited when representing bivalent rules that place heavy demands on attentional selection (Miller, 1999) or response selection (Rowe, Toni, Josephs, Frackowiak, & Passingham, 2000). These rules may be quite general in their application, extending, for example, to the selection among competing cues in semantic memory (Thompson-Shill, D'Esposito, Aguirre, & Farah, 1997). In effect, vLPFC together with dLPFC may serve to foreground some pieces of information while backgrounding others, all in the service of a goal.

Finally, fMRI studies suggest that rLPFC plays an important role in the temporary consideration of higher-order rules (such as E and F in Figure 7.3) for selecting among task sets, as when switching between two abstract rules (Bunge et al., 2005; Crone et al., 2006), integrating information in the context of relational reasoning (Christoff et al., 2001), or coordinating hierarchically embedded goals (Koechlin, Basso, Pietrini, Panzer, & Grafman, 1999). This region may be involved in reflecting on lower-order rules

and selecting among them at any level within a rule hierarchy—selecting between two univalent rules or switching between two pairs of bivalent rules. As a result, rLPFC may interact with different parts of prefrontal cortex (i.e., vLPFC or dLPFC) depending on the type of task involved (Sakai & Passingham, 2003, 2006)—and hence, we would argue, depending on the complexity of the rule systems involved.

Figure 7.3 illustrates the way in which regions of the PFC may correspond to rule use at different levels of complexity. As should be clear, the function of PFC is proposed to be hierarchical in a way that corresponds to the hierarchical complexity of the rule use underlying EF. As individuals engage in reflective processing, ascend through levels of consciousness, and formulate more complex rule systems, they recruit an increasingly complex hierarchical network of PFC regions.

One important implication of this conceptualization of EF is that it emerges from a dynamic interaction between bottom-up and top-down processes. As a result, EF takes time to occur. Information must first be processed at lower levels of consciousness and in particular parts of the PFC before it can be passed forward and processed at higher levels of consciousness and in other parts of PFC. In addition, information about a stimulus is reprocessed iteratively using the same network that was used for the original processing, with higher levels of consciousness guiding the reprocessing of information at lower levels of consciousness. Specifically, top-down PFC processes foreground specific aspects of information (hence backgrounding others), and these reweighted representations are used to "reseed" initial EF processing by influencing ongoing processing of the stimulus.

Because reflective processing takes time, the model makes predictions about the time course of EF as well as the potential consequences of requiring rapid responses (cf. White, 1965). EF can only be as effective as the amount of time allowed to complete the process. Many times, one must reach a judgment or initiate a behavioral sequence before EF processes have reached an optimal solution. In these situations, one can have partial EF—despite a person's goals.

HOT VERSUS COOL EXECUTIVE FUNCTION: TOWARD A NEW MODEL OF EMOTION REGULATION AS EXECUTIVE FUNCTION

Although EF can be understood as a domain-general construct at the most abstract, functional level (i.e., as conscious goal-directed problem solving), more precise characterizations (at the algorithmic and implementational levels) necessitate another distinction—that between the relatively "hot" motivationally significant aspects of EF more associated with ventral parts of the PFC, and the more motivationally independent "cool" aspects more associated with the lateral PFC (Zelazo & Müller, 2002; cf. Metcalfe & Mischel, 1999; Miller & Cohen, 2001). Whereas cool EF is more likely to be elicited by relatively abstract, decontextualized problems (e.g., sorting by color, number, or shape in the WCST), both hot and cool EF are required for problems that involve the regulation of motivation. Thus, hot EF is especially prominent when people really *care* about the problems they are attempting to solve, although in fact, emotion regulation involves both hot EF (control processes centered on reward representations) and cool EF (higher-order processing of more abstract information).

Interestingly, the link between EF and emotion regulation is most closely seen when the problem to be solved is that of modulating emotion, as in emotion regulation.

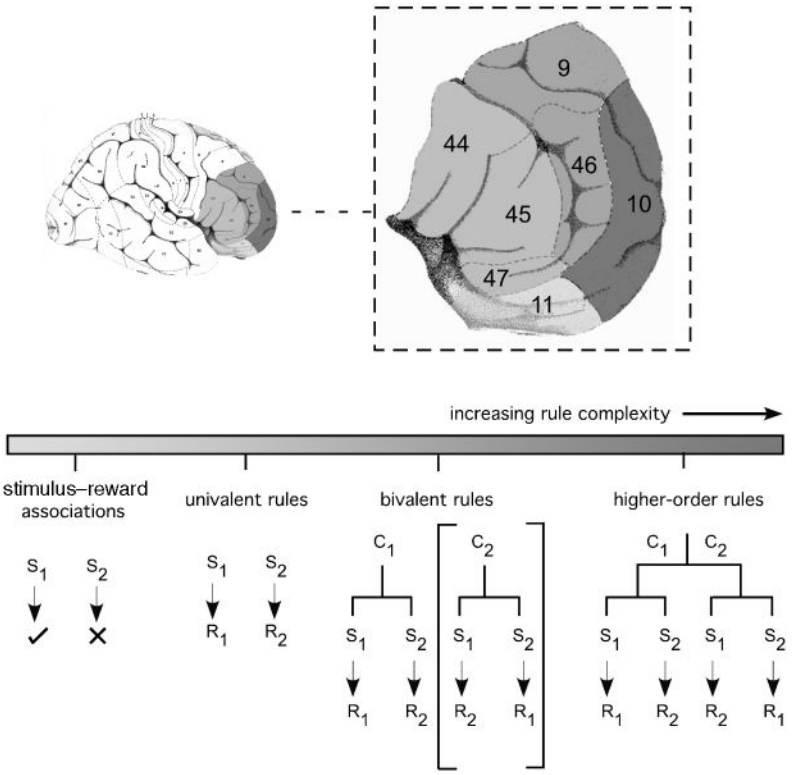

FIGURE 7.3. A hierarchical model of rule representation in the PFC. A lateral view of the human brain is depicted at the top of the figure, with regions of the PFC identified by the Brodmann's areas (BA) that comprise them: Orbitofrontal cortex (BA 11), ventrolateral PFC (BA 44, 45, 47), dorsolateral PFC (BA 9, 46), and rostrolateral PFC (BA 10). The PFC regions are shown in various shades of gray, indicating which types of rules they represent. Rule structures are depicted below, with darker shades of gray indicating increasing levels of rule complexity. The formulation and maintenance in working memory of more complex rules depends on the reprocessing of information through a series of levels of consciousness, which in turn depends on the recruitment of additional regions of PFC into an increasingly complex hierarchy of PFC activation. S, stimulus; ✓, reward; x, nonreward; R, response; C, context, or task set. Brackets indicate a bivalent rule that is currently being ignored. From Bunge and Zelazo (2006). Copyright 2006 by Blackwell Publishing. Reprinted by permission.

In such cases, EF *just is* emotion regulation—the two constructs are isomorphic. Yet, when the modulation of emotion occurs in the service of solving another problem (which we believe is the case for the majority of situations), then EF *involves* emotion regulation. It should be noted that emotion regulation in these two cases may differ. For example, when emotion regulation is a secondary goal, there may be a greater need for selecting among task sets (and hence, greater rLPFC involvement). Although it seems likely that emotion regulation occurs most often in the service other goals, research on emotion regulation has generally relied on paradigms in which emotion regulation is the participants' primary objective (e.g., Ochsner et al., 2004).

This characterization of hot EF in contradistinction to cool EF is consistent with neuroanatomical evidence that the ventral PFC differs from the lateral PFC in their pat-

terns of connectivity with other brain regions. The OFC is part of a frontostriatal circuit that has strong connections to the amygdala and other parts of the limbic system. Consequently, the OFC is anatomically well suited for the integration of affective and nonaffective information, and for the regulation of appetitive/motivated responses (e.g., Damasio, 1994; Rolls, 1999). In contrast, these connections are less direct in the case of the lateral PFC (indeed, they are partly mediated by the OFC). In addition to its connections with the OFC, the dLPFC is connected to a variety of brain areas that would allow it to play an important role in the integration of sensory and mnemonic information and the regulation of intellectual function and action. These include the thalamus, parts of the basal ganglia (the dorsal caudate nucleus), the hippocampus, and primary and secondary association areas of neocortex, including posterior temporal, parietal, and occipital areas (e.g., Fuster, 1989).

The distinction between hot and cool EF is also consistent with a large body of research regarding the functions of the dLPFC, on the one hand, and the OFC, on the other. Traditionally, research on EF in human beings has focussed almost exclusively on dLPFC, using measures such as the WCST and the Tower of London (Shallice, 1988). Results of this research contributed our current characterization of cool EF. A good deal of early research on the OFC was conducted with nonhuman animals, using two relatively simple paradigms: object reversal learning and extinction. As noted earlier, in object reversal, animals learn a simple discrimination between two objects and then the discrimination is reversed (the previously unrewarded object is rewarded and vice versa). On this task, animals with lesions to (the inferior convexity of) the OFC fail to switch their responses and instead perseverate on the initial discrimination (e.g., Butter, 1969; Dias et al., 1996; Iversen & Mishkin, 1970; Jones & Mishkin, 1972). More recent research has demonstrated that human patients with acquired OFC damage also reveal deficits in reversal learning, including perseverative responding to the previously rewarded stimulus (Fellows & Farah, 2003; Rolls et al., 1994).

Response extinction tasks are similar to reversal learning tasks in that they also involve a change in the reinforcement contingencies after a response has been learned to criterion. In this case, a response is reinforced, and then reinforcement is withheld. In such situations, nonhuman primates with lesions to (caudal) OFC (e.g., Butter, Mishkin, & Rosvold, 1963) and human patients with OFC damage (Rolls et al., 1994) display resistance to extinction, continuing to respond to the nonreinforced stimulus.

Findings of this sort have led to suggestions that the OFC is heavily involved in the reappraisal of the affective or motivational significance of stimuli (e.g., Rolls, 1999, 2004). According to this view, while the amygdala is primarily involved in the initial learning of stimulus–reward associations (e.g., Killcross, Robbins, & Everitt, 1997; LeDoux, 1996), reprocessing of these relations is the province of the OFC. In terms of the Bunge and Zelazo (2006) model, this type of reprocessing—as assessed by relatively simple tasks such as object reversal and extinction—may rely heavily on the OFC because it requires the explicit representation of a simple stimulus–reward association to govern approach or avoidance of a concrete stimulus.

Recently, researchers have noted that human patients with OFC damage are often impaired at the self-regulation of social behavior—especially in generating appropriate emotional reactions given social norms (Beer, Heerey, Keltner, Scabini, & Knight, 2003; Damasio, 1994; Rolls et al., 1994). Researchers working with human patients have also used a variety of more complex laboratory measures of hot EF, such as the Iowa Gambling Task (e.g., Bechara, Damasio, Damasio, & Anderson, 1994), which assesses decision making about uncertain events that have emotionally significant consequences (i.e., meaningful rewards and/or losses). Although initial studies suggested that the

OFC alone (especially on the right) was important for performance on this task, more recent research has revealed an important role for the dLPFC (Fellows & Farah, 2005; Manes et al., 2002; see also Hinson, Jameson, & Whitney, 2002). This may be due to the complexity of the rules required.

In addition, however, it should be noted that the various regions of the PFC are parts of a single coordinated system and probably work together—even in a single situation. Thus, it seems likely that decision making is routinely influenced in a bottom-up fashion by affective reactions (e.g., Damasio, 1994; Gray, 2004) and the representation of reward value (e.g., Rolls, 1999). Conversely, it seems likely that a successful approach to solving hot problems is to reconceptualize the problem in relatively neutral, decontextualized terms and try to solve it using cool EF (cf. Mischel, Shoda, & Rodriguez, 1989)—reflecting on the situation, creating more complex rule systems, and recruiting more lateral regions of PFC.

Indeed, in terms of the hierarchical model of PFC function (see Figure 7.3), it is not that ventral regions such as the OFC are exclusively involved in hot EF but, rather that they remain more activated even as the hierarchy of the PFC is elaborated. Simple rules for approaching versus avoiding concrete stimuli (the provenance of the OFC) are more difficult to ignore in motivationally significant situations. Thus, in effect, hot EF involves increased bottom-up influences on PFC processing, with the result that hot EF (vs. cool EF) requires relatively more attention to (and activation of) lower levels in rule hierarchies—discriminations at that level become more salient, leading to relatively more ventral PFC (i.e., OFC and perhaps vLPFC) activation even when higher levels in the hierarchy are also involved. Rather than positing discrete systems for hot and cool EF, this model views hot–cool as a continuum that corresponds to the motivational significance of the problem to be solved, and to the degree of reflection and rule complexity made possible by the hierarchy of PFC function. These two dimensions (motivational significance and reflection or reprocessing) are understood to be correlated and to correspond to what has been called psychological distance from the situation (Carlson, Davis, & Leach, 2005; Dewey, 1931/1985; Sigel, 1993; Zelazo, 2004)—a cognitive separation from the exigencies of the situation. It should be noted, however, that it is also possible that rule complexity and motivational significance are orthogonal aspects of prefrontal organization: More anterior parts of PFC may represent more complex rules, and more ventral parts of PFC may represent reward-related information. Further research is needed to test these alternatives.

Finally, another distinction that becomes relevant when considering EF at the implementational level is that between left and right hemispheres of the brain (cf. Tucker & Williamson, 1984). A growing body of evidence suggests that the right PFC may be more likely to be involved in hot EF than cool EF. For example, damage to the right (or bilateral) OFC has a greater effect on social conduct, decision making, emotional processing, and other purported OFC functions than does damage to the left OFC (e.g., Manes et al., 2002; Rolls et al., 1994; Stuss, 1991; Stuss & Alexander, 1999; Stuss, Floden, Alexander, & Katz, 2001; Tranel, Bechara, & Denburg, 2002). As discussed by Bechara (2004; see also Tranel et al., 2002), patients with right OFC damage reveal marked impairments in everyday functioning as well as on the Iowa Gambling Task, and these effects are similar to those revealed in bilateral OFC patients. By contrast, patients with left OFC damage are relatively unimpaired, suggesting that the reliable impairments demonstrated by bilateral OFC patients may derive primarily from the right OFC.

There are several possible reasons why the right OFC may be so important for these functions. Bechara (2004) suggests that right–left hemispheric asymmetries in OFC function may derive from the differential involvement of the right and left hemi-

spheres in avoidance (negative affect) and approach (positive affect), respectively (see also Davidson & Irwin, 1999; Davidson, Jackson, & Kalin, 2000). That is, adaptive decision making on the Iowa Gambling Task, and possibly measures of affective decision making more generally, requires avoidance of seemingly positive responses (a function for which the right OFC may be particularly well suited). The right hemisphere has also been implicated in the mapping of bodily states and the comprehension of somatic information (Davidson & Schwartz, 1976), and this too may help to explain the relative importance of right OFC to everyday decision making (Bechara, 2004; Damasio, 1994).

The hemispheric asymmetry in approach and avoidance is relevant in its own right. Building on earlier work using baseline resting electroencephalograph (EEG), research has revealed considerable evidence that processing negative information is more associated with activation in regions of the right PFC (Anderson et al. 2003; Cunningham, Johnson, Gatenby, Gore, & Banaji, 2003; Cunningham, Raye, & Johnson, 2004c; Sutton, Davidson, Donzella, Irwin, & Dottl, 1997), whereas processing positive information is more associated with activation in regions of the left PFC (Anderson et al., 2003; Cunningham et al., 2004c; Nitschke et al., 2003; Kringelbach, O'Doherty, Rolls, & Andrew, 2003; see Wager, Phan, Liberzon, & Taylor, 2003, for a meta-analysis). Given that human beings appear biased to attend to negative versus positive information (Ito, Larsen, Smith, & Cacioppo, 1998b), and that negative information is generally more arousing (Ito, Cacioppo, & Lang, 1998a), it may be the case that the right OFC is more involved in processing information with motivational significance, rather than negative information per se.

In the first part of this chapter, we suggested that EF can be understood at each of Marr's (1982) three levels of analysis—computational, algorithmic, and implementational. At the computational level, we characterized EF as an abstract, hierarchical, iterative, cybernetic function: deliberate, goal-directed problem solving. At the algorithmic level, we outlined a process model of EF that emphasizes the roles of reflection (through a series of levels of consciousness) and the formulation, maintenance in working memory, and execution of rule systems that vary in hierarchical complexity. At the implementation level, we presented a hierarchical model of PFC function. Key properties at the computational level—EF as hierarchical, iterative, and cybernetic—also apply to the algorithmic and implementational levels because these levels fulfill the function specified at the computational level.

We then distinguished between hot and cool aspects of EF and suggested that hot EF is associated with higher degrees of motivational significance. At the algorithmic level, this corresponds to attention to relatively simple discriminations between approaching and avoiding stimuli that are construed as relatively concrete. At the implementational level, this corresponds to greater activation in the ventral PFC and greater right-hemisphere involvement. This distinction is the basis of a new model of emotion regulation, which we now explore in more detail—again in terms of Marr's (1982) levels.

A NEW MODEL OF EMOTION REGULATION

Computational Level

At the computational level, one may have as a primary or secondary goal the modulation of emotion. Modulation may involve emotional upregulation (increasing the intensity of a specific emotion), emotional downregulation (decreasing the intensity of a spe-

cific emotion), maintaining an emotion, or a qualitative change in one's emotional reactions. Consider the case of downregulating anger, as a primary goal. First, one has to represent the problem, assessing (1) one's current state—a high level of anger, (2) one's goal state—a reduction in anger and, correlatively, an increase in detachment, and (3) options for reducing the discrepancy between (1) and (2). These options may include reappraisal of the anger-provoking stimulus, simple distraction, or reminding oneself about the extent to which one values detachment, among other possibilities. Second, one has to select a promising plan from among these options, considering the relative efficacy of the options as well as the effort involved. Given that one has other pressing demands, such as an article to write, distraction may be likely to work and easy to implement, so one proceeds to the third general step of executing this plan. Now, one needs to adopt a goal of focusing one's attention on the article, and one needs to keep this goal in mind and act on the basis of it despite a tendency to dwell on the anger-provoking stimulus. When absorbed in writing the article, all is well; however, when one's attention reverts to the stimulus, one has to recognize that one's efforts at downregulation have failed. That is, one has to engage in evaluation, including taking steps to correct one's errors—for example, by stepping up one's efforts to attend to a relatively engaging aspect of the distracting activity.

In most cases, one needs to consider multiple goals simultaneously, at various levels of abstraction, and one pursues them more or less automatically (Bargh, 1989; Carver & Sheier, 1982; Shallice, 1988). EF is involved in just those cases in which one is considering goals consciously and one is deliberately attempting to obtain them; normally one pursues a limited number of such goals at the same time. Nonetheless, as we saw, EF needs to be understood as a complex hierarchical function, and one inevitably needs to pursue more proximal subgoals (e.g., executing a plan) in the service of fulfilling a more distal, but still explicit, goal (e.g., solving the problem). It seems likely that emotion regulation is often a subgoal pursued in the service of another goal. That is, one strives to regulate one's emotion (e.g., upregulation or downregulation) *in order* to foster the fulfillment of some other goal about which one cares.

Algorithmic Level

At the algorithmic level, emotion regulation involves reflection and the formulation and use of rules at various levels of complexity. Reflection and rule use allow one to progress through the functional phases identified at the computational level of analysis. Whether emotion regulation is the primary goal of EF or a subgoal, it will involve the elaboration (via the reprocessing of information through levels of consciousness) of an increasingly complex rule system, or system of inferences. This more complex rule system, maintained in working memory as the activated contents of consciousness, entails a reappraisal of the emotion-relevant situation. That is, it entails contextualization of the situation; rather than accepting a relatively superficial gloss of the situation—one that extracts only its most salient, low-resolution aspects, leading to a relatively simple approach–avoidance discrimination—one's representation of the situation is reprocessed and integrated with other information about contexts in which the situation may be understood. One consequence of the ascent through levels of consciousness will be an increase in psychological distance (e.g., Dewey, 1931/1985) from the situation, which is bound to result in cooler EF. Another consequence of the more carefully considered construal of the situation, based on the formulation of a more complex system of rules, is that one can now follow higher-order rules for selecting certain aspects of the situation to which to attend. Generally speaking, attending selectively to certain

aspects of the now broadly construed situation will be an effective way to modulate one's emotional reactions to the situation. For example, one may increase the intensity of one's emotional reaction by attending to more provocative aspects or decrease the intensity of one's reaction by focusing on less provocative aspects. In contrast, processing that is restricted to a relatively low level of consciousness is likely to be perseverative, and this type of processing may underlie rumination in some cases.

Implementational Level

In addition to the hierarchically arranged regions of lateral PFC depicted in Figure 7.3, emotion regulation involves a number of other neural structures, and it is instructive to show how these regions may interact with the PFC. Indeed, attempting to understand emotion regulation in terms of EF, and hence considering the interplay between top-down and bottom-up processes that occurs in emotion regulation, prompts us to develop a more comprehensive neural model of emotion regulation, albeit one that is still focused relatively exclusively on the PFC (e.g., ignoring the key roles of parietal cortex and the hippocampus) and that glosses over important distinctions within regions (within the limbic circuit: nucleus accumbens, ventral striatum, and nuclei of the amygdalae, etc.; LeBar & LeDoux, 2003).

Figure 7.4 depicts the implementational level of our model of EF as a circuit diagram. To describe the model at this level, we first follow the flow of information involved in generating an emotional reaction and triggering some efforts at emotion regulation. Perceptual information about a stimulus is processed via the thalamus and fed forward (via the direct, subcortical route) to the amygdala, which generates an initial, unreflective motivational tendency to approach or avoid the stimulus (e.g., LeDoux, 1996). This amygdala response leads to various emotional sequelae not depicted here (e.g., sympathetic activation), but it also serves as input to the OFC, which implements an initial, relatively simple level of emotion regulation by processing amygdala output relative to a learned context (and simple approach-avoidance rules). When OFC activation fails to suffice to generate an unambiguous response to the stimulus (e.g., because the stimulus is ambivalent or signals the presence of an error), this triggers activation in the anterior cingulate cortex (ACC), which responds to the motivational significance of the stimulus—as understood at this level of processing. The ACC, on this model, serves to initiate the reprocessing of information via vLPFC and then dLPFC, with rLPFC playing a key, transient role in the explicit consideration of task sets. Broca's area is depicted separately from vLPFC in Figure 7.4 in order to capture the fact that the rule use involved in these top-down regulatory processes may be intrinsically linguistic (i.e., it may be mediated by private speech; Vygotsky, 1962; Luria, 1961). At the same time, however, we note that self-directed speech may not be necessary in some cases, consistent with research on the emotional regulation of prejudice showing that the right PFC, and not the left PFC, is sometimes involved in regulation (Cunningham et al., 2004a; Richeson et al., 2004).

As in EF more generally, in emotion regulation different regions of the lateral PFC are recruited as one engages in reflection and in the retrieval, maintenance, and use of rule systems at different levels of complexity. This route to emotion regulation is tantamount to the initiation of elaborative processing of a motivationally significant stimulus; as mentioned at the algorithmic level, this entails contextualization of the situation, and it may result in ER via reciprocal suppression between levels in the hierarchy of PFC regions (e.g., Drevets & Raichle, 1998). When lateral PFC regions are engaged,

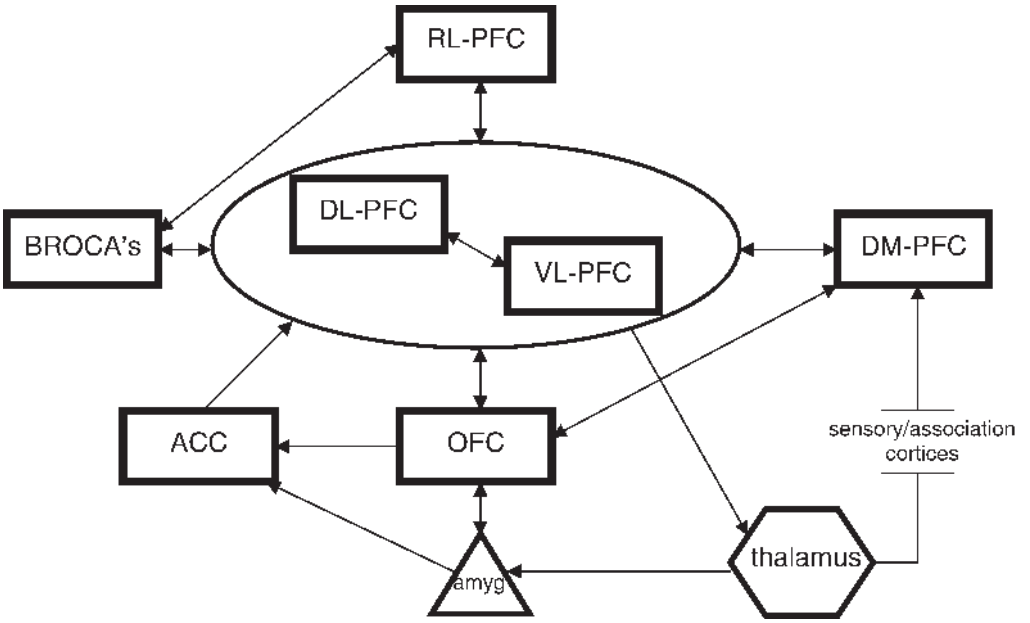

FIGURE 7.4. Neural circuitry underlying ER. Information about a sensory stimulus is processed by the thalamus and projected to the amygdala, leading to an initial motivational tendency to approach or avoid the stimulus, but also initiating further processing of the stimulus by the anterior cingulate cortex (ACC) and orbitofrontal cortex (OFC). The ACC responds to the motivational significance of the situation and may serve to recruit additional reprocessing of the stimulus via ventrolateral prefrontal cortex (vLPFC) and then dorsolateral prefrontal cortex (dLPFC), with rostrolateral prefrontal cortex (rLPFC) playing a transient role in the explicit consideration of task sets. Broca's area is involved insofar as top-down regulatory processes rely on private speech, and it is depicted separately from vLPFC, of which it is a part. Reprocessing by lateral regions of PFC corresponds to reflection (through levels of consciousness) and the elaboration of rule hierarchies, and it serves to regulate emotion by amplifying or suppressing attention to certain aspects of the situation (thalamic route) and by biasing simple approach–avoidance rules in the OFC.

rLPFC will permit reflective selection among task sets, and dLPFC and vLPFC will implement this selection, representing a reconfigured context for responding. The consequences of this new representation are propagated back down the hierarchy, biasing simple approach–avoidance rules in the OFC, which plays a more direct role in regulating amygdala activation.

The last PFC region that appears to play a critical role in ER is dorsomedial PFC (dMPFC; BA 9[medial]). Although the exact function of dMPFC is heavily debated, this region has repeatedly been shown to be involved in various aspects of reflective emotional processing. In a meta-analysis of emotion, Phan, Wager, Taylor, and Liberzon (2002) found that dMPFC was involved in many aspects of affective processing, regardless of the valence and sensory modality of the triggering stimulus. Interestingly, this region was much more likely to be activated in studies involving reflectively generated emotion, as opposed to perceptually generated emotion—for example, when people generated an emotional response in the absence of a triggering stimulus (Teasdale et al., 1999), when people monitored their emotional response (Henson, Rugo,

Shallice, Josephs, & Dolan, 1999), and when people anticipated an emotional response (Porro et al., 2002). In addition, this region appears to play an important role in the understanding of social agents (Frith & Frith, 1999; Gallagher & Frith, 2003; Mitchell, Banaji, & Macrae, 2005; Mitchell, Macrae, & Banaji, 2004), leading Cunningham and Johnson (in press) to suggest that this region may be a polymodal integration area for the complex processing and understanding of emotional information and may be involved in more complex aspects of emotion (guilt, shame, *schadenfreude*) that may drive or be a consequence of emotional regulation. This account relies on a distinction between direct, perceptual processing of stimuli (including rewards and punishers) and indirect processing that is mediated by reflective processing (e.g., *anticipated* rewards and punishers).

A series of studies from our lab that compare the more explicit to more implicit aspects of the emotional evaluation of stimuli allows for comparisons between relatively automatic emotional responses to stimuli and the emotional experience that is modified through emotion regulation. Importantly, in these studies, emotion regulation is not the person's primary goal per se but occurs in the service of other goals. For the most part in these studies, participants make either evaluative (good–bad) or non-evaluative (abstract–concrete; past–present) judgments during fMRI (Cunningham et al., 2003; Cunningham et al., 2004c, 2005b) or EEG recording (Cunningham, Espinet, DeYoung, & Zelazo, 2005a). Following scanning, participants rate each of the stimuli presented to them during scanning on several dimensions, including the extent to which they (1) had an emotional response to the stimulus, (2) experienced attitudinal ambivalence (having simultaneous positive and negative responses), and (3) attempted to regulate their initial emotional response. Using these ratings as parametric regressors, we have been able to map the relations among brain processing and specific aspects of evaluative or emotional processing.

As would be expected, emotionality ratings correlated with activation in the amygdala and the OFC for both good–bad and abstract–concrete trials—suggesting that the emotional significance of stimuli was processed relatively automatically (see Figure 7.5, left column). More critical for the discussion of emotion regulation as EF, ratings of emotion regulation correlated with activation in each of the areas in our proposed model—ACC, OFC, vLPFC, dLPFC, and rLPFC (see Figure 7.5, middle column). Providing support for the suggestion that vLPFC is involved in reweighting of the relevance of information and in selecting information for subsequent processing, we found the greatest vLPFC and ACC activity for stimuli rated as most ambivalent (Cunningham et al., 2003). In addition, self-reported emotion regulation correlated with activation in dMPFC. Interestingly, and in contrast to the correlations observed for the experience of an emotional response, the correlations between these brain regions and ratings of ambivalence and emotion regulation were found to be significantly greater for evaluative as compared to non-evaluative trials. This difference suggests that emotion regulation and the processing of complex emotions occurs primarily in the service of deliberate, goal-directed processing.

Similar results were found in an fMRI study of the regulation of prejudice—or emotion regulation in the context of attitudes about race (Cunningham et al., 2004a). In most college samples, participants are likely simultaneously to show (1) automatically activated negative behavioral responses to social outgroups and (2) motivation to suppress these feelings in order to display a more socially acceptable response (Cunningham, Nezlek, & Banaji, 2004b; Devine, 1989; Plant & Devine, 1998). Thus, on average, people are likely to adopt a goal of inhibiting or suppressing an emotional response that could potentially result in prejudice or discrimination, and they are likely

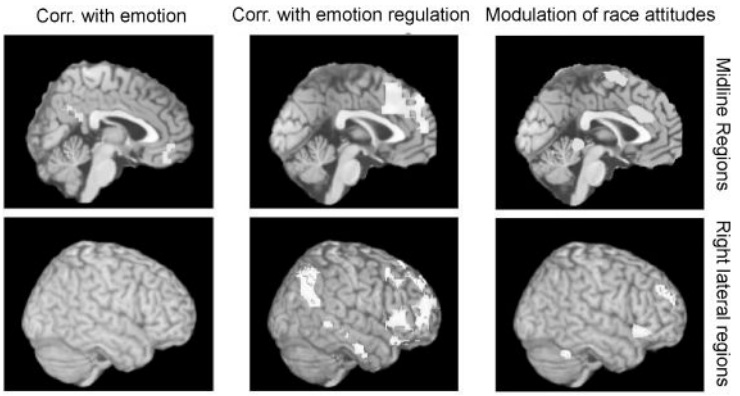

FIGURE 7.5. Data depicting the processing of emotional experience and emotion regulation. Data from the right lateral surface and the medial regions are presented for each analysis. Data for the correlation between emotion and emotion regulation are from Cunningham, Raye, and Johnson (2004c), and data for the modulation of race prejudice are from Cunningham et al. (2004a).

to use EF processes to accomplish this goal. In our study, participants were presented with black or white faces for either 30 msec or 525 msec. In the 30-msec condition, participants did not report seeing faces, whereas the 525-msec condition allowed sufficient time for the conscious recognition and processing of the face. When participants were not able to see the faces, greater amygdala activation was found to the black compared to the white faces consistent with the hypothesis that, even for individuals who claimed not to be prejudiced, there was an automatic negative emotional response to members of social outgroups. In contrast, when participants were able to see the faces and had the ability to regulate their emotional response, amygdala activation was significantly reduced and accompanied by activation in frontal regions (see Figure 7.5, right column). It is important to note that despite the vast differences between these studies, the particular PFC regions found were nearly identical to the regions found to be correlated with self-reported ER in Cunningham et al. (2004c; see Figure 7.5, middle and right columns, for comparison). Providing further evidence for the involvement of these regions in emotion regulation, we found that activity in rLPFC and ACC was significantly correlated with a reduction in amygdala activation to black compared with white faces.

It should be noted that emotion regulation does not necessarily imply the *inhibition* of a response. Similar to the fMRI studies just discussed, Cunningham et al. (2005a) presented participants with valenced stimuli and asked participants to make either good–bad or abstract–concrete judgments while high-density EEG was recorded. Consistent with hypotheses of hemispheric asymmetries in the processing of emotional stimuli (e.g., Davidson, 2004), greater anterior right sided activity was observed to stimuli rated as bad compared to stimuli rated as good. Interestingly, this effect, which began approximately 450 msec following stimulus presentation, was observed for both good–bad and abstract–concrete trials. Although the onset of the asymmetry was not influenced by task, the amplitude of the effect as measured later in processing (e.g., 1,200 msec poststimulus) was greater for the good–bad compared with the abstract–concrete trials. This suggests an automatic initiation of emotional processing followed by an amplification of a response as a result of reflective reprocessing of the stimulus (e.g., by the lateral PFC).

KEY IMPLICATIONS OF THE NEW MODEL

Reseeding

One key proposal of this model is that information about a motivationally significant stimulus is reprocessed iteratively using the same network that was used for the original processing. Specifically, PFC processes foreground specific aspects of information (hence backgrounding others), and these reweighted representations are used to "reseed" EF processing by influencing ongoing processing of the stimulus. This is accomplished, according to this model, by thalamocortical connections between the lateral PFC and the thalamus that bias attention to particular aspects of the situation as it continues to be processed in real time. As such, EF and emotion regulation should not be thought of as single processes that act in opposition to emotional processing (e.g., turning off a circuit). Rather, given the iterative nature of EF, the information is likely reprocessed multiple times before a goal state is reached. This highlights an important feature of the emotion regulation as EF model: many of the processes involved in emotion regulation are the very same processes that are used for emotion generation. Indeed, according to this model, successful emotion regulation is the deliberate, goal-directed attainment of a desired emotional state. When this state has been achieved, and the discrepancy between the goal state and the current state is reduced below some threshold, emotion regulation will cease.

Implications for Development of Emotion Regulation

The growth of the PFC follows an extremely protracted developmental course (e.g., Giedd et al., 1999; Gogtay et al., 2004; O'Donnell, Noseworthy, Levine, & Dennis, 2005; Sowell et al., 2003) that mirrors the development of EF. For example, developmental research suggests that the order of acquisition of rule types shown in Figure 7.4 corresponds to the order in which corresponding regions of the PFC mature. In particular, gray-matter volume reaches adult levels earliest in OFC, followed by the vLPFC, and then by the dLPFC (Giedd et al., 1999). Measures of cortical thickness suggest that dLPFC and rLPFC exhibit similar, slow rates of structural change (O'Donnell et al., 2005). On the basis of this evidence, Bunge and Zelazo (2006) hypothesized that the pattern of developmental changes in rule use reflects the different rates of development of specific regions within the PFC. The use of relatively complex rules is acquired late in development because it involves the hierarchical coordination of regions of the PFC—a hierarchical coordination that parallels the hierarchical structure of children's rule systems and develops in a bottom-up fashion, with higher levels in the hierarchy operating on the products of lower levels.

To the extent that the PFC is involved in emotion regulation, the development of emotion regulation should also be a protracted process and may be informed by research on the development of EF. A good deal is now known about the development of cool EF (see Zelazo & Müller, 2002, for review), but relatively little is known about the development of hot EF. One key line of work, however, comes from Overman, Bachevalier, Schuhmann, and Ryan (1996), who demonstrated age-related improvements in performance on object reversal in infants and young children. In addition, these authors found that prior to 30 months of age, boys performed better than girls—a finding consistent with work showing that performance on this task develops more slowly in female monkeys than in male monkeys, and that this sex difference is under the control of gonadal hormones (Clark & Goldman-Rakic, 1989; Goldman, Crawford,

Stokes, Galkin, & Rosvold, 1974). This suggests that there may be a similar neural basis to sex differences in emotion regulation.

Kerr and Zelazo (2004) assessed hot EF in slightly older children, using a version of the Iowa Gambling Task (Bechara et al., 1994). Children chose between (1) cards that offered more rewards per trial but were disadvantageous across trials due to occasional large losses, and (2) cards that offered fewer rewards per trial but were advantageous overall. On later trials, 4-year-olds made more advantageous choices than expected by chance whereas 3-year-olds (and especially 3-year-old girls) made fewer. Three-year-olds' behavior on this task resembled that of adults with damage to the OFC, suggesting that the task may provide a behavioral index of the development of orbitofrontal function. Subsequent work explored the basis of 3-year-olds' poor performance, identifying a role for working memory (Hongwanishkul, Happaney, Lee, & Zelazo, 2005) and demonstrating that even 3-year-olds develop somatic markers as indicated by anticipatory skin conductance responses (SCRs) prior to making disadvantageous choices (DeYoung et al., 2007). Paradigms such as this one may be used to explore the role of hot EF in emotion regulation (e.g., see Lamm, Zelazo, & Lewis, 2006; Lewis, Lamm, Segalowitz, Stieben, & Zelazo, 2006).

CONCLUSION

In this chapter, we provided a new model of emotion regulation that spans Marr's (1982) three levels of analysis—computational (concerning what emotion regulation accomplishes), algorithmic (dealing in more detail with the way emotion-relevant information is represented and how it is processed during emotion regulation), and implementational (examining the neural basis of emotion regulation). Naturally, this model is overly simple; the processes involved in emotion regulation are only beginning to be understood. Nonetheless, the model makes specific claims at all three levels of analysis and may provide a useful stimulus for future research on emotion regulation. In addition to testing hypotheses derived from the model (e.g., developmental constraints on emotion regulation), future research might usefully explore whether different strategies of emotion regulation rely on different aspects of EF and how the processes underlying emotion regulation overlap with those involved in the experience of complex social emotions (i.e., emotions that likely require relatively high levels of consciousness). Overall, however, we hope that this model demonstrates how an understanding of basic processes of EF may shed light on critical aspects of emotion, including the phenomenological experience of emotion and the dynamic regulation of this experience.

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NOTE

1. For the purposes of this chapter, we consider the OFC to be primarily the medial aspects of the orbital frontal cortex.

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Caregiver Influences on Emerging Emotion Regulation

BIOLOGICAL AND ENVIRONMENTAL TRANSACTIONS IN EARLY DEVELOPMENT

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CONCEPTUAL AND DEVELOPMENTAL CONSIDERATIONS

Defining the Construct of Emotion Regulation

Our definition of emotion regulation reflects recent theoretical and empirical work in both developmental (Cole, Martin, & Dennis, 2004; Fox & Calkins, 2003) and clinical psychology (Keenan, 2000; Sroufe, 2000) that highlights the fundamental role played by emotion processes in both child development and child functioning (Eisenberg et al., 2000). Consistent with many of our colleagues contributing to this volume (Gross & Thompson; Eisenberg, Hofer, & Vaughn; Rothbart & Sheese), we view emotion regulation processes as those behaviors, skills, and strategies, whether conscious or unconscious, automatic or effortful, that serve to modulate, inhibit, and enhance emotional experiences and expressions. We also view the dimension of emotional reactivity as part of the emotion regulation process, although we, like some of our colleagues (Gross & Thompson, this volume), see a value in examining this element of the process as distinct from the efforts to manage it, what we refer to as the control dimension (Calkins & Johnson, 1998; Fox & Calkins, 2003). The emotion regulation process is clearly a dynamic one in which reactive and control dimensions alter one another across time. Moreover, in our view, the reactive dimension, as opposed to the control dimension, is present and functional early in neonatal life, as it is strongly influenced by genetic and biological factors (Fox & Calkins, 2003; Rothbart & Sheese, this volume). Finally, we, like our colleagues, note that the display of emotional reactivity and emotion control are powerful mediators of both interpersonal relationships and socioemotional adjustment across the lifespan (Thompson & Meyer; Eisenberg et al., this volume).

The broad construct of emotion regulation has been studied in many ways across

early development (Cole et al., 2004), including through the examination of the child's use of specific strategies in emotionally demanding contexts and the effects of these strategies on emotion experience and expression. For example, specific emotion regulation strategies such as self-comforting, help seeking, and self-distraction may assist the young child in managing early temperament-driven frustration and fear responses in situations in which the control of negative emotions may be necessary (Stifter & Braungart, 1995). Moreover, emotion regulation skills may be useful in situations that elicit positive affective arousal in that they allow the child to keep such arousal within a manageable and pleasurable range (Grolnick, Cosgrove, & Bridges, 1996).

Although children appear to be quite proficient in the use of such basic skills at a relatively early age, it is clear that dramatic developments occur during the infancy and toddler periods of development in terms of the acquisition and display of emotion regulation skills and abilities. The process may be described broadly as one in which the relatively passive and reactive neonate becomes a child capable of self-initiated behaviors that serve a regulatory function (Calkins, 1994; Kopp, 1982; Sroufe, 1996). The infant progresses from near complete reliance on caregivers for regulation (e.g., via, for example, physical soothing provided when the infant is held) to independent emotion regulation (e.g., choosing to find another toy to play with, rather than tantrumming, when the desired toy is taken by a companion), although the variability in such regulation across children, in terms of both style and the efficacy, is considerable (Calkins, in press). As the infant makes this transition to greater independence, the caregiver's use of specific strategies and behaviors within dyadic interactions become integrated into the infant's repertoire of emotion regulation skills, across, we presume, both biological and behavioral levels of functioning (Calkins & Johnson, 1998; Calkins & Dedmon, 2000). The child may then draw on this repertoire in a variety of contexts, in both conscious, effortful ways (e.g., walking away from a confrontation with a peer), and in nonconscious, automatic ways (e.g., averting gaze when confronted by a frightening movie scene). Because this important developmental transition occurs within the context of early relationships, we examine in some detail the ways in which caregivers, in the context of the attachment relationship, facilitate this transition, at both a biological and behavioral level.

Because the lack of adaptive emotion regulation skills may contribute to adjustment difficulties characterized by uncontrolled (i.e., acting-out) or even overcontrolled (i.e., inhibited) emotion expression (Calkins, 1994; Calkins & Dedmon, 2000; Keenan, 2000), failure to acquire these skills may lead to difficulties in areas such as social competence and school adjustment. For example, children who have difficulty managing emotion in a flexible, constructive way may be less successful in negotiating peer relationships or in managing academic challenges (Keane & Calkins, 2004; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). Thus, the acquisition of adaptive emotion regulation skills and strategies is considered a critical achievement of early childhood (Bronson, 2000; Cole et al., 2004; Posner & Rothbart, 2000; Sroufe, 1996). Moreover, these skills may be linked, in important ways, to other dimensions of self-control or self-regulation that are also developing during early childhood. In this way, the influence of early emotion regulation on subsequent development may be considered quite pervasive (Calkins, in press). We examine this self-regulatory framework in some detail as it provides a roadmap for our discussion of the many ways in which caregiver behavior influences the child's emerging repertoire of emotion regulation skills.

A Self-Regulatory Framework for Understanding the Development of Emotion Regulation

Because we believe that emotion regulation processes are linked in fundamental ways to more basic physiological and attentional processes, and have consequences for later-developing and more sophisticated cognitive skills, we, like some of our colleagues (Eisenberg et al., this volume; Rothbart & Sheese, this volume) embed these emotion-related processes within the larger construct of self-regulation. So, for example, in our work, we routinely examine changes in children's responses to specific emotion-eliciting events; however, the level of analysis for such change includes physiological and attentional processes, as well as observable behavioral processes. Regulatory efforts occur across each of these levels, although each of these emotion regulation processes is also linked to children's responses to a variety of external events occurring everyday as they negotiate the worlds of home, school, and peers, and as they develop the skills to function independently in these worlds. So, for example, a child may be faced with the task of having to decide which of two friends to side with during a disagreement. Successful resolution of this challenge requires regulatory processes that occur across several levels of functioning, including the physiological (e.g., regulating increased heart rate that occurs as a function of the personal distress the disagreement causes), attentional (e.g., observing and processing relevant sides of the disagreement), behavioral (e.g., reaching out to restrain one friend intent on physically harming the other), and cognitive (e.g., imagining the future of each relationship depending on the resolution of the current argument).

As this example demonstrates, an emotional task may be parsed into many smaller challenges for the child, involving processes that are observable in different ways and across different levels of functioning. However, many of these same component processes might also be involved in the successful negotiation of other childhood challenges, which may not have an obvious emotion regulation demand, such as a math test, a soccer game, or a plea to a parent to attend a social event. Because of the challenge in distinguishing similar processes, which are often activated in different contexts and are components of the same or different biological and behavioral systems, in our view, it may be more useful to adopt an approach that considers multiple levels of analysis of self-regulation rather than isolating emotion regulation from related, or even integrated, processes (Calkins & Fox, 2002; Eisenberg et al., 2000; Posner & Rothbart, 2000). From this perspective, emotion regulation skills emerge during infancy and toddlerhood as a function of more basic or rudimentary regulatory processes, and they assume a central role in the development of the more complex self-regulation of behavior and cognition characteristic of early and middle childhood (Calkins & Fox, 2002; Calkins & Howse, 2004)

One rationale for examining the development and integration of these domain-specific regulatory processes emanates from recent work in the area of developmental neuroscience that has identified specific brain regions that may play a functional role in the deployment of attention and in the processing and regulation of emotion, cognition, and behavior (Posner & Rothbart, 2000; Rothbart & Sheese, this volume). This work has identified areas of the prefrontal cortex as central to the effortful regulation of behavior via the anterior attention system. This system is guided by the anterior cingulate cortex, which includes two major subdivisions. One subdivision governs cognitive and attentional processes and has connections to the prefrontal cortex. A second

subdivision governs emotional processes and has connections with the limbic system and peripheral autonomic, visceromotor, and endocrine systems (Lane & McRae, 2004; Luu & Tucker, 2004). Recent research suggests that these subdivisions have a reciprocal relation (Davis, Bruce, & Gunnar, 2001; Davidson, Putnam & Larson, 2000). Moreover, the functional relation between these two areas of the cortex provides a biological mechanism for the developmental integration of specific types of self-regulatory processes in childhood.

We acknowledge that these discrete self-regulatory processes are likely to be so intertwined that once integration across levels occurs in support of more complex skills and behaviors, it is difficult to parse these complex behavioral responses into separate or independent types of control. Nevertheless, from a developmental point of view, it is useful to describe explicit types of control and how they emerge, as this specification may provide insight into nonnormative developments and problems that emerge as a result of deficits in specific components of self-regulation at particular points in development (Calkins, in press; Calkins, Graziano, & Keane, in press). So, one way to conceptualize the self-regulatory system is to describe it as adaptive control that may be observed at the level of physiological, attentional, emotional, behavioral, cognitive, and interpersonal or social processes (Calkins & Fox, 2002). Control at these various levels emerges, at least in primitive form, across the prenatal, infancy, toddler, and early childhood periods of development. Importantly, though, the mastery of earlier regulatory tasks becomes an important component of later competencies, and by extension, the level of mastery of these early skills may constrain the development of later skills. Recent developmental neuroscience work suggests that because of its dependence on the maturation of prefrontal–limbic connections, the development of self-regulatory processes is relatively protracted (Beauregard, Levesque, & Paquette, 2004), from the development of basic and automatic regulation of physiology in infancy and toddlerhood to the more self-conscious and intentional regulation of cognition emerging in middle childhood (Ochsner & Gross, 2004). Thus, understanding the development of *specific* regulatory processes, such as emotional regulation, becomes integral to understanding how regulatory deficits across multiple levels affect the emergence of childhood behavior and behavior problems (Calkins & Fox, 2002).

Embedding emotion regulation in a larger self-regulatory framework has the advantage of allowing researchers to understand the multiple levels of infant and child functioning that may be influenced by *both* intrinsic, child-driven factors, such as temperament, and extrinsic, externally imposed factors, such as caregiver behavior and the emerging attachment relationship. Because this view of emotion regulation is more expansive than narrow, in the next section, we offer in some detail a description of the normative regulatory processes involved in early emerging emotion regulation.

Normative Developments in Early Self-Regulation and Emotion Regulation

Kopp (1982; Kopp & Neufield, 2003) provides an excellent overview of the early developments in emotion regulation, with reference to other related regulatory processes that support emotion-related regulation. This description has been verified by studies of both normative development (Rothbart, Ziaie, & O'Boyle, 1992; Buss & Goldsmith, 1998) and studies of individual differences (Stifter & Braungart, 1995). These descriptions provide an explanation of how infants develop and use a rich behavioral repertoire of strategies in the service of reducing, inhibiting, amplifying, and balancing dif-

ferent affective responses. Moreover, it is also clear from these descriptions that functioning in a variety of nonemotional domains, including motor, language and cognition, and social development, is implicated in these changes (Kopp, 1989, 1992).

Early efforts at emotion regulation, those occurring prior to about 3 months of age, are thought to be controlled largely by innate physiological mechanisms (Kopp, 1982; Derryberry & Rothbart, 2001; Rothbart, Derryberry, & Hershey, 2000). Such efforts are characterized primarily by general reactivity to stimuli and by approach (i.e., turning toward) versus withdrawal (i.e., turning away) from pleasant versus aversive stimuli. By 3 months of age, primitive mechanisms of self-soothing such as sucking, simple motor movements such as moving away, and reflexive signaling in response to discomfort, often in the form of crying, are the primary processes operating, independent of caregiver intervention (Kopp, 1982; Rothbart et al., 1992).

The period between 3 and 6 months of age marks a major transition in infant development. First, sleep–wake cycles and eating and elimination processes have become more predictable, signaling an important biological transition. Second, the ability of the infant to use simple actions voluntarily to modify arousal levels begins to emerge. This increase in control depends largely on the development of attention mechanisms and simple motor skills (Rothbart et al., 1992; Harman, Rothbart, & Posner, 1997; Kochanska, Coy, & Murray, 2001) and leads to coordinated use of attention engagement and disengagement, particularly in contexts that evoke negative affect. When confronted by aversive stimuli, infants are now capable of engaging in self-initiated distraction, which involves moving attention from the source of negative arousal to more neutral stimuli. For example, the ability to shift attention from a negative event (e.g., something frightening) to a positive distracter (e.g., a toy, pet, or parent) may allow infants to modulate their experience of negative affect.

By the end of first year of life, infants become much more active and purposeful in their attempts to control affective arousal (Kopp, 1982). First, they begin to employ organized sequences of motor behavior that enable them to reach, retreat, redirect, and self-soothe in a flexible manner that suggests they are responsive to environmental cues. Second, their signaling and redirection become explicitly social as they recognize that caregivers and others may behave in a way that will assist them in the regulation of affective states (Rothbart et al., 1992; Diener, Mangelsdorf, McHale, & Frosch, 2002). Successful use of such behaviors is critical in making the transition from passive, caregiver-directed regulation to active self-regulation (Calkins, 2002).

During the second year of life, the transition from passive to active methods of emotion regulation is complete (Rothbart et al., 1992). Although toddlers are not entirely capable of controlling their own affective states by this age, they are capable of using specific strategies to attempt to manage different affective states, albeit sometimes unsuccessfully (Calkins & Dedmon, 2000; Calkins, Smith, Gill, & Johnson, 1998). Moreover, during this period, toddlers begin to respond to caregiver directives and, as a consequence of this responsivity, compliance and behavioral self-control begin to emerge (Kopp, 1989). This shift is supported by developments in the motor domain as well as changes in representational ability and the development of language skills. Brain maturation contributes as well, and by the end of toddlerhood, children have executive control abilities that allow for the control of arousal and the regulation of emotional reactivity in a variety of contexts (Rueda, Posner, & Rothbart, 2004). The use of more coordinated motor skills and language translates into greater skill at dealing with peers and teachers in the preschool environment and for negotiating for autonomous behavior (e.g., “I do it myself”) in the home environment.

It is clear from this normative description of the emotion regulation process that multiple factors contribute to both successful acquisition of adaptive skills and to variations in the acquisition of and, perhaps, tendency to employ such skills. Next we explore the intrinsic and extrinsic sources of normative influence on early emotion regulation as well as those that produce individual variations with implications for later functioning.

THE EMERGENCE OF EMOTION REGULATION: INTRINSIC AND EXTRINSIC INFLUENCES

Like investigations of other areas of self-control (Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000), understanding the development of the control of emotions necessitates examination of both intrinsic and extrinsic factors (Calkins, 1994; Fox & Calkins, 2003). Intrinsic factors include the disposition, or temperament, of the infant, and the underlying neural and physiological systems that support and are engaged in the processes of emotional control (Calkins, 1994; Fox, 1994; Fox, Henderson, & Marshall, 2001). Extrinsic factors include the manner in which caregivers shape and socialize their infant's emotional responses and the relationship that develops between infant and caregiver as a consequence of these important interactions (Calkins & Fox, 2002; Fox & Calkins, 2003; Thompson, 1994; Thompson & Meyer, this volume).

Intrinsic Factors Implicated in the Development of Emotion Regulation

One well-tested assumption of the research on intrinsic factors and early emotional regulation is that individual differences in emotionality, or temperamental reactivity, play a role in at least the display, if not the development of, emotion regulation skills (Stifter & Braungart, 1995; Calkins, 1994). From this perspective, it is assumed that the tendency of infants to become emotionally aroused influence, either directly or indirectly, the kinds of emotion regulatory skills and strategies that children develop.

With respect to this reactive dimension of temperament, Rothbart notes that the initial responses of a newborn infant may be characterized by their physiological and behavioral reactions to sensory stimuli of different qualities and intensities. This reactivity is believed to be present at birth and reflects a relatively stable characteristic of the infant (Rothbart et al., 2000). Moreover, infants will differ initially in their threshold to respond to visual or auditory stimuli as well as in their level of reactivity to stimuli expected to elicit negative affect (e.g., Calkins, Fox, & Marshall, 1996). These initial affective responses that are characterized by vocal and facial indices of negativity are presumed to reflect generalized distress. Thus, this initial reactivity has neither the complexity nor the range of later emotional responses. Rather, it is a rudimentary form of the more sophisticated and differentiated emotions that will in later infancy be labeled "fear," "anger," or "sadness." However, an infant's tendency to become distressed, or not, because external events (e.g., loud voices) may influence the initial behavioral response to such stimuli (e.g., turning toward vs. away). Early patterns of responding may become part of the infant's behavioral repertoire and influence both the level and type of regulatory response needed in a given situation.

A second area of research on the intrinsic factors involved in the emergence of emotion regulation has addressed the underlying physiological processes and functioning that may play an important role in the etiology of early regulatory behaviors (Fox,

1994; Fox & Card, 1999; Porges, 1991, 1996). Theories of emotion regulation that focus on underlying biological components of regulation assume that maturation of different biological support systems lays the foundation for the increasingly sophisticated emotional and behavioral regulation that is observed across childhood.

Fox (1989, 1994), for example, has noted that the frontal lobes of the brain are differentially specialized for approach versus avoidance and that these tendencies influence the behaviors that children engage in when emotionally and behaviorally aroused. He further notes that maturation of the frontal cortex provides a mechanism for the more sophisticated and planful regulatory behaviors of older children versus infants. Porges (1996) argues that maturation of the parasympathetic nervous system also plays a key role in regulation of state, motor activity, and emotion. One index of parasympathetic functioning is heart rate variability, which has been linked specifically to deficits in emotional and behavioral self-regulation (Calkins, 1997; Calkins & Dedmon, 2000). Moreover, behavioral and physiological research with infants and young children clearly demonstrates that control of physiological arousal eventually becomes integrated into the processes of attention engagement and disengagement (Porges, 1996; Richards, 1987), which is central to both emotional regulation and, later, to behavioral regulation (Rothbart, Posner, & Boylan, 1990; Sethi et al., 2000).

Although dimensions of children's early functioning that may be considered intrinsic play an important role in laying the foundation for subsequent development, and perhaps constraining such development, these developments are clearly occurring in a social context, and from the very earliest point in development. One important assumption of much of the research on the acquisition of emotion regulation is that parental caregiving practices may support or undermine such development and thus contribute to observed individual differences among young children's emotional skills (Calkins et al., 1998; Thompson, 1994; Thompson & Meyer, this volume). Here, we explore two related dimensions that are important in early development: caregiving behavior and attachment relationships.

Extrinsic Influences on Emerging Emotion Regulation

During infancy, successful regulation largely depends on caregiver support and flexible responding (Kopp, 1982; Calkins & Fox, 2002; Sroufe, 2000). To the extent that a caregiver can appropriately read infant signals and respond in ways that minimize distress or, alternatively, motivate positive interaction, the infant will integrate such experiences into the emerging behavioral repertoire. That is, over time, interactions with parents in emotion-laden contexts teach children that the use of particular strategies may be more useful for the reduction of emotional arousal than other strategies (Sroufe, 1996). So, for example, a parent who has successfully and repeatedly redirected a child's attention from desired but unavailable objects (e.g., the telephone) is implicitly teaching the child to engage in self-initiated redirection when faced with such situations in the future. Moreover, deviations from supportive caregiving may contribute to patterns of emotional regulation that undermine the development of appropriate skills and abilities needed for later developmental challenges (Cassidy, 1994). For example, a child who is left to cry in frustration by a parent who simply removes the desired object and walks away may be unable to generate a constructive way to deal with a similar situation in the context of a preschool classroom where greater independence is required.

One hypothesis about the way in which caregiving practices affect developing emotion regulation is through the emerging attachment relationship. Attachment processes

are often activated in emotionally evocative contexts and serve specific emotion-regulatory functions. Thus, it is likely that they contribute to the acquisition of the repertoire of self-regulated emotional skills that develop in the child over the course of infancy and toddlerhood. Current theorizing about childhood attachment and its role in emotional functioning and behavioral adjustment has its roots in the work of John Bowlby (1969/1982), whose evolutionary theory of attachment emphasized the biological adaptedness of specific attachment behaviors displayed during the infancy period. Such behaviors permitted the infant to initiate and maintain contact with the primary caregiver, which served a survival purpose (Bowlby, 1988). In typical development, infants exhibit a repertoire of behaviors, including looking, crying, and clinging, that allow them to signal and elicit support from the primary caregiver in times of external threat. Bowlby argued that by the end of the first year of life, the interactive history between the infant and caregiver, including during times of stress or external threat, would produce an attachment relationship that would provide a sense of security for the infant and significantly influence the child's subsequent adaptation to a variety of developmental challenges (Bowlby, 1988).

Bowlby hypothesized that the mechanism through which early parent–child attachment affected later functioning involved a psychological construct having to do with expectations of self and other. Bowlby's notion of "internal working model" referred to cognitive representations of the self and the caregiver that were constructed out of repeated early interactions. Such representations provided the infant and young child with a guide to expectations about his or her own emotional responding and the likelihood and success of caregiver intervention in managing this affective responding. Thus, the experience of sensitive caregiving was hypothesized to lead to a secure attachment and expectations that emotional needs would either be met by the caregiver or managed with skills developed through interactions with the caregiver.

Numerous developmental scientists have conducted tests of Bowlby's theory, though Mary Ainsworth is likely the most noted. Ainsworth conducted pioneering naturalistic and observational studies of attachment processes in a longitudinal study of infants and mothers in Baltimore that focused on individual differences in mother–infant attachment relationships (Ainsworth, Blehar, Waters, & Wall, 1978). Ainsworth theorized that while all infants become attached to primary caregivers, the quality of this attachment varied as a function of the relationship history. She developed an empirical paradigm that examined infant responses as a function of this relationship history. In her "Strange Situation" laboratory procedure, she constructed a series of brief, but increasingly stressful, episodes designed to activate the infant's attachment system. On the basis of infants' behavior displayed in the Strange Situation, particularly those behaviors that reflected the dyads' ability to manage stress, she characterized infants as securely attached or insecurely attached with either resistant or avoidant profiles. She characterized secure infants as those comfortable with exploration and positive affect sharing during the low-stress context and proximity seeking and the ability to be comforted in the high-stress context of separation. In contrast, insecurity was indexed by either heightened distress or difficulty calming (referred to as resistance or ambivalence), or active avoidance, of the caregiver during the high-stress context of separation. Importantly, Ainsworth reported that the quality of different types of attachment relationships could be predicted by the quality of maternal caregiving observed in the home across the first year of life. Ainsworth argued that the experience of consistent sensitive and responsive caregiving teaches the infant about appropriate expectations regarding others as well as allows the infant to experience a reduction in arousal

level as a consequence of caregiver's behaviors (Ainsworth et al., 1978). In this way, her findings provided empirical support for Bowlby's internal working model construct and supported the hypothesized link between attachment and emotion processes

This early theoretical and empirical work makes clear, then, why the recent interpretations of Bowlby's attachment theory attribute significance to the role of attachment processes in the development of emotion regulation. Sroufe (1996, 2000), for example, argues that emotional development is inextricably linked with social development, with the course of emotional development described as the transition from dyadic regulation of affect to self-regulation of affect. He argues that the ability to self-regulate arousal levels is embedded in affective interactions between the infant and caregiver. These interactions provide infants with the experience of arousal escalation and reduction as a function of caregiver interventions, distress reactions that are relieved through caregiver actions, and positive interactions with the caregiver (Sroufe, 1996, 2000). Such experiences contribute to the working model of affect-related expectations that will transfer from the immediate caregiving environment to the larger social world of peers and others.

Cassidy (1994) has also addressed the role of attachment processes in the development of emotion regulation. She focuses on the adaptive function of different patterns of emotional responding in the context of the attachment relationship and argues that these patterns of affective responding are actually strategies that infants use to allow their attachment needs to be met. The open and flexible emotional communication that is characteristic of a secure attachment allows the infant to comfortably and safely express both positive and negative affect within a proximal and comfortable relationship with a responsive caregiver. Moreover, the different strategies of insecure infants also provide these infants with a means of meeting their own needs within the context of a less-than-optimal caregiving environment. The heightened distress characterizing some insecure infants also serves as a clear signal to gain the attention of the inconsistent or unresponsive caregiver. In a similar manner, avoidant behavior serves the adaptive purpose of minimizing the attachment relationship and has the effect of allowing the infant to maintain the needed proximity without threatening the relationship with the caregiver through displays of overt sadness or anger. Importantly, though, these short-term adaptations of the different patterns displayed by insecure infants may lead to long-term difficulties in other contexts. For example, heightened emotion expression, in the context of peer relationships, may lead to problematic peer interactions and have implications for the development of social competence (Cassidy, 1994).

In another extension of Bowlby's theory that has implications of the development of emotion regulation, Hofer (1994) describes how the biological experience of infant–caregiver interactions becomes a representational structure that guides affective functioning. He argues that these early interactions are, in fact, regulatory experiences that contribute to an inner affective experience composed of sensory, physiological, and behavioral responses. Over time, these affective experiences lead to organized representations, the integration of which is the internal working model. These organized mental representations are ultimately what guide the child's behavior, rather than the individual sensory and physiological components to which the infant responded earlier in infancy (Hofer, 1994).

Schore (2000) extends these psychobiological ideas even further in arguing that the interactive experiences between caregiver and child that are the essential elements of the emerging attachment relationship also affect the development of the prefrontal cortex. The right hemisphere, in particular, he notes, is especially influenced by experi-

ences in the social world, and, in turn, determines the regulation and coping skills that young children develop. Support for the role of the right frontal cortex in human behavioral and emotional regulation has emerged over the last several years (Fox, 1994; Fox & Card, 2000). For example, chronic exposures to stress and/or high cortisol levels may result in impaired functioning in the regions of the brain associated with inhibition and regulation, such as the prefrontal cortex (Goldsmith & Davidson, 2004).

The psychobiological explication of attachment processes offers insight into the mechanism through which interactive experiences across the first year of life become integrated into the internal working model that Bowlby articulated and, importantly, become elements of the child's emerging emotion regulation abilities. In the next section, we examine how specific dimensions of caregiver behavior and the emerging attachment relationship with the caregiver affect the development of infant emotion regulation across both biological and behavioral domains of functioning.

CAREGIVER–CHILD INTERACTIONS AND THE DEVELOPMENT OF EMOTION REGULATION

Caregiver Effects on the Biological Substrates of Emotion Regulation

In the aggregate, the number of studies examining the effects of specific caregiving behaviors on infant biological processes that may underlie emotion regulation is small; however, it is clear that these effects may place important constraints on subsequent behavioral development (Calkins, 1994; Calkins et al., 2002). Infants who have characteristically low thresholds for arousal, or who have difficulty managing that physiological arousal, are at a disadvantage because emergent emotion regulation strategies are dependent on the basic control of physiological processes that support behavioral strategies. To the extent that caregivers can provide the support for such physiological control early in early development, children should be more successful at using attentional and behavioral strategies to control emotional reactions. Moreover, it is likely that several complex caregiving practices, most of which are integral to early emerging attachment, can affect the biological aspects of emotion regulation. Here, we draw on both human and animal work to examine these interactive processes.

Because the biological underpinnings of emotion regulation are clearly evident as early as the neonatal period of development, the effects caregivers may have on the developing infant begin during the prenatal period. Moreover, these effects appear to be significant for the child's subsequent behavioral functioning. For example, in studies with both animals and humans, pregnancy stress in particular has been shown to be related to problematic outcomes such as hyperactivity, deficits in attention, and maladaptive social behavior, all of which are believed to be characterized by deficits in self-regulation and emotion regulation in particular (for reviews, see Weinstock, 1997; Koehl et al., 2001; Schneider, Coe, & Lubach, 1992). The mechanism for this effect is the increased amount of stress hormones expressed during pregnancy that may alter the fetuses' developing hypothalamic–pituitary–adrenal (HPA) axis and result in dysregulation of the stress response system (Koehl et al., 2001), a system that is clearly activated during emotion-eliciting situations (Stansbury & Gunnar, 1994).

Work with humans indicates that fetuses do indeed react to mild stressors induced during pregnancy (DiPietro, Costigan, & Gurewitsch, 2003). In this study, stress was induced using a Stroop color–word task administered to mothers at 24 and 36 gestational weeks. The fetus's responses to maternal stress, indexed by increased heart rate

and motor activity, increased over gestation, even as the magnitude of mother's sympathetic response to the stressor decreased. Clearly, even mild environmental intrusions experienced by the mother may have an effect on the developing fetus's physiological systems. Moreover, at least one study has shown that prenatal stress may have long-term consequences (O'Connor, Heron, Golding, Beveridge, & Glover, 2002). Specifically, mothers' prenatal anxiety predicted behavior problems, which are characterized by difficulties in self-regulation, in boys and girls at age 4, even after controlling for postnatal maternal anxiety.

Beyond the prenatal period of development, there are multiple opportunities for caregiver behavior to influence emerging emotional regulatory processes through effects on biological functioning. Indeed, Schore (2000) suggests that across the first year of life the mother–infant dyad continues to be a mutually regulating biological unit. Moreover, evidence from animal models suggests that caregiving affects infants' biological and behavioral systems of regulation through the environment the caregiver provides rather than through shared inherited traits. For example, Meeney and colleagues have shown that high levels of maternal licking/grooming and arched-back nursing in rats affects the neurological systems associated with the stress response, a process that has a long-term influence on stress-related illness, certain cognitive functions, and physiological functions (Champagne & Meeney, 2001; Francis, Caldji, Champagne, Plotsky, & Meaney, 1999; Caldji et al., 1998). Furthermore, cross-fostering studies demonstrate convincingly that these maternal behaviors are transmitted behaviorally through the nursing mother and not through the biological mother, indicating that early caregiving is a crucial factor in early development and may affect the organism's level of emotional reactivity even when it reaches adulthood (Champagne & Meeney, 2001; Calatayud, Coubard, & Belzung, 2004).

One process that seems to have a direct impact on an infant's developing regulatory systems early in life is caregiver tactile stimulation. For example, skin-to-skin contact or "kangaroo" therapy has been shown to increase the premature infant's ability to regulate physiological processes (e.g., modulate sleep patterns, temperature, and oxygenation consumption) and has been associated with better attachment relationships with parents later in life (Anderson, Dombroski, & Swinth, 2001; Conde-Agudelo, Diaz-Rossello, & Belizan, 2003; Feldman, Weller, Sirota, & Eidelman, 2002). One hypothesis that explains these effects is that skin-to-skin contact is a mechanism for improving the functioning of the premature infant's neurobiological systems (Feldman et al., 2002).

In addition, research with normally developing human infants has shown that touch is clearly a salient feature of early care and normative development. For example, empirical work reveals that while maternal touch and affection decreased from 2- to 6-months postnatally, and the use of distraction and vocalizing increased, both holding/rocking and vocalization together served to reduced distress in infants at both ages (Jahromi, Putnam, & Stifter, 2004). Other work has shown that 3-month-olds do not respond to a still face interaction, a normally stressful experimental paradigm, unless maternal touch was allowed during the prior interaction periods, but 6-month-olds responded whether or not touch was included in the paradigm (Gusella, Muir, & Tronick, 1988). These results are consistent with Kopp's (1982, 1989) notion that the caregiver gradually reduces her external regulation of the child, and that such regulation may be more important early in life, when the infant's biological systems are maturing.

Although touch is a mode of interaction that clearly influences infant's physiological stress response as evidenced by HPA axis activity, and subsequently may play a role in the regulation of emotion, other physiological systems may be involved in emotion regulation as well. For example, caregiver behaviors seem to affect the infant's parasym-

pathetic nervous system (PNS) regulatory processes, via the regulation of cardiac vagal tone. During homeostasis, the PNS enhances restorative and growth processes. In the context of environmental challenge, the PNS influences regulation of cardiac output through the vagal nerve pathways (Porges, 1996). Porges (1991, 1996) has proposed a hierarchical model of self-regulation in which behavioral, emotional, and motor regulation are dependent on appropriate physiological regulation, which is indexed by changes in parasympathetic responses or respiratory sinus arrythmia (RSA). Empirical research suggests that caregiver behavior may affect this physiological system, which is closely tied to emotion regulation abilities (Calkins, 1997). For example, several studies indicate that mother–infant coregulated communication patterns and more responsive parenting are positively related to good vagal regulation, and maternal intrusiveness and restrictive parenting are negatively related to such regulation (Porter, 2003; Haley & Stansbury, 2003; Calkins et al., 1998; Kennedy, Rubin, Hastings, & Maisel, 2004). And, infants who share more mutual affect regulation with their mothers (dyads that demonstrated more matched affect and synchrony of affective states) were more effective in their physiological regulation across a stress-inducing still-face paradigm (Moore & Calkins, 2004).

Although most studies of caregiver effects on infant biological development focus on individual systems, it is likely that such effects are occurring across multiple biological and behavioral systems. Hofer (1994; Polan & Hofer, 1999) addresses the multiple psychobiological roles that the caregiver plays in regulating infant's behavior and physiology early in life. Based on his research with infant rat pups, he describes these "hidden regulators" as operating at multiple sensory levels (olfactory, tactile, and oral, for example) and influencing multiple levels of behavioral and physiological functioning in the infant. So, for example, maternal tactile stimulation may have the effect of lowering the infant's heart rate during a stressful situation, which may in turn, support a more adaptive behavioral response. Moreover, removal of these regulators, during separation, for example, disrupts the infant's functioning at multiple levels as well. Clearly, then, opportunities for individual differences in the development of emotion regulation may emerge from differential rearing conditions providing more or less psychobiological regulation.

Researchers have examined whether specific attachment processes, elicited in attachment-related contexts such as the Strange Situation, also affect physiological indices of emotion regulation when the attachment system is activated. Much of this work is reviewed by Fox (Fox & Card, 1999), who notes that multiple physiological indices have been examined in relation to Strange Situation behavior, including measures of heart rate, cortisol, and brain electrical activity. One difficulty with this work, in general, is that the extent to which the measures reflect emotional tone or reactivity versus emotion regulation or control is not often clear. For example, most studies report elevated heart rate in response to both the Strange Situation and maternal separation (Donovan & Leavitt, 1985; Sroufe & Waters, 1977), but because separation distress alone is not indicative of attachment, it is difficult to know whether these measures can reveal much about individual differences in the nature of the attachment relationship and developing emotion regulation. Studies of endocrine system responding reveal similar relations to the heart rate work. Findings indicate that infants who are stressed during the Strange Situation also experience elevated cortisol. In one study, elevated cortisol was found among infants who were both highly fearful, as measured using a different empirical paradigm, and insecurely attached, suggesting, perhaps, that their experience regarding lacking of external arousal regulation has produced heightened arousal during the Strange Situation (Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996).

Evidence for the role of the activation of the frontal cortex in contexts in which the attachment system is activated comes from the work on brain electrical activity (EEG) and maternal separation. This work suggests that the frontal brain regions involved in affective expression and regulation (Fox, 1994) are differentially activated during maternal separation, with the right frontal region more activated in infants who were more distressed during separation (Fox, Bell, & Jones, 1992). Again, though, the specificity of these findings to emotion regulation versus emotional reactivity is unclear, as are implications for individual differences in security of attachment.

In sum, research with human and animal subjects demonstrates that caregiver effects are observable from the prenatal period onward and influence biological functioning across several systems. However, the degree to which such functioning translates into behavioral indices of emotion regulation is often unclear. Next, we explore relations between caregiver behavior and attachment processes and indices of emotion regulation.

Caregiving Effects on the Behavioral Indices of Emotion Regulation

Much of the research on caregiving practices and the emerging observable emotion regulation skills of infants has focused on attachment-related processes. The research examining attachment and emotion regulation processes in contexts that activate the attachment system is consistent in its findings. In multiple studies, conducted in different laboratories, researchers have demonstrated that infants with secure attachment relationships use strategies that include social referencing and express a need for social intervention (Braungart & Stifter, 1991; Nachmias et al., 1996). These same researchers report that insecure/avoidant children are more likely to use self-soothing and solitary exploration with toys (Braungart & Stifter, 1991; Nachmias et al., 1996). The strategies of both secure and insecure infants seem to reflect a history of experiences and expectations regarding the availability of the caregiver as an external source of emotion regulation, expectations that are clearly important when the attachment system becomes activated during the stressful context of the Strange Situation. Such work provides direct support for the notion that patterns of emotion regulation are evident quite early in development and are an integral component of the dyadic interactions that produce secure attachment.

Interestingly, studies assessing direct relations between attachment and emotion regulation skills and strategies in contexts other than the Strange Situations paradigm are relatively rare. Three recent studies, though, support the notion that there are relations between the two domains that are observable outside the immediate dyadic context. First, Diener and colleagues (Diener et al., 2002), observed that attachment classification as observed in the Strange Situation did predict the infant's regulatory strategies in a situation in which the infant is required to regulate negative affect independently but did not explicitly activate the attachment system. Their findings were quite consistent with work examining emotion regulation within the context of the Strange Situation. Infants in secure attachment relationships with both parents used strategies emphasizing social orientation. Thus, security of attachment leads to expectations of caregivers that extend beyond the immediate parent–child interactional context. In turn, these expectations lead to the use of specific kinds of emotional regulation strategies in situations that place regulatory demands on the child.

Gilliom, Shaw, Beck, Schonberg, and Lukon (2002) conducted a study that examined specific emotion regulation strategy use beyond the infancy period. The focus of this investigation was on preschoolers' use of specific anger control strategies during a

waiting paradigm. Specific strategies involving the control of attention were found to predict the anger reaction of the children in this situation. In addition, though, secure attachment in infancy was predictive of the use of specific strategies, including the use of attentional distraction, that led to successful waiting. By preschool, young children are capable of controlling their attention in a manner that leads to successful emotional and behavioral control. This study demonstrates that the effects of attachment beyond the infancy period are observable in the development and use of such strategies.

In another recent study examining the relation between attachment and emotional functioning beyond the dyadic context, Kochanska (2001) conducted an extensive longitudinal study of the development of fear, anger, and joy across the first 3 years of life. Her rationale for this investigation was that attachment processes should be implicated in the development of different emotion systems and that children with different attachment histories should display different patterns of functioning in these systems. Moreover, she argued that evidence for such a developmental process would provide an explanation of how early attachment processes might be linked to the range of outcomes and indices of adjustment that have been studied.

Differences in the emotional functioning of the secure and insecure infants in Kochanska's study were apparent at the end of the first year of life. Consistent with other research (Calkins & Fox, 1992), Kochanska found that insecure/resistant infants were more fearful than other infants. In addition, across the second and third year of life, insecure infants displayed a different pattern with respect to the display of both positive and negative affect. Secure infants showed a predictable decline in the display of negative affect, while insecure infants displayed an increase as well as a decrease in positive affect. A notable finding of this study that pertains to the development of emotion regulation concerns the pattern of the insecure/avoidant children. Recall that these children are likely to minimize their emotional reactions in the context of the Strange Situation. However, Kochanska observed that, over time, these infants display an increase in fear reactions, a finding that supports Cassidy's notion that a minimizing strategy, while effective in the short term, may lead to difficulties later in development. Clearly, the strategy of minimization is either ineffective over time or leads to repeated experiences of internal arousal that eventually become difficult to control.

Although data on the relation between attachment and emotion regulation strategies are limited, there have been a few studies examining the relations between aspects of parenting thought to be linked to attachment and emotion regulation. These studies are worth noting because they are conducted with toddlers, children for whom there are clear expectations of emerging autonomous emotional control. In one study of mothers and toddlers, for example, we examined the relations between maternal behavior across a variety of different situations and child emotional self-control in frustrating situations (Calkins et al., 1998). Our analyses indicated that maternal negative and controlling behavior (thought to be reflective of intrusive behavior characteristic of insecure attachment relationships) was related to the use of orienting to or manipulating the object of frustration (a barrier box containing an attractive toy) and negatively related to the use of distraction techniques. These data are important in light of findings that the ability to control attention and engage in distraction (such that ruminating over the object of denial is minimized) has been related to the experience of less emotional arousal and reactivity (Calkins, 1997; Grolnick et al., 1996) and to lower levels of externalizing behavior problems (Calkins & Dedmon, 2000).

From this brief review of current work in the area of caregiving practices, attachment processes, and emotion regulation, it is clear that there are multiple possible pathways to the development of emotion regulation in infancy and early childhood. More-

over, this theoretical and empirical work suggests that evidence for the role of attachment processes in the development of emotion regulation may come from a number of different directions. First, attachment processes may affect the development and functioning of physiological processes that support emotion regulation. Second, attachment processes may be predictive of specific emotional responses in the context of the relationship dyad itself and may be observed empirically in behavioral and emotional responses to the Strange Situation or in other interactions between the caregiver and the infant. Third, attachment processes may be implicated in the development and use of specific strategies outside the context of the attachment relationship such as during tasks requiring more independent self-regulation of emotion. These tentative conclusions, however, clearly suggest multiple directions for future research.

SUMMARY AND FUTURE DIRECTIONS

In this chapter, we have examined the early development of emotion regulation processes as a function of both intrinsic (temperamental, biological) factors and extrinsic (caregiving, attachment) factors. We emphasized the role of extrinsic processes because, although we acknowledge the significance of both sets of factors for adaptive development in the domain of emotion regulation, we also note that the significant developments that occur in emotion regulation, and that depend on competent physiological and attentional regulation mechanisms emerging early in development, occur in the context of significant first relationships.

Our review of research examining the effects of early attachment relationships on the development of emotion regulation demonstrates that the proximal effects of this relationship are quite evident. Evidence from the psychophysiological literature reveals that predictable biological responses can be expected from infants in contexts that activate the attachment system. Beyond this immediate dyadic context, though, there are also effects of the attachment relationship on developing emotion regulation. Secure infants and children use effective strategies when engaged in tasks that require more autonomous emotional control, rather than the anticipated external control provided in dyadic regulation. More distal effects of attachment on behavioral and emotion regulation that underlies adaptive functioning in preschool and early childhood have also been observed (Shaw, Keenan, Vondra, Delliquadri, & Giovanelli, 1997). However, clear interpretation of these data may require a more systematic evaluation of the role of mediational and moderational processes, the influence of other environmental factors on this development, and the transactional relationship between parent and child and child and parent.

First, empirical work that is more focused on process, rather than simple associations, might be more informative for elucidating the complex ways that caregiving and emotion regulation influence development. It would be important, for example, to be able to clearly specify that the physiological processes affected by early caregiving experiences are, in fact, predictive of specific skills or deficits in early self- and emotional regulation processes, rather than level general functioning, as most work now indicates. Or, it might be useful to examine the role of emotion regulation as a mediator of the relations between early attachment and other, more complex, kinds of self-regulation. In one of the few studies conducted to examine such a hypothesis, Contreras, Kerns, Weimer, Gentzler, and Tomich (2000) observed that specific dimensions of emotion regulation, including arousal and attention deployment, mediated the relation between attachment and peer social behavior.

A second step that would help illuminate these interactional processes would be to address the issues of moderators of the relation between caregiving or attachment and self-regulation. It is clear from some of the behavior problem literature, in which problem behavior is often viewed as a proxy for regulatory deficits (Shaw et al., 1997), that the direct relations are likely to be observed under some conditions but perhaps not others. For example, environmental factors that place even greater stress on the attachment relationship are also likely to have the effect of undermining the child's own efforts to develop a self-regulatory repertoire. Or, resiliency factors such as social support or positive peer relationships may offset the negative effects of a compromised caregiving experience. A focus on moderated effects will provide greater specificity in prediction while preserving the important role of attachment processes in emotional functioning.

Third, it is clear that the direction of effects in development is not always from parent to child. Transactional influences from the environment to the child and back again are clearly responsible for some pathways in development (Calkins, 2002). Moreover, it must be acknowledged that the child plays an important role in the dyadic interactions with caregivers that lead to the development of attachment relationships (Calkins, 1994). Consequently, these transactional influences may obscure the identification of longer-term effects of attachment on emotional processes but clearly are important to understanding developmental pathways (Cicchetti, 1993).

Finally, implicit in our suggestions for future research is the idea that conceptual and empirical specificity of emotion regulation processes is necessary but that such specificity depends on an appreciation that emotion regulation is integrally connected to other forms of self-regulation. Although the processes and outcomes of interest in studies of emotion regulation may center on behavioral phenomena, we are clearly advocating an approach that integrates biological and cognitive phenomena into both theoretical and empirical explications of these critical developmental processes. By adopting an expansive approach, we believe that an account of the developmental significance of emotion regulation for child and adult functioning will be greatly enhanced.

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How Emotions Facilitate and Impair Self-Regulation

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Bugs, trees, and snakes may thrive and prosper without much in the way of either self-regulation or emotion, but human life is quite different. Probably few days go by without either emotion or self-regulation. Indeed, both emotion and self-regulation may be essential to effective human functioning, at least in the complex cultural worlds in which most people live. It is possible to study emotion or self-regulation separately, but in daily experience they are often interconnected. But how?

Most chapters in this volume focus on the self-regulation of emotion, which is to say the effects of self-regulatory processes on emotion. In this chapter, the perspective is reversed, and we look at the effects of mood and emotion on self-regulation. We use "emotion" as a general term that includes discrete emotions, mood, and affect (see Gross & Thompson, this volume). Furthermore, we consider emotion regulation to be one specific type of self-regulation (Tice & Bratslavsky, 2000). The differences between the self-regulation of emotion and the effects of emotion on self-regulation are perhaps not as fully opposite as they may seem at first blush, but they do raise very different questions and emphases.

The most familiar and important issue in this connection is the negative impact that emotional distress has on self-regulation. The main part of this chapter covers research indicating that unpleasant emotional states tend to cause self-regulation to break down. There is no single causal mechanism for this, and in fact there may be quite a few different causal pathways leading from emotional distress to self-regulation failure.

On the other hand, emotion is not uniformly bad for self-regulation. Hence the final part of this chapter seeks to provide some balance by noting some ways in which

emotion (both positive and negative) has been shown to improve self-regulatory functioning.

HOW DISTRESS[1] IMPAIRS SELF-REGULATION

Along with clinicians, lawyers, parents, and indeed the general public, researchers have long observed that self-control appears to deteriorate when people are experiencing acute states of unpleasant emotion. Even the traditional folk concept of counting to 10 before saying anything when one is angry implies that intense emotion can cause people to say or do things that they will later regret, and these are presumably things from which the person would normally refrain. Likewise, common stereotypes suggest that when people are upset, they are more likely than otherwise to break their diets, indulge in substance abuse, or perform other behaviors that they would regulate (successfully) under other circumstances.

Ample research findings have confirmed that emotional distress undermines self-regulation. Anxiety, depression, and other bad feelings lead people (especially overweight people and dieters) to eat more than they usually would (Greeno & Wing, 1994; Heatherton & Polivy, 1992; Logue, 1993; Slochower & Kaplan, 1980). Cigarette smoking increases when people are distressed or upset (Ashton & Stepney, 1982; Schachter et al., 1977), and people who are trying to quit are more likely to relapse when they are emotionally upset (Brownell, Marlatt, Lichtenstein, & Wilson, 1986). Alcohol use and abuse also are stimulated by emotional distress, partly because people believe that drinking alcohol will counteract anxiety and improve one's emotional state (Sayette, 1993; Stockwell, 1985). Efforts to quit drinking are sometimes undermined and defeated by emotional distress (Hull, Young, & Jouriles, 1986; Pickens, Hatsukami, Spicer, & Svikis, 1985). There is some evidence that gambling and compulsive shopping, both of which defeat the self-regulation of money expenditure, are more common in response to emotional distress (O'Guinn & Faber, 1987; Peck, 1986). Last, delay of gratification appears to suffer when people are in a sad mood or other unpleasant emotional state (Fry, 1975; Mischel, Ebbesen, & Zeiss, 1973; Underwood, Moore, & Rosenhan, 1973; Wertheim & Schwartz, 1983).

Reviews of the literature on self-defeating behavior likewise have repeatedly concluded that emotional distress is a common theme and contributing factor to a wide range of self-defeating behaviors (e.g., Baumeister, 1997; Baumeister & Scher, 1988). Self-defeating behavior reflects a failure to guide one's behavior toward desired, beneficial outcomes, and as such self-regulation failure is often central to it (Baumeister, 1997).

Put another way, few experts would dispute the idea that emotional distress can interfere with effective self-regulation. Specifying the precise mechanism by which emotions have that effect, however, is difficult. Most likely there are multiple pathways. This section considers several.

Shifting Priorities

Most likely evolution gave human beings their exceptionally powerful capacity for self-regulation because it would bring them benefits in various ways, especially in terms of long-range outcomes. Self-regulation confers the capacity to seek delayed rather than immediate gratifications (Mischel, 1974, 1996). Foregoing short-term temptations to

pursue distal goals of longevity, fitness, thinness, education, wealth, and other options has enabled humans to make their lives happy and comfortable in ways most animals cannot even imagine.

To accomplish these long-term beneficial outcomes, much of self-regulation is specifically geared toward foregoing the pleasures of short-term temptations. Therein lies the seeds of a possible problem, however. Sometimes—and perhaps especially when people are feeling acutely bad, as during emotional distress—people want to feel good right now, or as soon as possible.

There is thus a basic and recurring conflict between many self-regulatory programs and the goal of escaping from emotional distress. Or, to put this another way, there is a basic conflict between emotion and mood regulation (here, defined as the common effort to escape from bad emotions and moods and/or enter good emotions and moods) and other forms of self-regulation. Thus, one aspect of self-regulation—emotion regulation—may sometimes demand precedence over other aspects of self-regulation, to their detriment. Many behaviors are regulated because they feel good and therefore tempt the person to indulge in them to a degree that can be costly in the long run. During emotional distress, however, the long run may seem to matter less, whereas the acute bad feelings in the present moment stimulate the desire to make them stop. Short-term but costly pleasures therefore grow more appealing to the emotionally upset person.

From this reasoning, several of us developed the hypothesis that emotional distress would cause self-regulation failure—because the distraught individual is trying to make him- or herself feel better (Tice, Bratslavsky, & Baumeister, 2001). The key to testing this was to show that people in such emotional states would fail to self-regulate if they thought indulgence might make them feel better, whereas they would not fail at self-regulation if there were no corresponding expectation of mood repair. To accomplish this, we adapted a procedure developed by Manucia, Baumann, and Cialdini (1984) informally known as the *mood-freezing manipulation*. Those authors sought to show that sadness leads to helping because people believe that helping will cure their sadness. They gave some participants a pill and told them that one side effect of the pill was that their current emotional state would be impervious to change for about an hour. Sad people would therefore remain sad for that period, regardless of what they did. Sure enough, Manucia et al. (1984) found that sad people who had taken the mood-freezing pill did not help. Other sad participants, however, who believed their moods were alterable, did increase their helping, suggesting that people were helping in order to improve mood.

Our first study explored the familiar notion that emotional distress causes people to eat fattening and unhealthy (but tasty) food. We induced either a happy or sad mood in people by having them engage in a guided imagery exercise, following the procedure developed by Wenzlaff, Wegner, and Roper (1988) in which people imagine themselves either saving a child's life or accidentally causing a child's death in a traffic accident. Then they participated in an ostensible taste test in which they were to rate cookies, pretzels, and cheese crackers. For our mood-freezing manipulation, we did not use a mood-freezing pill per se in this study. Rather, we relied on the simple expedient of telling some participants the truth. The experimenter in the mood-freezing condition explained that many people believe that eating good-tasting foods will make them feel better but research has clearly shown this belief to be false. She concluded, "Whatever mood you are in right now, you are very likely to stay in the same mood throughout the

experiment." In the control condition no such instructions were given. The food tasting and rating task was a sham, and in reality the main measure was how much people ate.

Consistent with the standard view that emotional distress impairs self-regulation, sad participants in the control condition ate more than happy participants. (There was also evidence from a separate survey that students in that population recognized such foods as unhealthy and normally sought to restrain how much of them they ate.) In the mood-freeze condition, however, sad participants did not eat more than happy participants. In fact, sad participants in the mood-freeze condition ate the least of all four conditions. The implication is that sad people eat junk food in the expectation of feeling better. When that expectation is removed, sad people do not eat. Sad people's eating less than happy people in the mood-freeze condition may be strong evidence of their shifted priorities leading to lack of interest in anything that they do not think will make them feel better immediately.

A similar conclusion emerged from two further studies. One of them involved delay of gratification, using a resource management game. This game was developed by Knapp and Clark (1991) as a classic commons dilemma demonstration to simulate the problem of managing fish stock: The short-term gain is to harvest as many fish as possible to maximize immediate profits, but long-term gains are maximized by harvesting slowly so that the fish will replenish themselves (because only the fish left alive will reproduce). Knapp and Clark showed that sad participants depleted the fish stock rapidly via premature harvesting, thus confirming that sadness leads to self-regulation failure. We replicated their finding but added a mood-freeze condition using an ostensibly mood-freezing candle with an aromatherapy cover story, and it eliminated the effect, especially among people who were chronic mood regulators (Catanzaro & Mearns, 1990). Thus, seeking immediate gratification when sad fits the priority shift pattern described, in which emotional distress shifts one's priorities from long-term goals to feeling better immediately. Sad people want to feel good now, and so they indulge in immediate temptations (and especially if they are mood regulators). But if the prospect of escaping from sadness is removed, then sad people do not shift toward seeking immediate gratification.

Procrastination was the focus of our third study. Procrastination is an important and sometimes costly form of self-regulation failure (Ferrari, Johnson, & McCown, 1995; Flett, Hewitt, & Martin, 1995; Shouwenburg, 1995; Tice & Baumeister, 1997). One reason procrastination occurs is that working on tasks requires the person to forego the pleasures and temptations of the moment in order to concentrate on distant deadlines and the sometimes dull or aversive steps toward them. People who feel bad may be more swayed by such temptations and the immediate promise of pleasure. We found that sad participants in the control (no-mood-freeze) condition procrastinated on an upcoming laboratory test, preferring to play video games and read magazines instead of studying. They did not embrace all time wasters, however: When the distracting tasks were dull (e.g., reading out-of-date technical journals or playing with preschool-level puzzles), they worked on the task the same as most other participants. In the mood-freeze condition, however, even the pleasant distractors failed to tempt sad participants away from studying for the test. Thus, sad people procrastinate when they expect that doing so will make them feel better, and only then.

These studies undermine the view that emotion directly causes many behaviors. Rather, the behavioral effects of these emotions are strategic: They are guided by the anticipation of change in emotional state. If sadness directly caused self-regulation to

fail, it would have done so even in the mood-freeze conditions. But it did not. Instead, sad people only yielded to temptations and failed at self-regulation when they had reason to expect that these indulgences would make them feel better.

The broader implication is that emotional distress shifts one's priority and focus away from the distal goals that underpin most self-regulatory efforts. Instead, sad people focus on feeling better in the short run. Apparently they are often willing to sacrifice some of their progress toward long-term goals in order to escape from their aversive emotional state.

Ignoring Relevant Information

A widely cited fact about the influence of emotion on decision is its insensitivity to probabilities. That is, emotional processes react strongly to the size of relevant outcomes, but they react weakly to comparable shifts in the probabilities. Loewenstein, Weber, Hsee, and Welch (2001) illustrated this point by noting that one can feel quite differently about winning $10,000 versus $10 million—although both would be positive events, the latter would alter one's life in sweeping ways that the former cannot. In contrast, the difference in odds between 1 in 10,000 and 1 in 10 million (such as one's chances of winning either sum) scarcely registers on one's emotional system.

Early evidence for the insensitivity of emotion to probabilistic outcomes was provided by Monat, Averill, and Lazarus (1972). They showed that when people anticipated a possible electric shock at a particular moment, their arousal levels increased as that moment approached (and decreased afterward). The probability of getting the shock did not alter the degree of arousal (unless it was zero). Thus, the body's arousal and emotional system responded to threat without registering the likelihood of a bad outcome.

Some emotions can cause people to ignore relevant information, in ways that contribute to self-defeating behavior and failures at self-regulation, as shown by Leith and Baumeister (1996). This investigation was designed to investigate the link between emotional distress and self-defeating behavior, and the central hypothesis was that distress would cause people to take foolish risks. (This was intended to replace previous, largely discredited theories about the impact of emotion on self-defeating behavior, such as the view that guilt makes people desire to suffer.) Participants chose between two lotteries, one of which contained a small chance at a large reward—and an expected gain that was substantially worse than the other lottery. Across a series of studies, participants in good or neutral moods generally made the sensible choice of the lottery with the better expected gain, but participants who were in aversive emotional states characterized by high-arousal states—especially anger and embarrassment—shifted toward favoring the high-risk, high-payoff lottery. Thus, emotional distress led to foolish risk taking. Consistent with this finding, research by Lerner and Keltner (2000, 2001) suggests that different negatively valenced emotions, such as fear and anger, may produce distinct effects on people's tendency to make risky choices.

In one study, Leith and Baumeister (1996) sought to undo the effect of emotional distress. Their initial theory had been that people in bad moods reappraise the outcomes based on having less to lose (because of already feeling bad) and more to gain, but multiple measures across several studies had failed to provide any support for that. Instead, then, they thought that perhaps emotional distress caused people to cut short their processing of relevant information, as suggested by some prior research on stress (Keinan, 1987). Hence they added a condition in which they instructed angry partici-

pants to pause for a minute and list the pros and cons of each lottery before choosing. These participants chose the play-it-safe lottery, just like neutral and happy participants.

The implication is that emotional distress caused people to attend only to the magnitude of the possible outcome and to ignore the odds. Hence when people were upset, they selected the option with the best possible outcome, even though that option carried a 98% of a bad outcome. A failure to regulate one's attention and cognitive processes to incorporate all the relevant information mediated between the unpleasant emotional state and the self-defeating outcome.

Escaping Self-Awareness

One of the landmark events in the evolution of self-regulation theory was the publication of *Attention and Self-Regulation* (Carver & Scheier, 1981). Carver and Scheier had been known as self-awareness researchers, indeed gradually taking leadership roles in an area that had rapidly burgeoned during the 1970s. Everyone expected that their book would be essentially a summary of self-awareness, but they chose to leave self-awareness out of the title. Their point was to suggest a functional purpose for human self-awareness. Specifically, they proposed that people attend to themselves for the purpose of regulating their responses.

Although the field may have been slow to catch on, the links between self-awareness and self-regulation have continued to be verified in subsequent work. Indeed, it is quite hard to regulate any behavior without paying some attention to it (see Baumeister, Heatherton, & Tice, 1994a, for review). As Carver and Scheier (1981, 1982) pointed out, self-awareness is typically more than simply directing attention to some feature of the self or inner state. Rather, it almost invariably contains comparison to some standard, whereas earlier self-awareness research had treated the comparison to standards as either a quaint coincidence or a distraction, Carver and Scheier proposed that the standards were central to what self-awareness was meant to accomplish. Self-regulation is a process of altering oneself to meet various standards, and so necessarily it relied on careful comparison of one's current actual state with the goal or standard. This is often useful and adaptive, and we shall return to the point later, in our discussion of the positive influence of emotion on self-regulation.

For now, the relevant point is that emotional distress can be linked to unpleasant self-awareness, and so it could motivate people to reduce or escape from self-awareness—which, in turn, would likely impair self-regulation. The negative effect of emotional distress on self-regulation could thus be a side effect of the effort to escape self-awareness.

Self-awareness is not easy to stop. Indeed, directing attention away from the self is itself a form of self-regulation, and as such it requires conscious supervision. Thus, paradoxically, the effort to stop attending to oneself could stimulate attending to oneself, because the monitoring system would regularly check to see "Have I stopped being aware of myself?" only to find that the very act of checking thwarts the goal.

To resolve that problem, Baumeister (1988, 1989, 1990, 1991) proposed that the mind often responds with cognitive deconstruction, which is to say a shift in self-awareness toward more concrete and hence less meaningful aspects of the self. Thus, sexual masochists escape from meaningful self-awareness by instead becoming aware of themselves as merely physical bodies experiencing intense sensations such as pain, or occasionally by being aware of themselves doing things incompatible with their normal identities (e.g., performing humiliating or degrading acts). In parallel fashion, the

presuicidal process is often set in motion by some event that depicts the self in a very negative lights, such as being responsible for some failure or calamity, and this experience evokes a very negative view of self that is fraught with emotional distress. To combat it, the presuicidal person often shifts into such a deconstructed state, marked by narrow focus on the immediate present, immersion or self-distraction in mechanical activities, and emotional numbness (Baumeister, 1990). It is the inability to sustain this numb state that prompts the person to move on to attempting suicide. If the person could remain feeling numb amid a relatively meaningless set of activities, there would be no need for the suicide attempt. Unfortunately, each attempt to resume meaningful thought and active engagement in life brings back the awareness of the damaged identity and the associated emotional distress.

The link to self-regulation failure has perhaps best been documented in connection with binge eating (see Heatherton & Baumeister, 1991). Binge eating is both a form of self-defeating behavior (in that it normally occurs amid attempts to lose weight by restricting one's caloric intake and thwarts that goal) and a form of self-regulation failure (in that it involves losing control of precisely the behavior, namely, eating, that the person otherwise regulates carefully).

What leads to an eating binge? Aversive self-awareness has been implicated in multiple ways as a cause (for review, see Heatherton & Baumeister, 1991). Women with bulimia and other binge-eating tendencies typically have negative evaluations of their bodies (Cash & Brown, 1987; Garner, Garfinkel, & Bonato, 1987; Powers, Schulman, Gleghorn, & Prange, 1987; Williamson, 1990), and they also show low self-esteem generally (Eldredge, Wilson, & Whaley, 1990; Garner, Olmstead, Polivy, & Garfinkel, 1984; Gross & Rosen, 1988). They are also prone to high self-awareness (Blanchard & Frost, 1983; Heatherton & Baumeister, 1991). This appears to be specific to public self-awareness, in the sense that dieters and binge eaters are heavily concerned with how others think of them and may even overestimate the extent to which other people focus evaluative attention on them (Bauer & Anderson, 1989; Garfinkel & Garner, 1982; Johnson & Connors, 1987; Weisberg, Norman, & Herzog, 1987). They do not normally show elevated attention to their own inner states, feelings, and processes. Indeed, if anything, they are exceptionally insensitive and unresponsive to these inner aspects of self (Garfinkel & Garner, 1982; Heatherton, Polivy, & Herman, 1989). One likely reason for this is that chronic dieting is in part a process of training oneself to ignore inner signals of hunger and desire for food.

Laboratory manipulations that alter self-awareness often affect eating and in ways consistent with the view that people may eat heavily as part of an attempt to escape self-awareness. Dieters eat more after their self-esteem is threatened, such as after being told they failed at a problem-solving task (Baucom & Aiken, 1981; Heatherton, Herman, & Polivy, 1991; Ruderman, 1985). Manipulations that both increase self-awareness and convey threat to esteem, such as telling dieters that they will have to give a speech or otherwise perform in front of an evaluative audience, lead to increases in eating (Heatherton et al., 1991; Herman, Polivy, Lank, & Heatherton, 1987). In such cases, the person is presumably trying to escape from aversive self-awareness. When people are self-aware without threat, eating is typically reduced. For example, when people believe they are being watched while eating, they eat less (Herman, Roth, & Polivy, 2003).

A full test of the model was conducted by Heatherton, Polivy, Herman, and Baumeister (1993). Dieters and nondieters were first given either a success or a failure experience. Then some were distracted from self by having them watch an intriguing film, while others were kept self-aware with a mirror. Dieters who experienced failure

but then could escape from self-awareness by watching the distracting film ate relatively large amounts. Dieters who were kept in a state of self-awareness (unable to escape it) ate relatively little. Nondieters were less affected by these manipulations. These results fit the pattern that self-awareness sustains self-regulation, whereas escaping from self-awareness seems to sweep away these inner restraints.

The relevance of self-awareness to regulating eating was demonstrated in an important study by Polivy (1976). In her study, participants were first exposed to a "preload" manipulation that induced some dieters to eat more than they normally would, thereby breaking their diets, while others kept within normal limits. After this, all were invited to eat as many tiny sandwiches as they wanted. The key measure was a surprise recall test, in which participants were asked to report or estimate how many they had eaten. Most participants, including nondieters and the dieters whose diets had not been violated, were quite accurate. In contrast, dieters who had broken their diets during the preload were wildly inaccurate. Thus, apparently, once people broke their diet, they stopped monitoring, and this lack of keeping track was associated with greater eating.

Similar conclusions emerge from research on alcohol consumption. Research by Hull and his colleagues (see Hull, 1981, for review) has shown that people consume alcohol in order to escape from aversive self-awareness and that alcohol does effectively reduce awareness of self. Although traditional work has assumed that stress is one cause of alcohol abuse, Hull (1981) reviewed evidence that this relationship has often been overstated and oversimplified, because not all stresses lead to increased alcohol consumption. For example, a death in the family is almost universally rated as among the most stressful events that people experience, but it does not normally lead to increased alcohol use or abuse. Only stresses that reflect badly on the self lead to alcohol abuse. Thus, apparently, people turn to alcohol in order to escape from aversive self-awareness.

An important study of alcoholic relapse confirmed the importance of escape from self-awareness (Hull et al., 1986). Patients nearly at the end of an alcoholism detoxification program filled out measures of self-awareness and life events. The highest rates of relapse were found among people who were chronically high in self-focus and whose life events were principally negative. This pattern is presumably the one most likely to engender an aversive self-awareness, prompting the individual to return to alcohol for solace and escape. High self-awareness is not aversive when life is going well, and in fact relapse rates among highly self-aware people with predominantly favorable life events were exceptionally low.

It is certainly no coincidence that alcohol abuse has been linked to binge eating. Polivy and Herman (1976; Polivy, 1976) found that dieters ate more after consuming alcohol than after drinking nonalcoholic drinks. (These were not the so-called expectancy effects, because participants who were falsely told that their drinks contained alcohol did not eat more than controls.) Apparently, alcohol reduces self-awareness, thereby impairing one's ability to monitor one's behavior and contributing to failure at self-regulation. In fact, Abraham and Beaumont (1982) found that nearly half their sample of bulimics reported that alcohol consumption led to their eating binges (see also Williamson, 1990).

More broadly, alcohol has been associated with many patterns of failure at self-regulation (for review, see Baumeister et al., 1994a; also Steele & Southwick, 1985). When intoxicated, people perform many acts that they otherwise would restrain. They spend more, boast more, fight more, and the like.

Converging evidence comes from recent studies on social exclusion and rejection. Based on the hypothesis that people are driven by a fundamental and powerful need to

belong (Baumeister & Leary, 1995), some of us began investigating how people would respond to social rejection. We anticipated that rejection and other forms of social exclusion (e.g., hearing that one is likely to end up alone in life) would precipitate emotional distress. Indeed, almost everyone who hears about this work assumes that people would feel sadness, anxiety, depression, or other forms of upset when told that no one in their group had selected them as a potential partner, or that their personality profile forecast a lonely future. However, most participants who experience these manipulations report no emotion and instead seem almost numb (e.g., Twenge, Baumeister, Tice, & Stucke, 2001). But they show a broad range of socially undesirable and even antisocial behaviors. How can these be explained?

We propose that the incipient emotional distress causes people to avoid self-awareness, and this facilitates escape into the numb state of cognitive deconstruction—but at some cost to self-regulation. Twenge, Catanese, and Baumeister (2003) found ample signs of the deconstructed state among socially excluded participants. They reported that time moved slowly, were lethargic on tasks, and engaged in less meaningful thought. In one study, they systematically chose chairs facing away from a mirror instead of ones facing toward the mirror, which is an important indication of evading self-awareness (because mirrors direct attention to the self).

And self-regulation? Recent work has confirmed that rejected people self-regulate less effectively than others (Baumeister, DeWall, Ciarocco, & Twenge, 2005). Across several studies, they ate more cookies and snack foods, consumed less of a healthy but bad-tasting beverage that the experimenter exhorted them to drink, and performed worse than others on a dichotic listening (attention control task). The loss of self-awareness appears to have been an important contributing factor: When participants were seated in front of a mirror and therefore unable to escape from self, they performed as well as controls on the dichotic listening task.

In sum, some of the effects of emotional distress on self-regulation may be connected with aversive self-awareness. Events that make the self look bad and feel bad about itself bring unpleasant emotional states along with an unpleasant awareness of self. People may seek to escape from self-awareness partly because escaping from it may help keep the emotional distress at bay (as in our studies on social exclusion). Unfortunately, however, self-awareness is an important and integral part of effective self-regulation. Escaping from self-awareness therefore handicaps efforts at self-regulation and can produce self-regulation failure.

EMOTION AS AID IN SELF-REGULATION

The preceding sections have established beyond doubt that emotion (especially high-arousal emotional distress) can impair self-regulation. But that is only part of the story. There are various signs that emotion can sometimes benefit self-regulation too.

Indeed, the view that the effects of emotion are mainly negative, even just in terms of effects on self-regulation, seems implausible from an evolutionary standpoint. As already suggested, self-regulation is one of the crucial and distinctive adaptations of human evolution, and effective self-regulation is an important key to success in the sort of cultural societies that humans began to form very early in their prehistory (see Baumeister, 2005). If emotion mainly functioned to impair and undermine self-regulation, emotion would essentially be a backward force against evolutionary progress. Under those circumstances, one might have expected natural selection to favor humans with ever smaller and weaker emotional repertoires. Such individuals would

have competed effectively against their more emotional peers, by virtue of superior self-regulation. The fact is that evolution has preserved human emotion in its often powerful and wide-ranging operations, even if the processes and functions of emotion may have changed somewhat.

One landmark in the shift toward a more positive and constructive view of emotion was *Descartes' Error* (Damasio, 1992), which presented insights and conclusions from Damasio's research program examining the effects of brain damage that left cognitive functioning intact but stifled emotional responses. These individuals did not resemble the wise, prudent, rational individuals one might have expected from the view of emotion as essentially a backward, animalistic response that mainly prompts people to do foolish and dangerous things in the heat of passion. Rather, their lives were often severely compromised and sometimes marked by seemingly self-defeating patterns. They also showed costly streaks of impulsive action and a failure to learn from their experiences and mistakes.

Although cynical critics may suggest that it would be unrealistic to expect brain damage to produce broad benefits to psychological functioning, these results do suggest that the loss of emotional responsivity does more harm than good, and they suggest that emotions may play a vital if not immediately obvious role in supporting effective self-regulation. In this section, we indicate several ways that emotion may benefit self-regulation (see Fredrickson, 1998, for more complete summaries of the positive emotions).

Signaling Discrepancies

An influential paper by Higgins (1987) proposed that people experience emotional reactions activated by perceiving discrepancies between the way they are and the way the would like to be or ought to be. Indeed, Higgins went on to propose that different patterns of emotional response are linked to discrepancies from the *ideal self* and discrepancies from the *ought self*. Perceiving that one falls short of one's ideals leads to low-arousal negative emotions such as sadness and disappointment. In contrast, perceiving oneself as falling short of one's "ought" standards (or the ought standards held about the self by others, such as one's parents' expectations for how one should behave) gives rise to high-arousal negative emotions, such as anxiety and guilt.

Although Higgins's initial goal was to link self-construals to emotional reactions, he soon elaborated this into a self-regulation theory (e.g., Higgins, 1996). Negative emotional states give rise to attempts to resolve the discrepancies to escape from the negative affective states. In this, he built on the analyses by Carver and Scheier (1981, 1982) who also emphasized that people feel aversive emotional states when they focus on how aspects of self fall short of relevant standards.

The most distinctive feature of Higgins's approach has been the specificity of emotional reactions—that is, the hypothesis that different emotions arise from different discrepancies. This work has come under some criticism, including failures to replicate (e.g., Tangney, Niedenthal, Covert, & Barlow, 1998), but it continues to excite interest over its theoretical implications. The alternative, after all, is to propose that all negative emotions are essentially interchangeable in their contribution to self-regulation in that all they accomplish is to make the person acutely aware that falling short of standards is bad. Future work may establish whether self-regulation does benefit from the extensive differentiation of human emotion.

Thus, falling short of standards produces negative affect. What about meeting standards, such as reaching goals? The consensus across a broad range of theorists is that

positive emotions stem from such positive outcomes. Indeed, the view that reaching goals causes positive emotion is almost a truism in the research literature on goal striving (e.g., Gollwitzer & Bargh, 1996; also Locke & Kristof, 1996). Apart from goals, reaching and surpassing other standards can likewise give rise to favorable emotions. Social comparison against others can make one feel good if one comes up superior (Festinger, 1954; Wills, 1981).

In sum, both positive and negative emotions may serve important signal functions in self-regulation. It is possible to view the feedback loop and its comparisons against standards as a purely cognitive and instrumental function, which would more or less correspond to how it operates in a room thermostat or guided missile. In humans, however, the feedback loop does not appear to be quite so dispassionate, and people feel good or bad depending on how they compare themselves against relevant standards. The thermostat example may suggest that emotion is not absolutely necessary for all feedback loop and self-regulating systems, but emotion is an integral part of the human self-regulating system.

Signaling Progress toward Goals

We have already noted that people feel good when they reach their goals and feel bad when they attend to how they have failed or fallen short. This characterization does, however, have one implication that seems incompatible with many observations. If people only felt good when they reached their goals and felt bad the rest of the time, they would presumably be quite unhappy most of the time, because successful goal achievement is at best an occasional and intermittent experience. If most of life is characterized by goal striving, then people spend most of their lives in a state of negative discrepancy—which would suggest they would be unhappy most of the time. But most research on happiness suggests that, on the contrary, people are generally happy much of the time (e.g., Argyle, 1987).

An elegant and instructive solution was proposed by Carver and Scheier (1990). They dramatically extended the role of positive affect in a way that made it much more plausible that people could spend large portions of daily life feeling good. In their account, positive emotion does not merely recognize goal achievement—it also recognizes progress toward goals and standards.

This important revision adopts a dynamic rather than static view, and as such it seems more appropriate to ongoing processes of self-regulation. A student whose goal is to graduate from college may spend 4 or 5 years in a state of not having reached that goal, but that does not condemn the student to feeling bad all that time. In contrast, the goal may actually foster positive emotions all along, at least whenever the student can feel satisfied with having made some progress toward the goal and being approximately on schedule. Negative affect would mainly arise on occasions on which the progress toward the goal is recognized as being blocked or too slow, such as when the student has to drop some courses, thereby losing some credits and necessitating extra semester to reach the goal.

Facilitating Attending to Relevant Information

Earlier we noted evidence that emotional distress can lead people to ignore relevant information, thus impairing their decision making. Research on the effects of positive emotion on decision making has yielded mixed results. However, one interpretation of the findings is that positive affect tends to facilitate self-regulation by encouraging peo-

ple to attend to relevant information, even if that information is negative (Aspinwall, 1998). Furthermore, evidence from neurological studies suggests that emotion in general may help people to pay attention to negative future consequences of their actions, improving their decision making (Bechara, 2003, 2004; but see also Shiv, Loewenstein, Bechara, Damasio, & Damasio, 2005).

Recharging a Depleted System

Building on Frederickson's (1998) "broaden and build" view of positive emotions, Tice, Baumeister, Shmueli, and Muraven (in press) conducted four experiments to demonstrate that positive emotions can recharge a depleted self-regulatory system. When people engage in any act of self-control, they may become depleted and have less self-control left for subsequent acts of self-regulation (Baumeister, Bratslavsky, Muraven, & Tice, 1998). But what recharges the system? If engaging in self-control can cause people to become depleted, is there any means of regaining self-control strength and recharging the system? There are probably multiple ways of recharging the system, and Tice et al. (2005) focused on the role of positive emotion as a means to increase self-control after depletion. In four experiments, they depleted people in a variety of ways, such as by having people suppress thoughts, learn a habit and then break it, or resist temptation to eat cookies. Depleted people were less able to engage in subsequent self-control efforts unless they were given a positive mood manipulation. Depleted people who were put in a positive mood were able to exert as much self-control on a task as were people who were not depleted. Thus, these studies suggest that one way in which emotions can affect self-control is by recharging a depleted system, to counteract the ego depletion effects of engaging in self-control. Engaging in self-control can deplete self-control strength, leading to poorer subsequent self-regulation, but positive emotions can recharge the system and increase self-control in depleted people.

Broader Context: Emotion as Feedback System

The preceding sections have suggested some important ways that emotion may serve self-regulation, such as by signaling discrepancies and recording progress (or lack of progress) in self-regulatory functions. A broader context has been proposed by Baumeister, Vohs, DeWall, and Zhang (2006), which depicts emotion as chiefly a feedback system. That approach takes issue with the widespread assumption that the main function of emotion is to cause behavior directly. Conscious emotion in particular may often be too slow to be useful as an online guide for immediate behavior. Indeed, in many cases emotional reactions develop only after the crisis or stimulating event has passed. What is the utility of feeling emotion after the fact? There are two possible and important answers.

First, retrospective emotion may facilitate learning. As Baumeister (2005) has proposed, as soon as a robot or computer finished dealing with one situation, it would turn its cognitive processing to the next event, and if humans were simply animals with computer brains, they might show the same pattern. But in a complex social world defined by language and culture, most events are susceptible to multiple interpretations. In the heat of a crisis, it may be difficult for a person to review all possible interpretations and select the right one, and thus sometimes people do the wrong thing. Learning from one's experiences and mistakes may, however, require some rumination about these different possible meanings and interpretations. A marital argument about an off-color joke that offended a neighbor at a dinner party could, for example, support multiple

lessons: Don't tell jokes; don't go to dinner parties; don't tell jokes to that particular neighbor; don't socialize with the spouse; don't tell off-color jokes in general, or that particular joke, to anyone; or even, get a new spouse. Some review of the event with various counterfactual mental simulations seems necessary to learn a useful lesson to prevent a repeat spat while not making overly drastic changes to one's life. There is some evidence that negative emotional states automatically stimulate counterfactual thinking (e.g., Roese, 1997). This pattern seems well designed to promote adaptive and beneficial learning.

Second, behavior may be guided by anticipated emotion. If full-blown emotion often arrives too late to change the course of events, the anticipation of emotion could still play a central role in guiding actions. Converging evidence from multiple sources has suggested that people often make choices and decisions based on anticipated emotional outcomes (e.g., Mellers, Schwartz, & Ritov, 1999), such as avoiding regret (for a summary, see Schwarz, 2000). Although the anticipation of possible regret can occasionally produce deviations from optimal decision making (Anderson, 2003; Krueger, Wirtz, & Miller, 2005), by and large the influence of anticipated emotion is likely to be highly beneficial.

The view of behavior as pursuing emotion rather than caused by emotion can put a more positive spin on the findings from the mood-freezing studies (reviewed earlier). Those findings (e.g., Tice et al., 2001; also Bushman, Baumeister, & Phillips, 2001) suggest that emotion does not directly cause behavior, but rather people make choices and perform actions that they expect will produce desirable emotional states. In those particular studies, decisions were compromised by the urgently felt drive to repair an acutely bad mood, but if people generally behave to bring themselves good moods, self-regulation is likely to benefit in most cases. This optimistic appraisal is especially plausible in light of the Carver and Scheier (1990) findings, which say that progress toward self-regulatory goals will yield positive emotions. Hence a main recipe for feeling good is to regulate one's behavior effectively in general.

This view also helps resolve one of the paradoxes of emotion theory, namely, the influence of guilt. Guilt has acquired a terrible reputation as senseless self-torture, and many pop psychologists cater to the widespread view that getting rid of guilt altogether would be a great boon to humankind. Yet guilt-prone people generally live well-adjusted lives and are valued members of society, whereas individuals who are immune to guilt (psychopaths) create havoc by exploiting and victimizing other people with indifferent impunity (Baumeister, 1997, 2005; Hare, 1993). Interpersonal analyses of guilt suggest that it is a powerful factor for improving interpersonal relations (Baumeister, Stillwell, & Heatherton, 1994).

Is it really necessary to torture oneself with guilt in order to be a good person? No. On the contrary, it is possible to be a highly effective, well-adjusted person who is a good relationship partner and a conscientious member of society without (hardly) ever feeling much in the way of guilt. Anticipated emotion is the key. A person with a well-developed sense of guilt can presumably anticipate which actions will lead to guilt and then avoid those actions. At most, an occasional experience of guilt, followed by scrupulous counterfactual analysis that will reveal what one did wrong and how the guilt could have been avoided, may be enough to train the system to anticipate guilt and subsequently guide behavior to avoid making similar mistakes in the future.

Some evidence that guilt functions in this way was provided by Baumeister et al. (1995), who obtained narrative accounts of transgressions that did versus did not make the person feel guilty. Although the two sets of transgressions were broadly similar in

many ways, one strong difference was that the guilty accounts were much more likely to contain a "moral" or lesson that the person had articulated, which indicates that episodes involving guilt seem to be encoded spontaneously together with conclusions about what one did wrong. They were also more likely than the other accounts to contain explicit statements that the person changed his or her behavior subsequently. Guilt thus seems to serve the first function we noted previously, namely, helping people consolidate the lessons from their misadventures, as well as the second function, which is changing behavior to avoid more episodes of guilt.

The emphasis on anticipated emotion as benefiting self-regulation puts a somewhat novel spin on the phenomenon of affective forecasting (Wilson & Gilbert, 2003). That pattern of work has shown that people typically overestimate the duration of future emotions, and it has been characterized as fallacy or shortcoming in human information processing, such as "immune neglect" (the failure to recognize the power of one's resources for recovering from misfortune). However, the overestimation of future emotion may also be highly adaptive, because in a sense it may be more useful to anticipate strong emotion than actually to feel it. Once the event is over, the emotion serves mainly to stimulate some rumination and counterfactual analysis. There is little need to go on feeling miserable for months. But anticipating that one might feel miserable for months may be crucial to enable the person to avoid making the mistake in the first place. (Overestimation in that way may help offset temporal discounting—that is, the tendency for future outcomes to have less impact on present decisions than they rationally deserve.)

CONCLUSION

This chapter has sought to appraise the impact of emotion on self-regulatory processes generally. We have presented both positive and negative effects.

On the negative side, it is well established that current emotional distress can impair self-regulation, and we suggested several mechanisms by which this may occur. People who feel emotional distress typically assign high priority to feeling better immediately, and the quest for good feelings may often entail subverting one's ongoing efforts at self-regulation (as when the dieter indulges in an eating binge in the hope of escaping from depressed feelings). Emotional states also compromise information processing, so that bad decisions may be made, such as ignoring probabilities of possible outcomes and failing to think through the potentially costly ramifications of a contemplated act. In addition, unpleasant emotions are sometimes linked to feeling bad about oneself, and thus people may seek to deconstruct or avoid self-awareness in order to reduce those emotional states—but when self-awareness is reduced, self-regulation is often compromised, insofar as monitoring oneself and one's actions is integral to effective self-regulation.

On the positive side, we think that emotion is typically vital for effective self-regulation, and this view gains some support from evidence that people who lack normal emotional responsivity suffer from several patterns indicating poor self-regulation. Emotion appears to be important to signal both success and failure at self-regulation, not merely in terms of final outcomes but also in terms of progress toward goals. Emotion can also prompt self-regulation to begin by accentuating that one's current behavior or attainments fall short of relevant standards. Emotion can stimulate learning from mistakes, and anticipated emotion can guide behavior and decision making, including encouraging people to self-regulate effectively.

There is no reason to assume that either of these lists is exhaustive. Emotion may benefit and impair self-regulation in additional ways, and further research is eagerly awaited to shed light on such processes. As just one example, research might profitably investigate whether positive emotions can have as adverse an effect on self-regulation as negative emotions have been shown to do. Recent news events have repeatedly shown celebrations over sports victories to end in tragedy, including extensive property destruction, alcohol abuse, and sometimes interpersonal violence, suggesting that positive emotion can sweep aside the normal restraints that promote civilized behavior.

The promise is considerable. Ultimately, self-regulation and emotion are two of the most ubiquitous and powerful operations in the human psyche, and neither is likely to be fully effective without the other. On the contrary, the two are deeply and multiply intertwined.

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NOTE

1. We use "distress" as an umbrella term to refer to unpleasant, upsetting, or negative moods or emotions.

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The Nonconscious Regulation of Emotion

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Emotions have long been recognized as powerful influences on human judgments and behavior, yet their function or purpose in our lives has been debated throughout intellectual history. Plato considered emotions, and affective reactions in general, to be "foolish counselors"; two millenia later leading philosophers such as Descartes continued to view emotions as afflictions that biased and obscured thought and decisions. But then came Darwin (1872), who compellingly argued for the functional and adaptive nature of emotional expression across species, followed a century later by scientific psychology, which eventually took Darwin's cue and began the experimental study of the interplay between emotion, cognition, and behavior. (For a contemporary version of Darwin's evolutionary argument, see Haidt, 2001.)

The behaviorist O. H. Mowrer (1960) was one of the first to note the important function emotions played in learning, especially in providing a "safe" internal preview or simulation of the potential consequences of the actual behavior. Herbert Simon (1967), early on in his pioneering work on human cognition and problem solving, called attention to the important role played by motivation and emotion, describing them as necessary and essential controls over cognitive processes. Motivational controls, Simon argued, were needed to prioritize the organism's activities and to provide stopping rules for goal pursuits, such as how to know when to move on from one goal to another; emotional controls were needed to provide interrupts or signals that something needs attention right now and it cannot just wait in the to-do queue. In this view, emotions are important signals about the current state of the world—to paraphrase John Lennon, emotions are what happen to us when we are busy pursuing other plans.

Carver and Scheier's (1981) seminal model of self-regulation gave emotions a formal and prominent place in the process of goal pursuit—lack of sufficient progress toward a desired goal was posited to generate negative emotions (dissatisfaction, anxiety) that gave a further prod to effort toward the goal; positive emotions (see also Carver, 2004) were said to signal that sufficient progress has been made toward the goal such that it is now safe to disengage from that goal for a time in order to pursue other important goals. In other words, progress at a goal (or lack of it) produces positive (or negative) affect, which in turn influences rate of action toward the goal. Affect or emotion in their model is a *signal* to the regulatory system to either increase or decrease effort. And similarly, but at a more chronic, lifelong level of goal pursuit, Higgins's (1987) self-discrepancy theory makes predictions of specific emotional responses to events which call to mind the gap between one's present state and one's long-term self-goals.

More recently, cognitive neuroscience researchers such as Damasio (1996), LeDoux (1996), Davidson and Irwin (1999), and Gray (2004) have documented how emotional processing is involved as a moderator or guide in all sorts of cognitive processes, such that impairment of such processing (as through stroke or other brain damage) has a profound negative impact on decision making, personality, and life quality. This domain of research too has confirmed the intimate relations between emotional and cognitive processes, such that the neural circuitry that supports affect and that which supports cognition appear to be highly interconnected.

As emotions are meant to signal us, as well as guide and shape cognitive processing, we must learn how to manage and deal with these interruptions to our ongoing goal pursuits if we want them to be successful, and not be continually distracted from them. Precisely because emotions have this capability to interrupt our ongoing goal pursuits, they inevitably create attentional and response *conflicts* that must be resolved (see McClure et al., this volume; Morsella, 2005; Oettingen, Grant, Smith, Skinner, & Gollwitzer, in press). Regulation of emotions is thus needed whenever there is a conflict between the responses suggested by the emotion and those called for by one's current goals.

NONCONSCIOUS SELF-REGULATION MECHANISMS

To date, most emotion regulation research has focused on intentional, conscious forms of regulation (Gross, 1999; see Jackson et al., 2003). However, there have been significant advances recently in the study of nonconscious forms of self-regulation (see review in Fitzsimons & Bargh, 2004), which have revealed several self-regulatory mechanisms that operate independently of conscious control. For instance, automatic evaluative processes operate immediately and unintentionally to encode nearly all incoming stimuli in terms of positive or negative valence (see Duckworth, Bargh, Garcia, & Chaiken, 2002), with this initial screening having important "downstream" consequences for approach versus avoidant behavioral predispositions (Chen & Bargh, 1999) as well as biasing further judgments in the direction of the initial, automatically supplied evaluation (Ferguson, Bargh, & Nayak, 2005). As do all nonconscious forms of self-regulation, these automatic evaluative processes keep the person adaptively tied to his or her current environment while conscious attention and thought might be elsewhere (e.g., focused on the person's current goal pursuits).

A second form of nonconscious self-regulation is afforded by automatic linkages between perceptual and behavioral representations such that perceiving another person's behavior creates the tendency to behave the same way oneself—again without intending to or being aware of this influence. This mechanism, alternatively known as the perception–behavior link within social psychology (Dijksterhuis & Bargh, 2001) and the "mirror neuron" effect in social–cognitive neuroscience (e.g., Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; see also Decety & Sommerville, 2003; Frith & Wolpert, 2004), connects us to each other through a brain mechanism designed to facilitate imitation and mimicry. Research has shown that we tend to imitate the posture, facial expressions, and bodily gestures of those with whom we interact, without intending to or being aware of doing so (Chartrand & Bargh, 1999, Study 1), and that in return such mimicry automatically fosters feelings of closeness and empathic understanding between the interaction partners (Chartrand & Bargh, 1999, Studies 2 and 3; also Lakin & Chartrand, 2003). Again, as a default mechanism or process while the conscious mind is elsewhere, the perception–behavior link keeps us on the same page with our interaction partners and help us to respond in an appropriate manner (i.e., similarly to the others we are with at the moment).

But the most relevant form of nonconscious self-regulation for current purposes is *nonconscious goal pursuit* (Bargh & Gollwitzer, 1994). According to the *automotive model* of nonconscious goal pursuit (Bargh, 1990), emotion regulation goals—like all goals—correspond to mental representations (see also Kruglanski, 1996). These are presumed to contain information as to when and how to pursue the goal, how likely one is to succeed, the value of that goal, and so on. More important for present purposes, goals as mental representations can develop automatic associations with other representations, to the extent they are active in the mind at the same time (see Hebb, 1949). Thus, if an individual chooses to pursue the same goal (e.g., to enjoy oneself) each time he or she is in a particular situation (e.g., the classroom) eventually the representations of the situation and of the goal would become automatically associated, so that activation of the former automatically causes the activation of the latter. Because representations of common situations become activated automatically themselves when we merely enter and perceive that situation, the goal too will become active at that time and begin operation, but without the person's conscious choice or knowledge.

Several studies have now shown that goals of various types and levels of abstraction can be nonconsciously activated (i.e., primed) to then guide information processing and social judgment (Chartrand & Bargh, 1996, 2002; Moskowitz, Gollwitzer, Wasel, & Schaal, 1999; Sassenberg & Moskowitz, 2004), verbal task performance (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Troetschel, 2001; Fitzsimons & Bargh, 2003), and interpersonal helping and cooperation (Bargh et al., 2001, Study 2; Fitzsimons & Bargh, 2003). One pillar of support for nonconscious emotion regulation, therefore, comes from existing evidence in support of this model of nonconscious goal pursuit. For example, unobtrusively priming participants with stimuli closely related to the goal of achievement causes them to outperform control groups on a variety of verbal tasks, and subliminal priming of the goal of cooperation caused participants to make a greater number of cooperative responses in a "commons dilemma" situation (Bargh et al., 2001, Study 2).

Critically, across these and similar experiments, the same outcomes are obtained when the goal is primed and operates nonconsciously as when participants are given the goal explicitly through task instructions (see Bargh, 2005; Chartrand & Bargh,

2004; Fitzsimons & Bargh, 2004, for reviews). Moreover, in none of these experiments are participants aware of either the activation of the goal or their pursuit of it, as indicated by systematic questioning during debriefing (as well as the frequently subliminal nature of the priming manipulation itself).

THE *A PRIORI* CASE FOR NONCONSCIOUS EMOTION REGULATION

Given that these nonconscious self-regulatory mechanisms have been established in the case of other external environmental influences, it is likely that emotions—powerful and persistent influences that they are—are also subject to nonconscious forms of regulation. It would be odd indeed if emotions constituted the one form of external influence that was *not* subject to nonconscious control. After all, they are meant to distract one from currently active goal pursuits and they can often engulf one's phenomenal field (Loewenstein & Lerner, 2002), and so we are quite frequently presented with occasions in which we need to control emotional influences if we are to stay on track and accomplish our situational objectives. And, in fact, there is evidence that infants begin to use emotion regulation strategies (such as attentional disengagement) as early as 3 months of age (Calkins, 2004; Calkins & Hill, this volume; Posner & Rothbart, 1998). Thus the sheer frequency alone of these regulatory attempts over the course of one's (early) life should culminate in their automation, according to basic, established principles of skill acquisition (see Bargh, 1996; Bargh & Chartrand, 1999).

Jackson et al. (2003) have recently called for the development of models and research methods to study the more automatic forms of emotion regulation, to complement the historical (and current) emphasis on conscious or voluntary forms. They also provide some of the early data in support of nonconscious emotion regulation: In their study, individual differences in the resting activation levels of the prefrontal cortex predicted the duration of negative affect caused by disturbing photographs, as measured by eye-blink startle magnitude, even though there were no explicit instructions to regulate emotion given to participants in this study. Ochsner, Bunge, Gross, and Gabrieli (2002) had previously shown that the same regions of the prefrontal cortex became active during conscious, intentional emotion regulation. Thus, chronic levels of activation in these regions, as measured by Jackson et al. (2003), seem to correspond to chronic—perhaps "automatic" (as the authors concluded)—emotion regulation tendencies, because participants engaged in them without being told to do so.[1]

The concept of *automaticity* is a complex one with multiple defining features (see Bargh, 1989, 1994; Moors & de Houwer, 2006; Wegner & Bargh, 1998) and cautionary tales can be told against invoking it prematurely (see Fiske, 1989, and Bargh, 1999, in the case of automatic stereotyping research). Automatic processes are characterized by their *unintentional,* relatively *effortless* (i.e., *efficient;* minimal attentional resources required) and *uncontrollable* nature and operation *outside awareness*; conscious processes are generally *intentional, controllable, effortful,* and the person is *aware* of engaging in them (see Bargh, 1994). However, these defining qualities of an automatic or conscious process do not always co-occur in an all-or-none fashion—some of the classic examples of automatic processes such as typing or driving an automobile (for experienced typists and drivers) nonetheless require an intention to be engaged in, and while stereotyping another person might well be unintentional, it is not uncontrollable (see Devine, 1989; Fiske, 1989). Thus, it is problematic to conclude that a process is automatic (conscious)

merely because it does not possess one of the features of a conscious (automatic) process.

Because of the problems inherent in the unitary concepts of automatic and conscious processing, researchers interested in automatic emotion regulation might wish to focus instead on the particular quality(ies) of most interest to them. For example, in the highly researched domain of automatic stereotyping and prejudice, the feature of special interest seems to be *intentionality*: Most research is directed at the question of whether people stereotype others even though they do not intend to do so (and perhaps even have strong intentions *not* to do so?). But to researchers of the attitude–behavior relation, it is the *efficiency* or effortlessness of how attitudes become activated by relevant stimuli that is the dimension of most interest (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Separate research methods have been developed for each of these component features (see Bargh & Chartrand, 2000; also Bargh, 2006) and some of these should prove useful to emotion researchers.

At the same time, the study of automatic emotion regulation is unlikely to be a repeat or merely a matter of applying what is already known about automaticity from cognitive or social psychology. Some of the hard-earned knowledge gained from the study of automaticity in social cognition will transfer to emotion regulation but some will not, and we would wager that emotion researchers will discover some new forms or domains of automatic and nonconscious phenomena that are unique to the case of emotion processing—just as some of the cognitive psychology research on automatic processes transferred to social psychological phenomena (e.g., stereotyping and attitude activation) but entirely new forms were discovered as well (e.g., nonconscious sources of affect, the perception–behavior link, and nonconscious goal pursuit). The past and ongoing research on automaticity in social cognition and self-regulation will likely be informative, even directive, to emotion researchers, but that research is unlikely to map perfectly onto the key concerns and phenomena of emotion research. We eagerly await the new discoveries to be made by researchers of nonconscious emotion regulatory processes in the years ahead.

GENERAL FORMS OF EMOTION REGULATION

As emotions serve important adaptive functions for the human organism, emotion regulation, if it is also to be adaptive and useful, should not be just a blanket, unconditional affair of suppressing or attenuating one's emotional reactions in all cases. Emotions are signals as to the state of the world and our place in it; it would make no sense to have an interrupt or override system that we routinely ignored. Moreover, true flexibility in responding, and adaptation to one's environment, do not always entail overriding impulses or environmentally triggered influences—to do so would be just as rigid as to always *act* on them (Gray, Shaefer, Braver, & Most, 2005). Indeed, some recent attention-based models of self-regulation have moved away from the idealization of top-down control over external influences, to a more balanced approach—one in which, "for any given context, there is an ideal balance in the allocation of top-down attention, such that an individual's goals are met but can be *flexibly modified by new information*" (MacCoon, Wallach, & Newman, 2005, p. 439; emphasis added).

True adaptation, in other words, does not only mean being able to pursue purposes independently of what is going on in the current environment (i.e., escaping stimulus control, as some models of self-regulation would have it; e.g., Mischel & Ayduk, 2004), it

also means being open to and taking advantage of the unexpected opportunities that arise. As the neuropsychologist Barkley (2004) put it, the field of mental health "tends to view impulsiveness as a problem or deficit, yet for most species that have a nervous system that learns from contingencies of reinforcement, there actually is no 'problem' of impulsiveness—it is their default state. The 'problem' posed by impulsiveness is relatively unique to humans" (p. 5).

What the existing research shows is that while there are a few general rules of emotion regulation, successful emotion regulation strategies vary as a function of one's current goals and purposes. That is, emotions tend to be regulated on the basis of whether they facilitate versus interfere with our particular ongoing goal pursuits.

Maintaining Stability and Equilibrium

One such general principle is that we need to manage our manifest variability in the eyes of others—to be seen as steady, predictable, and not likely to act suddenly, spontaneously, and unpredictably. In Tetlock's (2002) terms, we are accountable to others in our group on whom we rely for support and aid in pursuing our important life outcomes (many of which require the cooperation if not participation of others), and thus we need to manage their impression of us. Unpredictable = danger, and being *seen* as dangerous is also very dangerous to the person him- or herself. So we need to be "regular," to set within boundaries the range of reactions we might safely and reasonably have in a given situation.

Social or group *norms* serve this purpose by providing these guidelines for us within many situations. Certain emotions are appropriate in certain settings but not others; as Barker and Wright (1955) reminded us, the average person behaves very differently in a library, say, than at a football game (see also Aarts & Dijksterhuis, 2003). And to fit in and be accepted by our fellow group members, we need to respond in a similar fashion as they do to the same external events—for example, if we were grouchy or upset after the home team won, or if we were seemingly not concerned over a threat to the community or group, these would signal that our goals are not the same as the others', and this would threaten our standing within our group. Conversely, as research has shown, having the same emotional expressions or reactions as do the others in our group naturally and automatically strengthens the empathic bond between members (Chartrand & Bargh, 1999; Lakin & Chartrand, 2003).

This tendency to maintain a steady state or equilibrium, or *homeostasis,* is also emphasized in the cybernetic self-regulation model of Carver and Scheier (1981). Given this overarching goal of maintaining a steady state, emotional responses represent a break in equilibrium that should, according to the theory, automatically provoke emotion-regulatory responses.

Forgas and Ciarrochi (2002) have also argued specifically for the existence of automatic emotional homeostatic mechanisms. In their studies, either a good or a bad mood was first induced in participants, who were then asked to generate open-ended responses (e.g., complete word fragments, describe a typical male or female) that were coded for their positivity or negativity. The usual or default mood-congruency effect was shown at first in these free responses, but over time there was a spontaneous shift to mood-incongruent responses. Thus, those in a good mood shifted over time to generate negative instead of positive completions; those in a bad mood shifted over time from negative to more positive completions. Forgas and

Ciarrochi (2002) concluded that people automatically correct for mood-congruency effects over time by shifting to mood-incongruent retrieval, "apparently in an attempt to manage their moods".

Larsen and Prizmic (2005) also posit a general "equilibrium-seeking" emotion regulation goal; according to these authors we generally want "to limit the residual impact of lingering emotions and moods on subsequent behavior and experience" (p. 41) such that we not only seek escape from our bad moods but also often seek to downplay our good moods, especially under circumstances in which it might interfere with our current purposes. One such circumstance is when we expect to interact with another person, especially a stranger: Erber, Wegner, and Therriault (1996) found that people tend to regulate their mood to be neutral in preparation for social interaction, even downplaying their good moods in order to attain this neutral state.

Recently, Jostmann, Koole, van der Wulp, and Fockenberg (2005) have argued that preparation for action in general has the natural, automatic effect of moderating emotional experience. In their model, the personality trait of *action orientation* (a basic orientation toward action and change; as contrasted with *state orientation*) is associated with a tendency to regulate and moderate affective influences. In their studies, they obtained the usual or default affective priming effect on mood (using subliminal emotional faces) but only for state-orientation participants. Action-oriented participants, on the other hand, showed the same tendency toward reestablishing equilibrium as in the Forgas and Ciarrochi (2002) and Erber et al. (1996) studies—with the most negative affect following presentation of happy faces and the most positive affect after the presentation of angry faces.

Koole and Jostmann (2004) argue that such "intuitive affect regulation" serves to facilitate volitional action and higher-order goal pursuits. Note here the similarity of emotion regulation effects obtained for the chronic individual difference of action orientation in the Jostmann et al. (2005) studies and those found for the stable and chronic individual differences in resting prefrontal activation state in the Jackson et al. (2003) study described earlier. In both cases, the "chronic" participants regulated emotions more than did other participants, without being told to do so explicitly by the experimenter, and apparently without awareness of having tried to do so. These findings are consistent with what we would expect if these groups of participants had developed, over frequent use, automatic or nonconscious emotion regulation skills.[2]

However, we do not know from these observed personality differences in regulation success or *outcome* what the responsible regulatory *process* was—how, exactly, did the action-oriented or equilibrium-seeking individual accomplish the regulation? Most likely, they used one of the following strategies (but in an automated fashion) that have been identified in the case of conscious self-regulation.

SPECIFIC (CONSCIOUS) EMOTION REGULATION STRATEGIES

Emotion-regulation researchers have identified several conscious and strategic emotion-control strategies that are commonly used by people, with varying degrees of success, in order to regulate their emotional experience (see Loewenstein, this volume). Here we consider the potential of these for developing into nonconscious emotion regulation mechanisms, based on the principles of skill acquisition (essentially, frequent and consistent use over time in the same situation).

Gross (1999; Ochsner & Gross, 2004; this volume) has identified a variety of such strategies or goals that people select for purposes of moderating their emotional experience. Here we first briefly describe these strategies and then consider the possibility that these strategies could come to operate nonconsciously as well, given frequent and consistent choice of that strategy upon experience of a particular emotion (and also, perhaps, upon particular emotional or affective inputs in the absence of conscious experience of them; see Winkielman, Berridge, & Wilbarger, 2005).

Response modulation strategies involve either decreasing or suppressing emotional responses, or increasing or enhancing them, depending on how appropriate and helpful (vs. inappropriate and detrimental) the emotion is for one's current situation and purposes. For example, if at a funeral one remembers a funny story involving the dearly departed, one would most likely suppress the emotional response. Similarly, there are situations in which the enhancement of an emotional response is necessary. For example, hurricane victims waiting days for rescue workers to arrive may use their feelings of frustration and despair to enhance their visible outrage and anger in order to better gain empathy and needed assistance from others.

Attentional deployment strategies modify or redirect the focus of conscious attention in order to modify their emotions; a classic example is a small child covering his eyes during a scary stretch of a Harry Potter movie. This of course helps by cutting off the stimulus input that is driving an unwanted emotion. Distraction is another common attention deployment strategy, in which one shifts one's attention to something else in the environment or to an effortful internal mental operation (such as counting to 10 when angry).

Cognitive transformation or *reappraisal* involves recategorization of the situation or event that is producing the emotion so that its meaning or emotional significance is changed. The sports pages provide us with a real-life example of this strategy, as employed by Carlos Beltran of the New York Mets baseball team. Asked how he dealt with the intense booing and heckling visited on him by fans of his former team, the Houston Astros, he replied "I can't let it influence my play. I tried to look at it a different way. When they booed me, I tried to think they do it because they care about me. I tried to make it a positive and not a negative."

Other emotion regulation strategies that have been described in the literature are less cognitive and more behavioral in nature, such as *situation selection,* which involves seeking out or avoiding situations that one knows tends to produce certain emotional reactions (e.g., not playing music associated with a failed relationship), and *mood repair,* in which one deliberately does something fun or enjoyable, or stress-reducing such as exercising. But note that these behavioral strategies can become automated just as can the regulating cognitive processes, following the same principle of frequent and consistent use over time (Bargh & Chartrand, 1999).

These emotion regulation goals should be capable of nonconscious activation and operation to the extent the individual has employed them routinely, in a frequent and consistent manner, whenever he or she is in the given situation. Although there is little evidence yet as to whether these particular strategies do come to operate in individuals in an automatic fashion to successfully regulate emotions, this is a fledgling research area and we would not be surprised to see such evidence accumulate in the research journals over the next 5 to 10 years. For one thing, evidence does already exist that one form of emotion regulation—reappraisal of one's situation using social comparison processes (Gross, 1999)—indeed becomes able to operate in a nonconscious fashion. People engage in both upward and downward social comparison with others in order to man-

age their moods and their sense of self-worth and well-being (e.g., Aspinwall & Taylor, 1993); this strategic selection (upward vs. downward) of standards against which to compare oneself clearly constitutes an act of *reappraisal* of one's standing relative to others.

Spencer, Fein, Wolfe, Fong, and Dunn (1998) demonstrated that people tend to counter threats to their self-esteem by automatically denigrating outgroup members—those who belong to social groupings other than one's own. Their studies made use of a paradigm developed by Gilbert and Hixon (1991), in which a load on the participant's attentional capacity (via a secondary task) was found to eliminate the commonly found automatic stereotyping effect. Spencer et al. first replicated these findings, but then in an extension of the paradigm gave participants failure feedback (thus threatening their self-esteem) prior to the main task. Under these conditions, the automatic stereotyping effect reemerged, even though the person was operating under the same attentional load that Gilbert and Hixon had shown sufficient to knock out the stereotyping effect. The authors concluded that the automatic goal to restore positive feelings about oneself was so strong and efficient in operation that it was capable of overcoming the shortage of attentional resources to then denigrate minority groups (i.e., downward social comparison processes), thereby repairing their mood—despite the participants' lack of awareness that they were stereotyping anyone at all.

Some of the best early evidence for the existence of automatic emotion regulation capabilities comes from a new study by Zemack-Ruger, Bettman, and Fitzsimons (2005). These researchers subliminally primed words related either to guilt or to sadness and then assessed whether behaviors or goal pursuits appropriate for those particular emotional states were set in motion by the primes. Across four experiments, these behavioral and motivational effects were obtained—for example, guilt-primed participants showed higher self-control than those primed with sad emotion—despite no differences between conditions in consciously made ratings of emotional experience. Without the participant knowing it, then, nonconscious activation of the emotion representation triggered a nonconsciously operating goal appropriate to deal with that emotion—exactly what is called for by our hypothesis of nonconscious emotion regulation.

POTENTIAL FOR NONCONSCIOUS OPERATION

For each of the conscious emotion regulation strategies, the assumed causal sequence runs as follows: (1) the person experiences and becomes aware of the emotional state; (2) based on situational constraints as to appropriateness or advisability of expressing that emotion, as well as considerations of whether the emotion would be helpful versus harmful to one's current goal pursuits (i.e., the person's *lay theory* regarding the probable effect of the emotion on the goal pursuit; see Wilson & Brekke, 1994), the person decides whether to attempt to regulate his or her emotional state—and if so, how exactly to go about doing so; and finally (3) the person intentionally pursues that regulatory goal or strategy. These strategies would be expected to develop into nonconscious emotion regulation processes if the same strategy was chosen and pursued given the same emotional situation (i.e., the same emotion–situation complex, such as feeling anxious during the closing minutes of a college entrance exam, or experiencing elation at drawing a very winnable poker hand). With sufficient attempts at regulation, the consistently chosen regulation goal would come to be activated automatically upon the experience of that emotion in that context (see Bargh & Chartrand, 1999).

One straightforward method for testing whether these emotion regulation strategies might operate nonconsciously would be to attempt to subtly and unobtrusively prime those goals, and then present participants with relevant emotional stimuli or emotion-producing situations (see Bargh & Chartrand, 2000, for standard and easy-to-use priming methods, such as the popular "scrambled sentence test"). Goal priming has been one of the more successful research strategies thus far in the study of nonconscious self-regulation. Subliminal versions of priming manipulations can also be used later on in the research program in order to help rule out demand issues (i.e., concerns that the priming manipulation was perhaps too strong and thus telegraphed, consciously, the experimental hypothesis to the participants). If such priming of emotion regulation goals is successful in producing the same or similar effects as when the goal is pursued consciously (as through explicit experimental instructions), as research has shown is true of nonconscious self-regulatory goals in nonemotional domains, this would indicate that these goals are capable of becoming activated and then operating independently of conscious intention and guidance.

Note, however, that people often do not appreciate the actual emotional influences on their judgments, decisions, and behavior, and this lack of recognition would necessarily stand in the way of the development of a useful, successful nonconscious emotion regulation process in that case (see Wilson & Brekke, 1994). There are many strong influences on us that we do not appreciate as such (e.g., social influence attempts by authority figures, as in cognitive dissonance research), and others that concern us overmuch (e.g., subliminal advertising); thus, in order to successfully regulate our emotions we need a correct theory of the direction (facilitative vs. interfering) and strength of their effects (Wilson & Brekke, 1994). Often, however, we do not have this.

For example, Lerner, Small, and Loewenstein (2004) have demonstrated carryover effects of induced emotional states on subsequent pricing and purchasing behavior. In their paradigm, participants are induced to experience a certain emotion in the first part of the experimental session, and then its subsequent effects on judgment are assessed in what participants believe to be an unrelated experiment. These studies have shown that approach-related emotions (e.g., anger) cause participants to be willing thereafter to pay more than usual for an object (pen, coffee mug) that they do not have, and to charge more for an object they do, but participants who have recently experienced avoidance or withdrawal-related emotions (e.g., disgust) are not willing to pay much for the object and require significantly less in return to give it up. Participants in these studies typically show no awareness of how the emotion they consciously felt previously might have influenced their economic decisions, making it unlikely that these biasing effects of recent emotional experience will be successfully regulated, even by conscious regulatory attempts—much less by eventual nonconscious emotion regulation skills. As they used to say of Bob Feller's fastball, "You can't hit what you can't see."

Development of Emotion Regulation Skills

Given the importance of frequent and consistent experience in the development of nonconscious goal pursuit capabilities, we should look to the developmental literature to see how young children deal with emotions and emotional stimuli. This literature shows that from early infancy onward, each of us gets plenty of practice at regulating our emotional states, with such skills beginning to develop as early as infancy. Posner and Rothbart (1998), using brain imaging techniques to study the development of exec-

utive attention networks, found that the earliest type of regulation ability that developed in infants in response to distress was attention allocation, such as distraction, which emerges during the first year of life (see also Rothbart & Sheese, this volume). Other lines of research also support the conclusion that infants begin using attentional strategies of engagement and disengagement from the emotion-producing stimulus at 3–6 months of age, and these continue as important regulatory strategies during the preschool years (Calkins, 2004).

Self-control abilities, on the other hand, take significantly longer to develop. In their review, Posner and Rothbart (1998) concluded that successful inhibitory control does not begin to develop in children until about 3 years of age. Yet here too these skills of response inhibition and emotion suppression do emerge and become highly practiced during the preschool years, so that they become easier and less effortful—that is, increasingly automated and potentially nonconscious. Thus the basic skills necessary for nonconscious emotion regulation begin to emerge relatively early in life and would be expected to attain nonconscious operation capability by young adulthood, if not before.

Regulatory Success as a Determinant of Nonconscious Operation

As we have noted, the frequency with which a given regulatory strategy is employed is an important determinant of whether that strategy will become automated. But frequency of use is not the entire story. Although researchers have delineated the different strategies people tend to use, they also note that these strategies are not equally effective in achieving the desired aims. For example, Gross (1999) and Larsen and Prizmic (2005) have concluded from available experimental evidence that reappraisal works better than suppression or distraction at reducing emotional intensity. According to Ochsner and Gross (2004), suppression might mask the observable manifestations of emotion (such as in one's facial expression), but it does not reduce the emotional experience itself (indeed, it increases physiological responding); reappraisal, on the other hand, is effective at attenuating both the behavioral responses and the underlying emotional experience.

Does the relative success of an emotion regulation strategy matter to whether it develops into an automatic or nonconscious form of emotion regulation? There are sound theoretical and good empirical reasons that, independently of frequency of use, relative success of the regulatory strategy should also be important in the development of automatic or nonconscious emotion regulation strategies. First of all, success at a goal attempt is known to increase subsequent strength of that goal or motivation, whereas failure decreases motivational strength (e.g., Bandura, 1977; Heckhausen, 1991). Moreover, relevant to the present thesis of nonconscious emotion regulation capabilities, these same effects on subsequent motivational strength following success or failure have now been obtained when the goal was pursued nonconsciously (Chartrand & Bargh, 2002). Consistent with these ideas, Ochsner and Gross (2004), in their review of emotion regulation strategies, concluded that reappraisal is both the most successful and the most frequently used strategy.

Moreover, recent research suggests that success might have its effect on goal strength through increasing the positive affect associated with the goal representation itself; in other words, the *incentive value* of the goal. Custers and Aarts (2005) used sub-

liminal affective conditioning to implicitly link various goals with positive affect; doing so influenced how hard participants worked on the task (incentives) as well as their desire to complete the tasks. Thus, nonconsciously produced positive affect—such as that resulting from a successful act of goal pursuit—may well play a key role in the development of nonconscious emotion regulation abilities through automatically increasing the motivational strength of the emotion regulation goal.

Consistent with this prediction, Mauss, Evers, Wilhelm, and Gross (2006) have recently shown that a participant's implicit attitude toward emotion regulation itself (which can be considered as the incentive value of the goal of emotion regulation for that individual) was related both to how well the person could regulate his or her emotions in the experimental session and to how effortful the person found the attempt. The more positive the implicit affect associated with the goal of emotion regulation, the better and more automatically (efficiently; less effortfully) that goal operated for the individual.

Different Emotions, Different Strategies

It is likely that different emotions will have different strategies effective for regulating them (see Larsen & Prizmic, 2005), and thus different nonconscious regulation mechanisms associated with them. After all, different emotions serve different functions or purposes for us (Haidt, 2001; Loewenstein & Lerner, 2002), and thus it would follow that different regulatory strategies will be effective on them in turn. For example, disgust-related reactions make us tend to turn away and withdraw from the stimulus, but one can easily imagine doctors and disaster-relief workers having to develop suppression or reappraisal strategies to push on through this tendency in order to accomplish their objectives; these same folks might not regulate anger at all, as it has approach and energization qualities that might be useful under such circumstances (see Loewenstein & Lerner, 2002). The findings of Zemack-Ruger et al. (2005) discussed previously are also consistent with this reasoning; in their study subliminally presented guilt-related stimuli automatically triggered a self-control regulatory goal in their participants, whereas stimuli related to sadness did not.

CONCLUSIONS: THE POTENTIAL BENEFITS OF NONCONSCIOUS EMOTION REGULATION

The word "regulation" comes from the Latin *regula* or "rule"; thus, according to Webster's dictionary (Merriam-Webster, 2002) to regulate means "to govern or direct according to rule," or "to bring order, method, or uniformity to"—that is, to make regular. To make a process automatic upon certain conditions is the pinnacle of regularity; whenever condition *X* arises, goal or behavior *Y* is engaged. Automatic processes are much more consistent and reliable than conscious processes, for several reasons, and so nonconscious emotion regulation has the potential to be more effective than conscious regulation over the long term. Across several major domains of social psychological research—attitudes and persuasion, stereotyping and prejudice, and causal attribution—it has been shown that conscious goals are not pursued unless the person has both the motivation as well as the ability to do so. Often, the person is distracted or cognitively busy and thus fails to select the goal, or fails to notice the opportunity to do so, or just does not have the spare attentional capacity given the other things going on at the

time—there are many possible slips "twixt cup and lip" when it comes to carrying out our intentions (Heckhausen, 1991).

Therefore, to the extent that an emotion regulation goal can be triggered automatically compared to consciously, it becomes a more reliable and consistent influence on us; it can also run effectively under busy conditions that would prevent the conscious goal process from operating (see Bargh & Thein, 1985); and it can take advantage of opportunities present in the environment that might otherwise have been missed because of conscious attention being directed elsewhere at the moment, or because there is not enough time right then to decide and prepare the correct response through conscious means.

One immediate potential benefit of research into nonconscious emotion regulation, then, would be the application of the findings to the treatment of life problems that heretofore have resisted conscious regulation attempts. For example, in the field of addiction counseling and treatment, the major difficulty is the overcoming of compelling direct environmental cues that trigger the craving and the behavioral routines long associated with satisfying it. Treatments that have traditionally focused on *conscious* means of behavior change do not apparently work very well (Sayette, 2004). Perhaps it is time to meet fire with fire in the case of treating such addictions. That is, it may be that a nonconscious emotion regulatory goal could succeed where conscious regulation attempts routinely fail.

This might sound too good to be true, but evidence already exists for this very process in the case of controlling unwanted stereotype influences on judgments of others. Moskowitz et al. (1999) showed that those participants who were committed to the goal of egalitarianism—of treating people from minority groups fairly—had developed an automatic, nonconscious goal of egalitarian treatment of others. More than that, the researchers were able to show that this goal was capable of *inhibiting* automatically activated stereotypes *before* they could influence the person's judgments. Remarkably, in these egalitarian participants, the group stereotypes did become activated automatically upon presentation of group-relevant stimuli, but were immediately *deactivated* by the nonconscious goal—all within less than a second. The strongest of the unwanted influences of the stimulus environment, then, including emotional experiences, might be best met with counteracting nonconscious regulatory goals—fighting fire with fire, as it were—instead of the conscious regulatory strategies that, in many cases at least, have not proven up to the job.

In sum, then, the study of nonconscious emotion regulation is a promising new direction for research and has the potential for exciting new insights regarding the role of emotions in our lives, as well as expanding our knowledge of nonconscious self-regulatory mechanisms. The significant advances that were made in other domains when the research spotlight turned to the automatic components of the phenomenon—stereotyping and prejudice, the attitude–behavior relation, interpersonal interaction, and goal pursuit, among others—stand as a promissory note to emotion researchers today.

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NOTES

1. That participants engage in a mental process spontaneously, without being told to do so, as in the Jackson et al. (2003) study (see also Handley, Lassiter, Nickell, & Herchenroeder, 2004), is suggestive and consistent with the emotion regulation process being automatic but is not conclusive by itself (see below; also the excellent discussion of this issue by Uleman, 1989). People do many things in an experimental session without being explicitly instructed to do them, in part because of their assumptions about what the experiment is about and what is expected of them (e.g., demand effects).
2. Relevant to this point is the research program by Heckhausen, Gollwitzer, and colleagues on implemental versus deliberative mind-sets: this research has shown that it is a general feature of actional or "implemental" mind-sets (relative to "deliberative" or predecisional mind-sets), once the choice of action has been made, to deflect external impulses or suggestions for responses (e.g., priming effects), providing a kind of "tunnel vision" that keeps the person on track in pursuit of the desired goal (see Gollwitzer, 1999; Gollwitzer & Bayer, 1999).

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Emotion Regulation and Externalizing Disorders in Children and Adolescents

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Within the past two decades, the field of child development has experienced a surge of research attention on the regulation of emotion. This burgeoning literature has helped to expose the centrality of emotional processes to various aspects of healthy development (see Eisenberg, Hofer, & Vaughn, this volume) and to elucidate the interrelationships between cognitive, social, and emotional aspects of childhood (Cole, Martin, & Dennis, 2004). As this book attests, the range of scientists interested in emotion regulation is rapidly growing, yielding a better understanding of the multilevel factors that may influence our experience and expression of emotions.

Recently, investigators have begun to apply knowledge of emotion regulation to the study of psychopathology in children and adolescents. The applicability of emotion regulation research to clinical phenomena is potentially far-reaching, given the prominence of emotional disturbance in many forms of pathology. In fact, even a cursory examination of current diagnostic manuals in psychiatry reveals that emotion-related problems are central to the descriptions as well as diagnostic criteria for many if not most forms of psychopathology (American Psychiatric Association, 2000). Not only will clinical investigators and clinicians benefit from what is learned in emotion regulation research, but this research effort may be aided by a developmental psychopathology perspective in which normal and abnormal emotion regulation trajectories can be studied side by side, with the potential for mutual elucidation (Cicchetti & Cohen, 2006). That is, understanding clinical conditions in which emotion dysregulation is salient should aid in informing the field about general processes of emotion regulation.

In this chapter we examine the relationship between emotion regulation and externalizing disorders, the most common form of childhood psychopathology (Kazdin, 1995). The externalizing label is applied to numerous forms of problem behavior, ranging from hyperactivity/impulsivity and social problems to antisocial behavior and aggression. Although externalizing disorders have traditionally been conceptualized as problems of behavior and cognition rather than affect (see Quay & Hogan, 1999), these conditions are inextricably tied in with emotional processes. In fact, their very depictions include disorganized, explosive, and defiant patterns of affect and behavior, which interfere with learning, social maturation, and the rights of others (American Psychiatric Association, 2000). Thus, on the face of it, emotion and emotion regulation would appear to be centrally involved in such conditions.

Beyond face validity per se, a small but developing body of research indicates that deficits in emotion regulation may coincide with the disinhibitory problems of attention-deficit/hyperactivity disorder (ADHD) and may represent a key mechanism in the emergence of particular forms of antisocial behavior (Barkley, 1997; Olson, Sameroff, Kerr, Lopez, & Wellman, 2005; Silk, Steinberg, & Morris, 2003). A central goal for research in this area is to link normally developing processes of emotion regulation to the timing and manifestations of clinical disorders of the externalizing spectrum. Given the multiple definitions of emotion regulation in current use and given the incomplete knowledge base about the unfolding of emotion regulation strategies and processes across childhood and adolescence (Cole et al., 2004), this remains an elusive goal at present. As we emphasize throughout this chapter, it is crucial to consider specific forms of the relevant behavior patterns when examining emotional and emotion regulatory processes, as it increasingly appears that deficits in emotion regulation are relevant to some but not all forms of externalizing behavior. Because global portrayals of externalizing behavior as indicative of emotion dysregulation may obscure rather than clarify important associations, we emphasize specificity of linkages to the extent allowed by the current literature. Finally, despite considerable speculation as to the importance of emotion dysregulation for externalizing psychopathology, research in this area is of relatively recent origin, with a range of definitions and research paradigms utilized to tap emotion regulation and dysregulation. Hence, a review of basic models and research methods is in order.

MODELS OF EMOTION REGULATION AND RELATIONS WITH PSYCHOPATHOLOGY

Emotion Regulation: Definitions and Differentiations

To appreciate the developmental roots of emotion regulation, we first turn to the important area of temperament. The influential model of Rothbart defines temperament as individual differences in reactivity and self-regulation with respect to emotion, attention, and motor activity (Rothbart & Bates, 1998). This and other models of temperament posit that such response tendencies become evident extremely early in development, revealing strongly psychobiological underpinnings (at the same time, these tendencies persist throughout the lifespan and become inextricably intertwined with experience). Reactivity, in the context of emotion, refers to individual, perhaps dispositional, differences in basic emotional responsiveness to eliciting stimuli. Negative reactivity, for example, would reflect a temperamental proneness to irritability, anger, or fear in response to environmental triggers. Regulation, in contrast, would

refer to an individual's ability to modulate that reactivity through a variety of cognitive and behavioral processes. Importantly, these regulatory processes show tremendous development throughout the periods of toddlerhood, early childhood, and preadolescence.

One component of Rothbart's model, effortful control, is particularly germane to our discussion of emotion regulation (for elaboration, see Eisenberg et al., this volume; and Rothbart & Sheese, this volume). *Effortful control* represents "the ability to inhibit a dominant response in order to perform a subdominant response" (Posner & Rothbart, 2000). Consequently, effortful control is often employed to dampen emotional reactivity (Eisenberg & Spinrad, 2004). This control is achieved through the voluntary management of attentional resources, including the capacities to focus or shift attention between stimuli and to inhibit behavioral responses. In an anger-arousing situation, this process could mean shifting attention away from the source of anger (e.g., another child who has stolen one's toy) and inhibiting the dominant behavioral response (e.g., physical retaliation). Inhibiting a behavioral response is itself proposed as a core means by which all of us regulate our emotional states (Eisenberg et al., 2000). That is, refraining from a physical response to frustration may prevent emotional escalation and instead have a soothing effect.

Additional forms of emotion regulation are likely to occur through involuntary, or *reactive* forms of control (Eisenberg & Spinrad, 2004). These automatic responses to emotional stimuli may include the reorienting of attention or distraction, which can occur without conscious awareness and serve to modulate one's emotional experience and aid in the inhibition of an emotion-related behavioral response. For additional work on the complex construct of inhibition, we recommend the masterful review of Nigg (2000), which posits a number of separable forms of inhibitory processes.

Gross and Thompson (this volume) conceptualize emotion regulation as a series of processes that can be both automatic and voluntary (as well as conscious and unconscious), which may occur either before or after the activation of an emotion and which serve to amplify, maintain, or diminish its intensity. Clearly, this definition of emotion regulation embodies many of the aforementioned ideas from temperament theory. The relationship between temperament and emotion may be best expressed through a metaphor from Saarni, Campos, Camras, and Witherington (2006, p. 273): "temperament is rather like a season of the year, whereas emotions are the mercurial weather conditions that shift from day to day, demanding adjustment and accommodation on a frequent basis" (p. xx). Thus, temperament does not dictate the nature of each emotional experience but instead has a general influence on a child's ability to regulate a range of emotions. A child high in negative temperamental reactivity may well be capable of instances of positive reactivity (e.g., exuberance) but will generally respond in an angry or fearful fashion to evocative stimuli. For a more complete discussion of the complex relationship between temperament, emotions, and emotion regulation, please see Rothbart and Sheese (this volume).

Clinical research employing these concepts has typically focused on the relationship between the *dys*regulation of emotion and symptomatology associated with various disorders. Cole, Michel, and Teti (1994a) separated dysregulation into two forms—*overregulated* and *underregulated*—arguing that most forms of psychopathology result from either underregulating or overregulating the intensity or expression of particular emotions. This dichotomy (or, more likely, continuum) could potentially map onto more descriptive classifications of behavior disorders of childhood and adolescence. The most fundamental of these contains, at one anchor, *internalizing* problems (including

sadness and other indicators of depression, anxiety, social withdrawal, and somatic concerns), and at the other, *externalizing* problems (involving the focus of the current chapter, namely, disinhibited, aggressive, and antisocial behavior). Although it seems reasonable to place at least some forms of externalizing behavior at the "underregulated" end of the continuum, it is less clear whether internalizing problems truly reflect an overregulation of positively valenced emotions or an underregulation of negative emotions such as fear.

As Cole et al. (1994a) admit, this model may be oversimplifying a complex set of processes, and the concept of emotion regulation has evolved to allow more careful applications to the processes underlying psychopathology. Indeed, it is important to be mindful of the difference between an emotion and its regulation (Cole et al., 1994a; Gross & Thompson, this volume). The mere presence of sadness or anger does not in itself indicate overregulation or underregulation; these emotions have important survival value and allow us to appraise situations and act accordingly. We certainly would not want them to be regulated into nonexistence. However, as our understanding of the mechanisms behind internalizing and externalizing problems increases, it seems likely that children extreme on these behavioral dimensions will show patterns of underregulating certain emotions while overregulating others. For example, children with severe anxiety may lack the ability to effectively diminish the intensity of experienced fear while simultaneously constricting their experience of positive, approach-valenced emotions. Similarly, children in the externalizing spectrum may not underregulate all of their emotions. Yet, as we argue in the subsequent sections, children prone to reactive forms of aggression struggle to regulate their experience of emotions such as anger.

Externalizing Psychopathology: Dimensional and Categorical Perspectives

What precisely do we mean by psychopathology in the "externalizing" spectrum? When investigators in the middle of the last century began to apply factor-analytic methods to understand the nature of child behavior problems, analyzing quantitative ratings of a range of symptoms, two large factors consistently emerged: (1) problems of the internalizing spectrum and (2) externalizing problems, including impulsive and hyperactive behaviors as well as anger, defiance, aggression, and antisocial actions. A large number of factor-analytic investigations have replicated this essential distinction (e.g., Achenbach, 1991). It is noteworthy that problems related to impulse control, attentional focus, and motoric overactivity fall somewhere in between the two poles of internalizing and externalizing in broadband factor-analytic work; they typically yield dimensions of behavior that are separable from either internalizing or externalizing dimensions in finer-grained data analyses. Thus, as emphasized below, explanatory power typically increases when one separates aggression and antisocial behavior on the one hand from inattention, impulsivity, and hyperactivity on the other.

Two key points are immediately salient. First, even though internalizing and externalizing factors have usually been found to constitute orthogonal dimensions, actual samples of youth (particularly those with clinical-range problems) typically display positive associations between these two domains, which can be of substantial magnitude (Achenbach, 1991). Thus, it is a mistake to think that youngsters with externalizing problems are necessarily free of depression or anxiety—an important complication for investigations of emotion regulation (or other relevant processes) in relation to externalizing behavior patterns and a major complexity for those designing

interventions. Second, each of these broad dimensions includes a number of partially independent subdimensions. Thus, the internalizing domain can be separated into depression versus anxiety versus preoccupation with bodily pains (among others). Pertinent to this chapter, the externalizing domain comprises several important subtypes.

1. As just noted, patterns of inattention, impulsivity, and hyperactivity are statistically associated with aggression and antisocial behavior in most samples, but they diverge from these latter behaviors in important ways (Hinshaw, 1987; Waschbusch, 2002). That is, they have different patterns of risk and causal factors, with inattention/impulsivity/hyperactivity linked more to genetic and psychobiological causal influences and aggressive behavior more specifically associated with aberrant parenting and other psychosocial risks. Furthermore, they have partially distinct long-term developmental trajectories (for a review, see Hinshaw, 1999). Placing these domains together into one, large externalizing category may mask differences of clinical and conceptual importance.

2. Further differentiation is also salient. For instance, *inattention* is differentiable from *hyperactivity* and *impulsivity* (Hinshaw, 2001; Milich, Balentine, & Lynam, 2001). Inattentive behavior patterns predict academic underachievement and social isolation, whereas hyperactivity and impulsivity are more closely linked with peer rejection and with externalizing features related to aggression.

3. Crucially, the domain of aggression and antisocial behavior is not homogeneous. As summarized in Hinshaw and Lee (2003), several subareas are quite important to distinguish.

First, *overt aggression* (fights, verbal assaults, physical confrontations) is separable from both *covert* manifestations of antisocial behavior (such as theft, destruction of property, lying, and cheating) and so-called *indirect aggression*—behavior patterns that involve harming the reputation of another through talking behind his or her back or destroying reputations. This latter construct is synonymous with (but not identical to) *relational aggression,* prevalent in girls and involving malicious gossip and other means of aligning with certain peers to exclude or damage the reputation of another.

Second, within the domain of overt aggression, *verbal* versus *physical* forms are separable, displaying differing developmental trajectories and correlates. Another important distinction is made between planful, proactive aggression (which overlaps with the construct of instrumental aggression)—involving calculated means of obtaining resources important to the self—and hostile, reactive, or retaliatory aggression, which by definition features a more explosive and angry presentation, linked with frustration and threat. As we highlight subsequently, emotion regulation processes are differentially linked with this important subdivision.

So far, we have been discussing psychopathology viewed continuously, as constituting dimensions of behavior. Another tradition in psychopathology is that of categorical entities or clinical diagnoses. The debate over whether psychopathology is best characterized in terms of underlying dimensions versus distinct taxa or categories is a long and contentious one. In their incisive review, Pickles and Angold (2003) aptly point out that such perspectives are complementary rather than diametrically opposed: Depending on one's framework, psychopathology exhibits both categorical and dimensional features, much in the same way that light simultaneously exhibits both continuous (wave) and discrete (photon-related) properties.

In the categorical tradition, clinicians and investigators concerned with exter-

nalizing psychopathology have focused on the clinical disorders of ADHD as well as the disruptive behavior disorders of oppositional defiant disorder (ODD) and conduct disorder (CD). Each of these has a constituent list of symptoms, associated features, typical age of onset, and developmental course; diagnoses are assigned on the basis of developmentally extreme, pervasive, and persistent symptom patterns that yield substantial impairment (American Psychiatric Association, 2000).

Specifically, ADHD includes the two symptom domains of inattention/disorganization and hyperactivity/impulsivity. Age of onset is typically before 7 years of age. Children displaying the former pattern are diagnosed with the Inattentive subtype; they typically do not show much evidence of aggression or antisocial behavior. Children with the latter pattern constitute the Hyperactive/Impulsive type, and those with high levels of both symptom profiles (constituting the majority who are referred for assessment and treatment) are diagnosed with the Combined type. The latter two are prone to evidence noncompliant and aggressive behavior patterns (American Psychiatric Association, 2000; see also Barkley, 2003). Across all three types, the prevalence of ADHD is believed to be between 5% and 8% of the child and adolescent population, with a male:female ratio of approximately 3:1 in community samples and higher among clinic-referred youth.

Although ADHD is viewed by some social critics as a modern-day diagnosis for mildly bothersome children or a means of pathologizing normal-range behavior patterns, when the diagnosis is carefully made, children and adolescents with ADHD show substantial impairments, including marked risk for school failure and discordant family interactions, a greatly increased risk for rejection by their peers, lowered levels of independence, and surprisingly high rates of accidental injury (Barkley, 2003; Hinshaw, 2002b; Hinshaw, Sami, Treuting, Carte, & Zupan, 2002). The impairments associated with ADHD are highly likely to persist into adolescence and adulthood. Thus, ADHD is a condition mandating clinical attention; research into its underlying mechanisms is proceeding at a rapid pace.

Moving to the disruptive behavior disorders, ODD refers to a persistent pattern of rule-breaking, irritable, hostile, and noncompliant behaviors, serving as a precursor to serious antisocial behavior in perhaps a third of all cases. Emotional dyscontrol is implicit in such symptoms. CD, on the other hand, connotes a more severe category of youth who violate the rights of others or show serious rule breaking. The CD diagnosis includes a combination of overtly aggressive behaviors (e.g., fighting and assault) and covert antisocial activities (e.g., lying and cheating). Moreover, unlike ODD, the diagnostic criteria for CD do not include affective disturbance per se, although as we discuss later, affective problems may be relevant for certain individuals within this category.

An important subdivision exists for CD with respect to age of onset. That is, children who begin to display serious antisocial activities before the age of 10 years are quite likely to reveal a constellation of risk factors that include early neuropsychological difficulties, hostile and inconsistent parenting (with a strong likelihood of early patterns of insecure attachment), an extremely high male:female ratio, and a propensity for comorbidity with ADHD that begins early in development (see Moffitt, 1993). This relatively small subgroup (perhaps 2–3% of the population) is highly likely to show persistent patterns of aggression and antisocial behavior across the lifespan (Moffitt & Caspi, 2001). Indeed, a number of investigators have estimated that this subgroup may be responsible for nearly half of the criminal activity in a given society (Hinshaw & Lee, 2003). On the other hand, patterns of adolescent-onset CD are far more normative, more evenly spread between the sexes, and prone to desist following adolescence (although more lasting problems may be evident in some cases). Thus, the age of onset

of serious aggression and antisocial behavior appears to mark an important diagnostic distinction.

In our next sections, we consider the relevance of emotion and emotion regulation first for ADHD and then for conduct problems/aggression

EMOTION REGULATION AND ADHD

In his influential unifying theory of ADHD, Barkley (1997) proposed that primary deficits in behavioral inhibition would result in downstream problems with several executive functions. In brief, behavioral inhibition occurs when a child withholds a dominant response; this inhibition then allows the coming online of important executive functions such as working memory, internalization of speech (which includes problem solving and self-questioning), and—of central importance for this chapter—the regulation of affect and arousal. Theoretically, deficits in inhibitory control would interfere with motor control, resulting in the symptom of hyperactivity. They would also prevent the display of measured emotional responding and self-regulation. Thus, Barkley's clear contention is that a fundamental deficit in inhibitory control would yield disruptions to regulatory executive processes in children with ADHD. Such youth would consequently be expected to exhibit emotional reactivity, to be relatively unable to anticipate emotionally charged events (because of reduced capacity for forethought), to have problems in evaluating the impact of their actions on others in emotionally charged situations, and to have a propensity for showing low capacity to regulate their emotional states in the service of achieving a goal.

How are such inhibitory deficits to be understood in the context of effortful control (see Posner & Rothbart, 2000)? Such constructs certainly overlap, but Barkley's conception of inhibitory deficits as related to ADHD is narrower than that of most views of effortful control. The latter include not only the suppression of a prepotent response but also the voluntary allocation and shifting of attention to relevant stimuli. One of the needs of emerging and overlapping fields of research—specifically emotion regulation and developmental psychopathology—is to align definitions and paradigms so that different research efforts can build on one another.

Given the centrality of inhibitory deficits in ADHD, the prediction from Barkley's model is that poor emotion regulation should be ubiquitous in individuals with this disorder (excepting the Inattentive type, which, Barkley contends, does not exhibit the fundamental deficit in inhibition). Yet evidence is mixed, as we discuss next. One key problem is that much of the research on this topic has not accounted for the frequent association of ADHD with aggression and antisocial behavior; in categorical terms, it has not accounted for the comorbidity of ADHD with ODD or CD. As a result, emotion regulatory deficits attributed to ADHD may actually pertain to underlying patterns of aggression. Unless this diagnostic association is accounted for, results are difficult to interpret.

Consistent with Barkley's conceptualization, irritability, hostility, and emotional lability and inflexibility have all been observed as part of the clinical picture for ADHD (Barkley, 1990, 1997; Cole, Zahn-Waxler, & Smith, 1994b; Landau & Milich, 1988). However, experimental research has not yielded support for any particular pattern of ADHD-related emotional deficits. Some studies have documented higher negative and positive emotional reactivity in children with ADHD than in comparison children (Maedgen & Carlson, 2000). Evidence for impaired emotional inhibition has also been found (Walcott & Landau, 2004). Another investigation failed to find higher levels of

emotional reactivity yet did show that boys with ADHD were generally less empathic than their healthy peers—a provocative result given the importance of empathic responding for interpersonal relationships (Braaten & Rosen, 2000) and the linkages of certain temperamental and emotion regulatory patterns with the development of empathy (Rothbart & Sheese, this volume). Other studies have identified impaired emotion recognition in youth with ADHD, which is attributed to a failure to properly attend to emotional cues (Cadesky, Mota, & Schachar, 2000). In addition, levels of ADHD symptomatology have been negatively correlated with accurate identification of emotions in oneself and in others (Norvilitis, Casey, Brooklier, & Bonello, 2000). Overall, a range of emotion-related problems and deficits has been attributed to ADHD, yet each investigation within the small set of relevant studies has tended to utilize idiosyncratic methods and measures, leading to a lack of consistency across findings (see Cole et al., 2004, for a critique of this general state of affairs within research on emotion regulation).

Furthermore, with the exception of Cadesky et al. (2000), the aforementioned reports did not control for the presence of aggression or conduct problems or create subgroups to reflect the presence of these symptoms in their ADHD samples. A key investigation from our own laboratory argues that it is the presence of associated aggression that carries with it the presence of emotion regulation problems (Melnick & Hinshaw, 2000). In this report, we examined boys with ADHD with and without comorbid aggression, as well as nondiagnosed comparison boys, placing them in an experimental task in which frustration was elicited. Specifically, when interacting with his parents, each boy was given an engaging model to build, from which two key pieces had been excluded by the investigative team without prior knowledge of the family. Every boy and family in the sample noticed the missing pieces, yet great variability in subsequent responses occurred. We were particularly interested in emotional reactivity and emotion regulation.

Observational measures, coded from videotapes of the interchanges, revealed that the highly aggressive subgroup of boys with ADHD showed both higher emotional reactivity and lowered quality of emotion regulation strategies than did either the ADHD subgroup low on aggression or the comparison sample. Indeed, the latter two groups did not differ significantly on either emotional dimension. Because the ADHD subgroups were equated on levels of hyperactivity/impulsivity, we argued for a within-population distinction between children with ADHD with and without aggression (Hinshaw, 1987; Jensen, Martin, & Cantwell, 1997). That is, we claimed that high levels of emotional reactivity and problems in emotion regulation may not characterize all youth with ADHD but pertain only to the subgroup exhibiting concurrent aggression. From this admittedly oversimplified model, ADHD is characterized by problems in attention and impulse control and is linked to deficits in executive functions (e.g., planning, set maintenance, and set shifting) as well as clear problems in academic achievement, but it is not necessarily characterized by significant emotion dysregulation unless externalizing behavior patterns (particularly aggression) accompany the ADHD symptoms.

Clearly, such work requires replication. Furthermore, the observational coding of the emotion patterns, which constitute a strength of the investigation in one respect, is not ideal for inferring such internal emotion regulation strategies as cognitive reappraisal. That is, emotion comprises partially distinct aspects of facial displays, internal experiences, observable behaviors, and physiological response patterns; measuring only one or two of these channels will yield an incomplete picture of emotion or emotion

regulation. In addition, micro-observational paradigms are required to distinguish reactivity from regulation (although some models view this distinction as potentially artificial; see Gross & Thompson, this volume). Still, the noteworthy finding was that observable reactivity (which tended to be explosive in the ADHD–aggressive subgroup) and observable dysregulation (which was characterized by a failure to use soothing, coping, or distraction strategies in this group) were specific to the subgroup with comorbid ADHD and aggression.

Overall, Barkley's theoretical model of ADHD—which posits a fundamental deficit of inhibitory control leading to problems with the display of key executive functions, including regulation of affect—has placed emotion regulation as a major facet of this disorder. Symptom lists and clinical lore also attest to the ubiquity of emotional lability, explosiveness, and difficulties in "coming down" from excitable states as part and parcel of ADHD. Yet existing research has suffered from several core difficulties: (1) a lack of attention to paradigms that can differentiate emotional reactivity from emotion regulation; (2) a failure to engage in cross-modal measurement of either form of emotion; and (3) a lack of appreciation of the *specificity* of any emotion regulation deficits to ADHD per se as opposed to conditions that are frequently comorbid with this disorder, particularly the disruptive disorders of ODD or CD. The findings of Melnick and Hinshaw (2000), however, do not entirely oppose Barkley's theory, as it may be that deficits in behavioral inhibition, when of sufficient severity, are responsible for both the emotion regulation problems and the associated aggression. Nonetheless, generalization of such findings to other paradigms tapping emotion regulation, to girls with this condition, and to other comorbid conditions is essential for uncovering specificity of linkages between clinical disorders and emotion regulatory deficits (see Hinshaw, 2003; for a review). Crucial in this regard will be investigations of high-risk toddlers and preschoolers, who can be followed prospectively through developmental periods crucial to the establishment of emotion regulation and effortful control strategies.

EMOTION REGULATION AND CONDUCT PROBLEMS/AGGRESSION

Evidence continues to mount linking poor emotion regulation, and particularly negative emotional reactivity, to conduct problems in children and adolescents. Children with high levels of negative reactivity tend to display strong and consistently aversive emotional reactions to environmental events, ranging from anger and irritability to fear (Frick & Morris, 2004). Such emotions have been linked to conduct problems and aggression both cross-sectionally (Eisenberg et al., 2001; Hubbard et al., 2002; Olson et al., 2005; Shields & Cicchetti, 1998; Silk et al., 2003) and prospectively (Bates, 1991; Caspi, 2000; Eisenberg et al., 1997). Not surprisingly, negative emotional reactivity seems to play the largest role in antisocial behaviors that themselves comprise highly aroused responses to environmental stimuli (Frick & Morris, 2004).

As noted earlier, investigators have made an important distinction between aggressive acts that occur as emotionally charged, defensive reactions to perceived threat, labeled *reactive aggression*, and those that constitute unprovoked, premeditated behaviors typically meant to achieve personal gain, labeled *proactive aggression* (Price & Dodge, 1989). Not surprisingly, high negative reactivity and poor emotion regulation are associated with reactive but not proactive aggression (Hubbard et al., 2002; Shields & Cicchetti, 1998). In particular, children who consistently exhibit reactive aggressive

behaviors tend to display particular sociocognitive biases that may be linked closely with poor emotion regulation. These involve diminished capacity to attend to social cues, leading to misinterpretation and incorrect processing of social information (Crick & Dodge, 1996; Dodge & Coie, 1987). At the same time, such sociocognitive deficits tend to predict emotion dysregulation, highlighting the circular and transactional nature of emotion–cognition linkages.

Emotional arousal may also limit a child's ability to correctly evaluate potential responses to social information. Consequently, in their social interactions, reactive–aggressive children have been shown to attend selectively to signs of hostility, to take ambiguous information from social interactions and attribute hostile intentions from their peers, and to retrieve aggressive responses to perceived threat rapidly and indiscriminately (Asarnow & Callan, 1985; Crick & Dodge, 1996). Escalating displays of negative reactivity in these children are believed to contribute to their high levels of peer rejection and peer victimization, which are then likely to reinforce their hostile sociocognitive biases (Dodge, Lochman, Harnish, Bates, & Pettit, 1997). Once again, transactional patterns linking sociocognitive biases, emotion processing, and peer response characterize the developmental patterns of youth with reactive aggression.

In addition to hostile sociocognitive biases, it may simply be more difficult for a child prone to intense negative reactions to inhibit aggressive responses. In a heightened state of anger, a child is more likely to lash out at another child impulsively without considering the consequences (Hubbard et al., 2002). In fact, reactive–aggressive children exhibit more heightened physiological signs of emotional arousal than their proactive–aggressive and nonaggressive peers, suggesting that they may be "hotheaded" and physically primed for aggressive responses (Hubbard et al., 2002). It is unclear whether this arousal reflects a chronic overabundance of negative affect or a vulnerability to emotional provocation; both problems suggest the intermingling of high reactivity and low regulation. Although it might appear that reactivity would constitute the more salient dimension with respect to aggressive behavior, the intertwined nature of reactivity and regulation places a premium on paradigms that can yield more specific information on each process.

Relating to a core theme from the previous section, very little of the research on emotion dysregulation in youth prone to reactive aggression has considered comorbidity. That is, it may well be that the impulsivity characteristic of reactive–aggressive children and adolescents is most likely to occur in those who display combinations of aggression and ADHD. Once again, we caution investigators to be as specific as possible in their designations of diagnostic subgroups or associated dimensions of pathology, to prevent claims about emotion regulation–psychopathology linkages that are confounded.

Youth tending toward proactive aggression display a different sociocognitive pattern, with a proclivity for estimating considerable personal gains from aggressive behavior but failing to show the cue-reading and hostile-attribution biases characteristic of reactive–aggressive children and adolescents (for a review, see Coie & Dodge, 1998). It is therefore tempting to conclude that the sociocognitive and emotional faculties of aggressive children can be reliably distinguished based on the type of aggressive acts they tend to commit. Yet many youth referred for treatment display a combination of reactive and proactive aggression, precluding simplistic, dichotomous models.

With that caveat in mind, it appears that poor emotion regulation plays a lesser role in the commission of covert antisocial behaviors, such as stealing and lying, which are not typically characterized by heightened negative affect (Frick, O'Brien, Wootton,

& McBurnett, 1994). It may actually be the case that both proactive aggression and covert forms of antisocial behavior are characterized by *under*arousal and a lack of emotional reactivity (Lahey, Hart, Pliszka, Applegate, & McBurnett, 1993). In other words, despite the frequent overlap of multiple forms of antisocial behavior in the same individual, the dimensions encompassing planful, instrumental, and covert forms of this type of behavior may signal a more cold-blooded and less emotionally reactive style. Furthermore, in their research on antisocial children, Frick and colleagues (Barry et al., 2000; Frick, Barry, & Bodin, 2000) identified a subset of youth demonstrating callous–unemotional traits (e.g., lack of empathy, absence of guilt, and shallow emotional range), which are thought to represent precursors of the core features of classical adult psychopathy (Cleckley, 1976). Antisocial children who exhibit such a lack of emotionality tend to display more severe conduct problems than those antisocial children low on callous–unemotional traits, (Caputo, Frick, & Brodsky, 1999; Lynam, 1998; Wootton, Frick, Shelton, & Silverthorn, 1997). Research has mushroomed in the last few years on this subgroup of children and adolescents, who may be at marked risk for severe antisocial behavior later in life (see, e.g., special issue of *Journal of Abnormal Child Psychology*; Salekin & Frick, 2005).

Although this prepsychopathic, hypoemotional group of antisocial youth seem distinct from the overly reactive group described earlier, their pathways to aggressive behavior may not be entirely dissimilar. Indeed, callous–unemotional children are not only prone to covert, highly planned antisocial behaviors but are also likely engage in overt, spontaneous aggressive acts as well. In fact, disinhibition is a central feature of this psychopathic profile in children (Frick et al., 2000), just as it is a defining feature of reactive forms of aggression and just as impulsive behavior is a hallmark of adult psychopathy. Specifically, the disinhibition exhibited by children with callous–unemotional traits is characterized by low levels of fear in threatening situations and poor responsiveness to punishment cues (Frick et al., 2000; Kagan & Snidman, 1991).

Behavioral disinhibition may interact with callous–unemotional traits in a number of ways. For example, low levels of fear may result in unresponsiveness to parental discipline, ambivalence about parental or peer disapproval, and low levels of anxiety in response to one's own misbehavior (Frick et al., 2000). These factors conceivably combine to produce a child who is unafraid of being disciplined, unmotivated to behave appropriately, and unable to feel remorse for his or her misbehavior. This pattern differs from the reactive–aggressive children described earlier, who may behave aggressively in a more defensive manner due to heightened emotional reactions (e.g., anger or fear). Thus, it is possible that (1) problems with emotion regulation are characteristic of only certain types of reactive, highly aroused aggressive acts, but that (2) disinhibition represents a risk factor for reactive aggressive acts as well as those that are propelled by need for sensation seeking and a lack of particular emotions (i.e., empathy and remorse).

Although reactive–aggressive and callous–unemotional behavior patterns show disparate developmental trajectories, sociocognitive biases, and patterns of emotional dysfunction, investigations into their neurobiological bases reveal considerable overlap, at least in this early stage of research. For example, theoretical accounts of reactive aggression and psychopathy both implicate hypoactivity of the orbitofrontal cortex and amygdala (Blair, 2003; Davidson et al., 2000). The amygdala is involved in aversive conditioning (LeDoux, 1998) and may be implicated in registering and regulating expressed anger (Davidson, Putnam, & Larson, 2000). Abnormalities in this structure (or its functionality) could potentially explain both the underreactivity of psychopathic

individuals, due to a lack of fear in situations with the potential for punishment, and the dysregulated anger expressions of individuals prone to reactive aggression. Although it is difficult to derive substantive conclusions about the neuroaffective processes underlying aggressive behavior from these studies, rapid improvements in imaging techniques should ultimately provide a more nuanced understanding of these two classes of externalizing behaviors.

Overall, research on linkages between emotional processes and conduct problems/aggression is proliferating. A host of sociocognitive information-processing deficits and biases appear to characterize youth with reactive–aggressive tendencies; these are linked in transactional fashion with problems in emotion recognition and emotion regulation. Comorbidity of such children with ADHD is often, however, underexplored. Children and adolescents characterized by proactive aggression display a distinct profile of sociocognitive processes; emotion dysregulation may not pertain as readily to such youth or to the class of antisocial behavior known as covert. On the other hand, still another conceptualization of aggressive and antisocial activities, termed "callous–unemotional" and thought to be a precursor of later psychopathic tendencies, is believed to be characterized by emotional underreactivity, prompting poor response to punishment cues, and interacting with sensation-seeking tendencies to propel a pernicious course of antisocial behavior. Neurobiological studies with adults have identified anatomical and functional abnormalities in individuals prone to violent behavior but have yet to conclusively distinguish between reactively aggressive and callous–unemotional individuals. Given the exciting work occurring in this area at present, a review of the linkages between emotion regulation and conduct problems/aggression a decade from now should yield a more complete and comprehensible set of findings.

FUTURE DIRECTIONS

Space limitations preclude more than a headline review of future directions for this important area of investigation. Still, each of these points should provide for important research contributions in the coming years.

1. The emergence of risk for serious forms of externalizing behavior during infancy and toddlerhood, along with the emergence of effortful control and emotion regulation during these same developmental periods, means that prospective investigations must begin early in development. Indeed, as Tremblay (2000) has emphasized, longitudinal investigations into aggression have largely been hampered by a failure to capture the first years of life, when the origins of chronic aggression may first be evident. He argues that investigators hoping to study these complex developmental phenomena must be willing to recruit pregnant women to ensure that data collection begins in infancy, if not prenatally. This type of longitudinal design would allow documentation of the earliest displays of emotionality and regulation and enable the examination of myriad environmental factors (e.g., prenatal, perinatal, social, familial and peer-related) that may influence emotional and behavioral trajectories.

2. Relatedly, it will be vitally important to assess the complex physiological and genetic contributions to emotion regulation and externalizing psychopathology. A large and growing body of work has served to illuminate the neurological bases of aggression and other externalizing behaviors (Blair, 2004; Raine, 2002; Raine et al., 2005). Similarly, the rapidly growing field of affective neuroscience is increasingly able to provide

descriptions of the neural circuitry underlying emotion and emotion regulation (Ochsner et al., 2004; Ochsner & Gross, this volume; Davidson, Fox, & Kalin, this volume). Very little work, unfortunately, has bridged the gap between these literatures to investigate the role of basic physiological emotion processes in externalizing behaviors.

A 2000 paper by Davidson et al. did, however, make connections between research on individual differences in the physiology of emotion regulation and investigations documenting neuroanatomical and neurochemical abnormalities in individuals prone to impulsive aggression. The authors proposed that this particular type of aggressive behavior can be traced to improper function of a number of areas critically involved in the regulation of negative affect, including the orbital frontal cortex, amygdala, and the anterior cingulate cortex. Given the likelihood of substantial genetic influence on neurodevelopment, future investigations in this area will require genetically informative designs, employing multigenerational studies with twin and adoption methods. These paradigms will help distinguish the contributions of environment, genes, and the interaction between the two in the formation of both aggression, emotion regulation, and their shared neural substrates. Such investigations would benefit from the use of not only behavioral indicators but also emotion and emotion regulation paradigms.

3. The concepts of *multifinality* and *equifinality* will serve as important guides for understanding the range of developmental pathways involving emotion dysregulation. As defined by Cicchetti and Rogosch (1996), multifinality refers to the possibility of multiple developmental trajectories arising from the same original risk factor. For example, disparate outcomes characterize youth who begin life with either extremely inhibited or extremely disinhibited temperamental styles, revealing that developmental trajectories incorporate the cumulative effects of early, biologically loaded states (e.g., temperamental tendencies) with a range of environmental triggers and contexts. Similarly, early problems with emotion regulation may serve as antecedents to both internalizing and externalizing outcomes in later life, depending on a host of interactive factors and contexts.

Conversely, equifinality refers to the divergent pathways that may come to produce the same developmental outcome. For example, poor emotion regulation, poverty, violent neighborhoods, and physical abuse all represent childhood risk factors for adolescent aggression; these could work individually or jointly to yield externalizing behavior patterns. Equifinality signals that a given endstate may be the result of differing developmental processes.

In developmentally oriented investigations related to emotional processes, it will be crucial to examine the potential for both processes to be operating. In other words, (1) high emotional reactivity and poor emotion regulation may produce both internalizing and externalizing outcomes in the presence of divergent environmental triggers and contexts; and (2) divergent risk factors, including various difficulties with emotion and emotion regulation, may converge to produce aggressive behavior. Approaches that span the entire lifespan will be welcome in this endeavor (e.g., Williams, Ponesse, Schachar, Logan, & Tannock, 1999).

4. To the greatest extent possible, it will be useful for investigators to employ laboratory tasks or other paradigms that can effectively separate reactivity from regulation (see the authoritative conceptual review of Cole et al., 2004). Distinctions between these concepts are not always entirely clear; behavioral rating scales, in particular, are unlikely to provide much specificity, given the rather global nature of their constituent items as well as tendencies for adult informants to have difficulties in specifying distinct emotional or behavioral processes. Clarity may be enhanced by making greater use of

physiological measures of emotion, including indices of autonomic and neuroendocrine reactivity and coding schemes of interactive sequences of behavior that can reliably and validly tap subcomponents of emotional processing. Still, the thoughtful conceptual model of Gross and Thompson (this volume) provides caution that emotion and its regulation may not be as distinct as sometimes claimed.

5. Future investigations should address the role of environment and socialization in the genesis of emotion regulation. Emotion regulation strategies are thought to take root soon after birth, when infants learn to maintain affective homeostasis through the consistent responsivity of their caregivers (Tronick, 1989). Throughout childhood and adolescence, emotion regulation is likely to improve with cognitive and neurological development, but at the same time caregiver and peer environments undoubtedly influence the use of particular regulatory strategies (for a recent empirical investigation, see Chaplin, Cole, & Zahn-Waxler, 2005). It will be important to uncover the transactional processes that exist between dysregulated children and their parents or peers (see Campbell, 2002). For example, emotionally dysregulated children are likely to have charged negative responses to frustrating situations (e.g., being disciplined), which in turn may evoke a heightened negative response from parents, leading to further dysregulation from the child. It is a mistake to think that socialization experiences flow linearly to the development of emotion regulation, or vice versa; reciprocal and transactional processes are undoubtedly the rule.

In our own study (Melnick & Hinshaw, 2000), we found evidence to support such interlocked processes, with maternal negativity during the frustration task (i.e., negative tone, disapproval, or exasperation toward the child) predicting poor overall regulation by the child. Understanding the temporal relations between such constructs is important: For instance, do child tendencies elicit negative parenting, does faulty socialization predict emotion dysregulation, or both? Better comprehension of such dyadic exchanges could produce clinical benefits, where treatments might be designed to help parents and their children learn to mutually defuse emotional confrontations.

Finally, we highlight that many constituent processes are likely to reveal at least moderate heritability. In other words, temperamental dimensions, impulse control strategies, externalizing behavior patterns per se, and—one would assume—emotion regulatory processes all reveal genetic underpinnings, meaning that caregiver–child linkages may reflect genetic mediation as much as psychosocial transmission. Again, genetically informative designs are needed to understand the separations and linkages.

6. As our understanding of the specificity of relationships between emotion regulation and externalizing behaviors improves, it will be imperative to design treatments that foster emotion regulation skills in disordered or at-risk children (i.e., those with aggressive-spectrum externalizing problems). A particularly appealing aspect of such intervention work is that it represents one of the few instances in human research in which experimental control can occur, given the random assignment of children (or families) to various intervention conditions. Far more use needs to be made of research design and data-analytic strategies that can allow for examination of key moderator variables and mediator processes, providing answers to such questions as (1) for whom particular interventions work most effectively and (2) what processes are most relevant for producing clinically meaningful change. Hinshaw (2002a) and Kraemer, Wilson, Fairburn, and Agras (2002) provide elaboration of the potential utility of moderation and mediation to be examined in the context of experimental work on treatment and prevention.

7. Because of the higher prevalence of serious externalizing problems among boys

than girls, most of the extant literature in this area has been conducted with male samples. Thus, it is not clear whether links between poor emotion regulation and externalizing behavior (particularly reactive aggression) apply similarly to girls. Research has documented significantly lower rates of overt aggression in girls, but higher rates of relational aggression (referring, again, to means of indirectly retaliating against a peer by gossip, spreading rumors, or other means of social influence; see Hinshaw & Lee, 2003). It is unknown whether this form of aggressive behavior is associated with emotional arousal. Indeed, it is quite possible that poor emotion regulation in girls manifests in different ways than in boys, such as in depressive symptomatology (for a review, see Zahn-Waxler, 2001).

We are poorly informed, as well, to the applicability of current findings to children from diverse cultural backgrounds. A quick perusal of current literature on emotion dysregulation in children reveals the use of predominantly Caucasian, middle-class samples. Large, culturally diverse, gender-balanced samples would permit comparison of multiple emotion regulation trajectories and relationships to pathological outcomes. Raver (2004) presents an eloquent and sophisticated plea for the use of method equivalence and model equivalence tests to understand the applicability of emotion regulation strategies to diverse populations.

CONCLUSION

It is an exciting time to be working in the area of developmental psychopathology, given the convergence of information and paradigms from areas as diverse as molecular genetics and gene–environment interactions, neuroscience, socialization research, lifespan approaches, and affective science to the thorny yet fascinating issues related to the development of significant behavioral and emotional disturbances in childhood and adolescence. We agree with Cole et al. (2004) that a concerted effort to deal with key measurement issues (including separation of emotion from its regulation, attention to temporal effects and contextual factors, and convergent methods and operations) is sorely needed, particularly in the application of emotion regulation strategies to psychopathology. At the same time, careful attention to such principles as continuous versus categorical models of psychopathology, specificity of emotion and emotion regulation linkages to discrete forms of externalizing behavior, and developmentally sensitive research designs are crucial to success in these endeavors. Conceptual linkages with temperament, effortful control, and contextual factors that influence the display of externalizing behavior are clearly needed in relevant research. Externalizing problems and conditions are costly to individuals, families, communities, and society at large; the promise of approaches that bring to bear the considerable power of emotion regulatory paradigms could yield unprecedented means of gaining conceptual and clinical understanding with regard to this domain of behavior.

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Alcohol and Affect Regulation

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EMILY R. GREKIN

> Wine removes the cares pressing upon the minds of sorrowing mortals who, when filled with this juice of the grape, no longer need sleep and no longer remember their daily miseries. There is no other like cure for all their troubles.
>
> —EURIPIDES, *Bacchae* (~450 B.C.)

Historians and anthropologists have documented the prominent role of alcohol in the daily life of humans across diverse societies from the beginning of recorded history (Poznanski, 1959; Roueché, 1960). Indeed, there appears to be considerable evidence that many Neolithic cultures were well acquainted with alcohol and, writing in 1960, Berton Roueché noted that "all but three of the numerous Stone Age cultures that have survived into modern times have demonstrated an indigenous familiarity with alcohol" (p. 6). Thus, when we begin to examine the role of alcohol consumption in human behavior, we should appreciate that we are looking at a phenomenon that has been a significant part of human experience for thousands of years. In this chapter we provide an overview of research addressing two interrelated questions:

1. What are the effects of alcohol on emotion and other affective states?
2. To what extent and under what conditions do people use alcohol to regulate emotions and affect?

Toward these goals, we first consider the short- and long-term affective consequences of alcohol consumption, as well as those variables that moderate and mediate the alcohol/affect relation. We then consider relations between affective states and drinking drawing on general population surveys, comorbidity studies, experimental studies of emotion manipulation and drinking, studies of daily drinking and affect, and research on emotion and alcoholic relapse.

A GENERAL PERSPECTIVE ON THE PSYCHOPHARMACOLOGY OF ALCOHOL

Before describing the relation between alcohol consumption and various affective states, we briefly discuss some general issues regarding the pharmacology of alcohol. Specifically, we wish to highlight the fact that the term "alcohol consumption" indexes a host of variables and that, when considering the effects of alcohol consumption, a number of parameters should be considered in order to specify the types of effects that might be expected from a given dose of ethanol.

Like all drugs, the effects of alcohol tend to be dose dependent. Typically, a "dose" is defined as the amount of alcohol administered (e.g., grams of pure ethanol per kilogram body weight) or the resulting blood alcohol concentration (BAC). Moreover, the effect of alcohol on the ascending limb of the BAC curve (i.e., when BAC is rising) often differs from the effect observed when BAC is falling, even at comparable BACs. Holdstock and de Wit (1998) reviewed existing studies examining the effect of BAC limb and dose on a variety of measures. They concluded that "at high doses, and during the descending limb of the alcohol dose-response curve, ethanol typically produces sedative-like effects. However, at low doses, and during the ascending limb, ethanol often has stimulant-like effects" (Holdstock & de Wit, 1998, p. 1903). In other words, limb effects appear to be dose dependent with the descending limb associated with sedation at higher doses. Presumably, most drinkers drink for immediate (i.e., rising limb) effects which are most proximal to consumption (and associated with greater reward). Punishing, sedative effects, however, are likely to be experienced by heavier drinkers, but these are somewhat delayed. These biphasic effects set up an inherent paradox for the drinker who uses alcohol as a response modulation strategy; although alcohol can bring about short-term emotion regulation it can also have a "rebound" effect—ultimately amplifying initial negative emotions.

Beyond the pharmacological effects of alcohol, beliefs about the consequences of alcohol consumption can be an important determinant of its affective and behavioral consequences. Marlatt, Demming, and Reid (1973) were the first researchers to demonstrate that expectancy (i.e., believing one has or has not consumed alcohol) can have powerful effects on behavior. They did this by experimentally crossing expected and actual beverage content so that the pharmacological effects of alcohol, the belief that one has consumed alcohol, and their interaction could be independently estimated (i.e., a balanced placebo design). Since then, numerous studies have demonstrated the role of expectancies on both internal affective states and observable behavior. Although, overall, the effect of expectancy on mood is small, expectancy does appear to increase the incidence of illicit social behaviors, supporting the hypothesis that expectancy provides an attributional excuse to engage in desired but socially prohibited acts (see Hull & Bond, 1986, for a review). These findings suggest that nonpharmacological aspects of drinking can serve an emotion regulation function to the extent they affect appraisal or other cognitive emotion regulation strategies.

Social context also plays a role in determining the affective consequences of drinking. In general, group drinking contexts promote self-reported euphoria and other positive emotions while solitary drinking promotes sedation and dysphoria (Doty & de Wit, 1995; Pliner & Cappell, 1974; Sher, 1985; Warren & Raynes, 1972). These findings suggest that the effectiveness of alcohol consumption as an emotion regulation strategy may depend on social context, with solitary drinking (itself, an indicator of a problematic drinking) a less effective emotional regulation strategy than social drinking.

Another important consideration in the alcohol/affect relationship is the frequent coadministration of other drugs (especially nicotine but also marijuana, cocaine, caffeine, and others) (see Sher, Wood, Richardson, & Jackson, 2005). Unfortunately, relatively few laboratory-based studies in humans coadminister alcohol with other psychoactive drugs. Notably, while some alcohol/drug interactions (e.g., interactions with nicotine) appear to result in reduced levels of intoxication, others (e.g., interactions with marijuana) appear to increase intoxication (or at least impairment). In the case of cocaine, simultaneous use produces a novel metabolic by-product (cocaethylene) that appears to have psychoactive properties of its own. Given that existing literature suggests that the use of multiple substances is common and that there are important alcoholx other drug interactions (Sher et al., 2005), understanding the real-world role of alcohol in regulating emotions and other affective states may require a more extensive consideration of other drugs that are concurrently used with alcohol.

It should be emphasized that there is great individual variation in susceptibility to intoxication due to both metabolic and pharmacodynamic factors (Ramchandani, Bosron, & Li, 2001a; Ramchandani, Kwo, & Li, 2001b). Many individual-difference variables have been studied as moderators of alcohol response, including genetic variation (indexed by family history and, more recently, by allelic variation in several candidate genes), personality traits (especially those associated with disinhibition, aggression, and negative emotionality), alcohol outcome expectancies, and cognitive functioning (especially those related to executive functioning) (see recent review by Sher & Wood, 2005). For present purposes, it is reasonable to assume that there are likely to be large individual differences in alcohol effects on a range of affective states as a function of dispositional variables. Further, it is likely that these differences are partially heritable and may relate to the predisposition to use alcohol as an emotion regulation strategy. That is, the degree to which alcohol is effective in altering emotional states is an important individual difference that likely influences whether someone uses alcohol as a response-modulation strategy.

THE EFFECT OF ALCOHOL ON AFFECTIVE STATES

Despite the prominent role of alcohol in the history of humankind, formal study of the psychological effects of alcohol is a relatively recent phenomenon. The scientific footing for the study of alcohol as an emotion regulation strategy was established by Masserman and Yum (1946) who conducted experiments on alcohol and "experimental neuroses" in cats. These studies demonstrated that fear and avoidance behavior could be reduced by the administration of alcohol. A decade later, Conger (1956) proposed a "drive-reduction" theory of alcohol. This theory (which would later be renamed the tension-reduction hypothesis [TRH]) posited that alcohol reduced "drives" (i.e., emotional–physiological states) associated with avoidance. Conger's theory, strongly entrenched in Hullian learning concepts, was specific to approach–avoidance situations and has held up to empirical scrutiny reasonably well . In contrast, studies which have defined "tension" more broadly (e.g., general life stress as opposed to approach–avoidance conflict), have not always found an alcohol/tension-reduction relationship (e.g., Greeley & Oei, 1999; Sher, 1987; Stritzke, Lang, & Patrick, 1996). Throughout most of the second half of the 20th century, the TRH and related concepts such as the "self-medication" hypothesis (e.g., Khantzian, 1990) were the dominant explanations for drinking behavior and figured predominantly not only in the alcohol literature but in

more general behavioral explanations of drinking and alcoholism from both behavioral (e.g., Bandura, 1969) and psychodynamic (e.g., Khantzian, 1990) perspectives.

EFFECTS OF ALCOHOL ON EMOTIONAL STATES: DIRECT AND INDIRECT EFFECTS

The pharmacological agent, ethyl alcohol, has numerous effects on body systems, but for present purposes we restrict our discussion to brain systems that affect emotion and cognition. From a learning perspective, we can classify alcohol effects into three broad classes: (1) positive reinforcing effects (e.g., euphoric and arousing), (2) negative reinforcing effects (e.g., anxiolytic and antidepressant), and (3) punishing effects (e.g., depressant). For purposes of discussion, it is also useful to consider two broad classes of actions: (1) direct effects of alcohol on brain mechanisms controlling emotions (and on peripheral organs providing proprioceptive feedback on arousal) and (2) indirect effects of alcohol on emotions mediated via brain mechanisms regulating cognition (e.g., attention, memory, and appraisal). Although these two perspectives are not incompatible with each other, they tend to invoke different explanatory mechanisms and levels of analysis. Specifically, direct alcohol effects tend to invoke neurochemical explanations while indirect alcohol effects invoke higher-level cognitive theories.

Effects of Alcohol on Emotions: Direct Effects on Central Brain Mechanisms Underlying Various Affective States

It is sometimes said that alcohol is a "dirty drug" because it has effects on multiple, distinct neuropharmacological systems. Positively reinforcing effects of alcohol, such as euphoria and increased arousal, are thought to be largely associated with enhanced monoaminergic (e.g., dopamine and norepinephrine) and opioid peptide activity (National Institute on Alcohol Abuse and Alcoholism [NIAAA], 1997). For example, dopamine has been both directly and indirectly (i.e., neuromodulation of other neurotransmitters) implicated in the motor stimulation and euphoric effects of alcohol (Weiss & Koob, 1991). These dopamine-mediated effects have been found in both self-administration and injection studies and can be traced to ethanol-sensitive neurons in the "shell" of the nucleus accumbens (Di Chiara, 1997). The subjective experience of arousal in response to alcohol consumption has been linked to norepinephrine. Specifically, alcohol has a biphasic effect on norepinephrine; low doses of alcohol increase norepinephrine levels and alertness while high doses decrease norephinephrine levels and alertness (Fromme & D'Amico, 1999). Norepinephrine is concentrated in the locus coeruleus and may underlie the stimulant effects of low alcohol doses on the ascending limb of the blood alcohol curve (Fromme & D'Amico, 1999). Opioid peptides are also thought to partially mediate alcohol's positively reinforcing effects (Kranzler & Anton, 1994; Nevo & Hamon, 1995). Opioids have analgesic and reward properties that can lead to craving and that appear to be blocked by receptor antagonists such as naltrexone (Froehlich, 1997). While opioid neurons are found in a variety of different brain regions, those in the hypothalamus and pituitary gland may be particularly sensitive to alcohol administration (Fromme & D'Amico, 1999).

Alcohol's anxiolytic, sedative, and motor-impairing effects are thought to be mediated by alcohol's effects on the gamma-aminobutyric acid ($GABA_A$) receptor. Notably, drugs that facilitate GABA-ergic activity via their actions on subunits of the $GABA_A$

complex (e.g., benzodiazepines, alcohol, and other sedative drugs) have been shown to increase sedative and motor impairment effects in animals and to decrease passive avoidance (i.e., reduce conditioned inhibition or conflict) (Fromme & D'Amico, 1999). Moreover, drugs that act as "inverse agonists" and antagonists at the $GABA_A$ receptor have demonstrated the ability to counteract anxiolytic and impairing psychomotor effects of alcohol (Wood, Vinson, & Sher, 2001). $GABA_A$ receptors are spread throughout the brain and therefore affect multiple types of behaviors (sedation, motor impairment, anxiolysis, etc.) but $GABA_A$-mediated anxiolytic effects appear to be most associated with the distribution of the a-2 subunit in the hippocampus and cortical regions (Mohler, Fritschy, & Rudolph, 2002).

Although most rewarding effects of alcohol are thought to be centrally mediated, it is possible that some effects are mediated peripherally. For example, alcohol has been shown to have beta-blocking activity and, consequently, could reduce peripheral arousal (e.g., heart palpitation and tremor) in stressful situations, especially where physiological arousal itself creates an escalating cycle of arousal/anxiety (e.g., performance anxiety; see Sher, 1987, for a discussion of this issue). It should also be noted that one of alcohol's most punishing acute subjective effects (e.g., flushing) appears to be due to intermediary by-products of ethanol metabolism, (specifically, acetaldehyde, a toxic metabolite of alcohol), and it appears that many of the effects of acetaldehyde are manifested in the periphery.

Effects of Alcohol on Emotions: Indirect Effects Mediated via Effects on Cognitive Brain Mechanisms

A number of current theories suggest that alcohol's effects on emotion are mediated by cognition. We briefly describe three of these theories, namely Steele and Josephs's (1990) attention-allocation (or "alcohol myopia") theory, Hull's (1981) "self-awareness" theory, and Sayette's (1993a) "appraisal-disruption" theory. Common to all these theories is the recognition that the emotional effects of alcohol are highly variable, not only *between* individuals but also across time and situations *within* individuals, and that contextual effects are critical in understanding this variability. These cognitive theories place primary emphasis on the proposition that alcohol-related disruption of information processing lies at the heart of alcohol's effects on emotion.

Steele and Josephs's (1990) "alcohol myopia" theory proposes that alcohol's effects on emotion are mediated by attentional processes. Specifically, alcohol is posited to result in a narrowing of the scope of attention, limiting the ability to attend to multiple cues. Under these circumstances, only those situational cues that are most immediate and salient are likely to be attended to. As we have recently discussed (Sher & Wood, 2005; Sher et al., 2005), this hypothesis has received support across multiple domains and provides a coherent explanation as to how alcohol can lead to either an animated, euphoric, celebratory experience or to a depressive, "crying in one's beer" experience. For example, Steele and Josephs (1990) have shown that alcohol consumption followed by distracting pleasant or neutral stimuli can attenuate stress responses, but when no distraction is present, alcohol consumption either no longer reduces anxiety or produces anxiogenic effects.

Sayette's (1993a) appraisal-disruption theory proposes that alcohol disrupts the appraisal of a situation as benign or stressful by "constraining the spread of activation of information previously stored in nodes in a memory network" (Sayette, 1999, p. 260). That is, alcohol serves to diminish the elaboration and integration of new information

that typically takes place when one is confronted with a stressor. According to Sayette, this perspective predicts that stress-reducing effects should be strongest when a stressor is experienced following (rather than prior to) intoxication because disruption of appraisal is more likely. In contrast, if alcohol is consumed following a stressor, little effect should be found. Although there have only been four studies directly comparing the temporal ordering of alcohol consumption and stressor exposure, this prediction is supported by existing research (Sayette, 1993a, 1999; Sayette, Martin, Perrott, Wertz, & Hufford, 2001).

Hull's (1987) "self-awareness" theory posits that alcohol interferes with cognitive processes necessary for maintaining a self-aware state. That is, under conditions of intoxication, individuals are less able to encode the self-relevance of various threats. According to this theory, alcohol should have greatest stress-reducing effects on stressors that are self-relevant (e.g., personal failure) and in individuals who are highly self-aware. Hull (1987) reviews support for this perspective which includes data demonstrating that (1) alcohol reduces self-awareness (e.g., as indicated by lower levels of self-referential speech, poorer recall of self-relevant words) and (2) alcoholics high in dispositional self-awareness are particularly likely to relapse when they experience stressors that are self-relevant.

Based on these cognitive theories, recent research has attempted to identify mediators of the alcohol/emotion relationship. For example, Curtin, Patrick, Lang, Cacioppo, and Birbaumer (2001, p. 527) related attentional processing (using the P3 component of the event-related potential) to conditions where threat cues were presented in isolation versus divided attention (visual–motor task plus threat cues) and fear was assessed using fear-potentiated startle and response latency measures. During the divided-attention task (but not during the threat cue only condition) individuals receiving a moderately high dose of alcohol had both attenuated P3 responses and attenuated fear indices relative to the no-alcohol condition and impairments in cognitive processes seemed to account for reductions in fear responses and behavioral inhibition.

General Findings of Alcohol Effects on Emotions

Extensive research on alcohol/affect relationships has yielded numerous findings. Although there are a number of consistencies in the literature (described below), there are also numerous inconsistencies. Many of these inconsistencies are undoubtedly attributable to the myriad methodological issues surveyed previously. Others are likely due to specific aspects of experimental protocols and measures of emotion. As noted by Lang, Patrick, and Stritzke (1999), the overwhelming majority of research on alcohol and affect focuses on negative emotions (especially anxiety), in large part because many of these studies were originally motivated by the tension-reduction hypothesis. Moreover, until relatively recently, there were few standardized protocols for assessing positive emotions. Despite seeming variability in findings noted by many reviewers (e.g., Greeley & Oei, 1999; Lang et al., 1999; Sayette, 1993a; Sher, 1987; Steele & Josephs, 1990; Stritzke et al., 1996), several general conclusions can be put forward. First, the effects of alcohol on negative emotions are most clearly demonstrated when a specific, discrete stimulus is used to induce a negative emotional state (e.g., threat of harm) and when intoxicating doses of alcohol are administered. Moreover, and consistent with cognitive theories, alcohol's effects on negative emotions appear to be somewhat context dependent, at least at lower doses. (Presumably at high doses, the direct pharmacological effects are prepotent and less likely to be moderated by environmental factors.) It is

also important to note that alcohol-induced attenuation of negative emotions has been observed across multiple response domains (e.g., self-report, autonomic reactivity, facial expressions, and behavioral avoidance) (Greeley & Oei, 1999; Sher, 1987). (Although existing studies of alcohol effects on affect-modulated startle have yielded negative findings [Curtin, Lang, Patrick, & Stritzke, 1998; Stritzke, Patrick, & Lange, 1995], these studies have employed lower doses of alcohol than those associated with robust effects.) Finally, it bears reemphasizing that there are large individual differences in alcohol effects and that some of this variability appears related to risk for developing alcoholism (Newlin & Thomson, 1990; Sher, 1991; Sher & Wood, 2005), perhaps because alcohol is a more effective response modulator for some.

ALCOHOL CAN (AND PROBABLY DOES) CAUSE EMOTIONAL DYSREGULATION

A growing body of evidence suggests that alcohol use can increase underlying affective disturbance and disrupt cognitive functions important in emotional self-regulation. Support for this proposition comes from studies that find associations between alcohol use and both short- and long-term emotional change. Although the research literature tends to focus on affective changes that occur as a function of neuroadaptation to alcohol (e.g., see discussion of allostasis below), the recursive model described by Gross and Thompson (this volume) suggests that the consequences of intoxication can have profound effects on emotion. That is, intoxication-related behavioral acts can elicit negative reactions from others as well as from the self (e.g., regret over violating self-standards or embarrassment or shame over a public transgression), leading to negative affective consequences.

Short-Term Affective Dysregulation

Although alcohol consumption is presumably motivated by the acute positively and negatively reinforcing effects of alcohol, indulgence can also lead to punishment in the form of hangover. Hangover is an acute condition marked by dysphoria, including anxiety, depression, and a range of somatic symptoms (headache, fatigue, sleep disturbance, etc.; Slutske, Piasecki, & Hunt-Carter, 2003). Hangover is a well-known state to many drinkers and represents short-term perturbations in affective state that often follow alcohol consumption. These short-term changes may have important consequences for the drinker. Indeed, it is assumed that postconsumption dysphoria can motivate relief drinking (i.e., "hair of the dog") and that such a process can be significant in the etiology of alcohol use disorders (Piasecki, Sher, Slutske, & Jackson, 2005).

Long-Term Affective Dysregulation

Although short-term rebound effects from drinking, such as hangover, may be common, they are often isolated incidents in social drinkers. In contrast, heavy, chronic drinkers often experience a range of persistent changes relevant to emotional functioning. First, alcohol withdrawal symptoms are strongly associated with affective disturbance, primarily anxiety (e.g., Sellers, Sullivan, Somer, & Sykora, 1991) potentially setting up a vicious cycle whereby chronic, heavy alcohol use leads to affective disturbance which then motivates further drinking. Second, some forms of anxiety and mood disor-

ders appear to be "alcohol induced" and differential diagnosis of substance-induced mood disorders is considered critical for nosology and treatment (American Psychiatric Association, 1994, 2000; Schuckit, 1994). Anxiety and mood disorders that remit spontaneously after a short period (less than a month) of abstinence and that only appear in the context of ongoing substance use should be considered substance induced and not "independent." Third, even ostensible "independent" anxiety and mood disorders often appear to temporally follow the occurrence of an alcohol use disorder (and this is especially true in the case of depression, Kessler et al., 1997). For example, in a multinational pool of five epidemiological studies (Merikangas et al., 1996), it was found that among those with co-occurring alcohol dependence and depression, 20% reported that the onset of the disorders occurred together, 38% reported that depression came first, and 42% reported that alcohol dependence came first (the study did not compare order of onset for anxiety disorders and alcohol dependence).

Notably, these epidemiological studies assume the accuracy of retrospective symptom reporting when trying to sequence disorders that may have been experienced decades earlier. Moreover, there can be co-occurrence between alcohol consumption and minor symptomatology prior to any formal symptom onset and many symptoms (e.g., tolerance to alcohol and worry) can have insidious onsets and be difficult to date. Unfortunately, few prospective studies of alcohol use disorder (AUD) comorbidity exist to help unravel the direction of effect. Those studies that do exist typically cover early periods of development (e.g., Costello, Erkanli, Federman, & Angold, 1999), when AUD symptomatology has not yet occurred, or begin later in development (e.g., Kushner, Sher, & Erickson, 1999) when extensive symptomatology is already in place. Moreover, Costello et al. (1999) found that comorbidity processes can begin in childhood, further highlighting the difficulty of disentangling cause and effect using retrospective reports in adults. Nevertheless, existing data do suggest that a prior diagnosis of alcohol dependence predicts both onset and persistence of anxiety disorders (Kushner et al., 1999). However, even well-conducted prospective studies beginning early in development are not capable of disentangling the direction of effect between alcohol involvement and psychiatric symptomatology as it is possible that third variables such as a common genetic diathesis influence both alcohol involvement and comorbid anxiety and mood disorders.

Putative Mechanisms of Alcohol-Induced Chronic Affective Changes

Several alternative mechanisms can be used to explain alcohol-related changes in emotional functioning. Chronic adaptation to alcohol can result in neuropharmacological changes associated with anxiety and depression. Typically, these chronic effects are the opposite of acute effects. For example, acute effects of ethanol are associated with increased GABA-ergic activity and anxiety reduction while chronic effects are associated with decreased GABA-ergic activity and heightened anxiety. In addition, acute alcohol effects are associated with increased dopaminergic and opioid activity and associated heightened reward while chronic effects are associated with decreased dopaminergic and opioid activity and associated dysphoria and/or anhedonia (see Fromme & D'Amico, 1999).

A general perspective on changes associated with the chronic use of various drugs of abuse is termed "allostasis." Allostasis refers to adaptive homeostatic changes that occur in response to repeated drug challenges (e.g., Koob & LeMoal, 2001). According

to this theory, an organism responds to drug challenges by producing counter-directional (i.e., homeostatic) responses that increase over time. Allostasis explains the phenomenon of acquired tolerance, the tendency for a given dose of a drug to elicit progressively less response over time as proposed by Solomon and Corbit (1974) in their opponent-process theory and Siegel and colleagues (e.g., Siegel, Baptista, Kim, McDonald, & Weise-Kelly, 2000) in their Pavlovian account of tolerance development. However, the allostatic perspective goes further than opponent process and Pavlovian perspectives on tolerance that appear to assume a homeostatic or hedonic setpoint that the organism maintains over time, only intermittently perturbed by acute alcohol consumption. Specifically, the allostatic perspective posits that repeated homeostatic challenges present an adaptive burden and result in a shift of "setpoint" in the direction of the opponent process. Theoretically, such a process could explain intermediate- to long-term deviations in tonic mood, resulting in a more depressed and/or anxious alcohol-dependent person. Such a perspective is also consistent with the general principle that acute and chronic effects of alcohol are opposite in direction with respect to both neuropharmacological effects and their behavioral correlates.

An alternative, but not necessarily contradictory, approach describes the toxic effects of alcohol on neurocognitive functions important for self-regulation. Although alcohol-induced cognitive deficits are most associated with severe alcohol dependence, it has become increasingly clear that there is a monotonic dose–response relation between alcohol intake and neurocognitive functioning (Parsons, 1998) that can be observed at alcohol doses of 21 or more drinks per week (on average). Moreover, recent clinical data from humans and experimental data from rodents suggest that adolescence is a period of exquisite sensitivity to alcohol's effect on the brain (Monti et al., 2005). The importance of such neurocognitive compromise in emotion regulation is not yet clear. However, some types of deficits observed in humans (e.g., verbal, problem solving, and semantic memory skills) may be important in emotional self-regulation to the extent they relate to appraisal processes and other cognitive regulatory strategies.

A developmental perspective on adolescent alcohol use disorders suggests yet another, more speculative, possibility: that heavy alcohol involvement during this period of life preempts the developmental opportunities for learning various, affect-regulating, emotional-cognitive strategies. For example, alcohol consumption motivated by an acute interpersonal challenge can serve to reduce distress but can preclude the learning of more adaptive emotional regulation strategies. Such a perspective is consistent with the one proposed by Baumrind and Moselle (1985) for understanding the social–developmental consequences of adolescent substance use.

In summary, existing theories of the effects of alcohol on emotions typically view alcohol consumption as an emotional regulation strategy that serves to bring about a desired emotional state. At the same time, however, heavy alcohol consumption has chronic effects on affect and cognition that could, paradoxically, create more emotional dysregulation. Indeed, this may represent a core, pathological process in the development of severe alcohol dependence. Although these emotional changes induced by chronic consumption are presumably due to neuropharmacological changes in the brain, alcohol intoxication can lead to behavior culminating in a range of major life stressors. Such stressors (e.g., social rejection, job loss, legal problems, health problems, and humiliation) can also lead to affective disturbance. From a developmental perspective, preemption of normal social learning when alcohol is overused as an emotion regulation strategy is an additional mechanism to consider when considering the potential harm associated with heavy alcohol involvement in adolescence.

THE EFFECT OF EMOTIONAL STATES ON DRINKING

It is one thing to demonstrate that alcohol can alter emotions and other affective states. It is another to demonstrate that people (or animals) will use alcohol strategically to regulate emotions. To address this issue, we consider field surveys of alcohol and emotion, laboratory studies of stress-induced drinking, comorbidity between alcohol dependence and "emotional" disorders, studies examining the structure and correlates of alcohol outcome expectancies and "reasons for drinking," daily diary studies of mood and alcohol consumption, and studies of relapse in alcohol dependence.

Field Surveys of Drinking and Emotions

Field surveys of alcohol and emotions have produced mixed results. While some cross-sectional studies have found significant positive associations between various measures of "stress" and alcohol consumption and misuse (e.g., Aseltine & Gore, 2000; Cooper, Russell, Skinner, Frone, & Mudar, 1992), others have found small or nonexistent relationships (e.g., Rohsenow, 1982; Cahalan & Room, 1974). It is important to note that field studies are correlational in nature and therefore do not permit causal interpretations. For example, some research suggests that much of the alcohol/stressful event relationship can be attributed to aversive events that directly result from drinking (e.g., losing a job due to alcohol use; Hart & Fazaa, 2004). It should also be noted that several field studies have found relationships between stress and alcohol problems but not between stress and alcohol consumption (McCreary & Sadava, 2000), suggesting that tension-reduction drinking may be most relevant for pathological alcohol users. In addition, some research suggests that individual differences may mediate or moderate the stress/drinking relationship. For example, alcohol consumption appears to be more strongly related to stress among adolescents (e.g., Aseltine & Gore, 2000) than among older adults (e.g., Welte & Mirand).

Laboratory Studies of Emotion-Induced Drinking

Despite extensive experimental research on alcohol and emotion, few studies have examined the relationship between induced emotion and subsequent, ad lib drinking. In measuring *ad lib drinking,* one of two alternative contexts is typically used: (1) a totally unstructured drinking situation where participants have alcohol available to them if they wish to consume it, or (2) an unobtrusive "taste rating" task where participants are asked to rate a selection of different alcoholic beverages on various taste dimensions and consume as much as they need to in order to complete the task. Although somewhat constrained and artificial, studies of *ad lib* drinking can provide useful insights into the nature of different challenges that promote or inhibit alcohol consumption.

Most of the experimental research on affect-induced drinking suggests that individuals consume higher levels of alcohol when they anticipate a negative experience and when there are few alternative ways to cope with the experience. For example, Pelham et al. (1997) found that adult subjects who interacted with a deviant child confederate consumed significantly more alcohol than adult subjects who interacted with a non-deviant child confederate. Similarly, Kidorf and Lang (1999) found increases in alcohol consumption among undergraduate subjects who were asked to make videotaped

speeches about their faults. This finding was especially strong for subjects high in trait anxiety and men who expected alcohol to increase social assertiveness. Other laboratory studies have found increases in alcohol consumption following such diverse stressors as difficult or unsolvable intellectual tasks, public speaking criticism, interpersonal evaluation, and failure feedback (Sher, 1987).

Although most laboratory research on stress-induced drinking assumes that drinking is motivated by the pharmacological properties of alcohol (sedative effects, etc.), other studies suggest that individuals drink before stressful tasks to create an excuse for potential failure, that is, for self-presentation reasons (i.e., self-handicapping; Jones & Berglas, 1978). For example, Tucker, Vuchinich, and Sobell (1981) administered either a solvable or an unsolvable test to college students who were then offered alcohol and told that they would be given a second test of equal or greater difficulty. Subjects who took the unsolvable test chose to drink more alcohol (i.e., to self-handicap) than subjects who took the solvable test, regardless of upcoming test difficulty. Notably, self-handicapping behavior decreased significantly when students were offered a performance-enhancing option (a study manual). Thus, it appears that participants chose to drink/self-handicap only when they did not have ways to improve future performance. From this perspective, alcohol consumption can represent either a cognitive strategy or a type of situational modification, where interpersonal expectations are altered by redefining the social context as more permissive than it otherwise might be.

As suggested earlier, the degree to which a stimulus will elicit drinking appears to be partially determined by the availability of alternative emotion regulation strategies. This finding may be particularly important in that alcohol consumption can lead to cognitive impairment and may disrupt attempts to cope effectively. The coping opportunities that might mitigate the occurrence of emotion-induced drinking are diverse, ranging from the opportunity to retaliate against an aggressor to reducing physiological arousal through relaxation to preparing oneself appropriately for the demands of a challenging task (Sher, 1987). That is, the "opportunity for coping" appears to be a general finding, replicable across experimental demands and types of coping/emotion-regulating activities. Thus, although individuals will use alcohol consumption as an emotion regulation strategy, other emotion regulation strategies (including other response-modulation strategies) may be preferred and used more often, even in those people who are willing to drink for emotion regulation reasons.

We note that there has been relatively little experimental research on the effects of positive emotions on alcohol consumption. This is unfortunate because individuals in our culture frequently report drinking for social and celebratory reasons. Notably, however, Gabel, Noel, Keane and Lisman (1980) found greater alcohol consumption following exposure to erotic, as opposed to neutral or negatively valenced, slides. In addition, two studies which found *decreased* drinking following social-evaluative stress (Holroyd, 1978; Pihl & Yankovsky, 1979) were based on comparisons to an esteem-enhancing (not neutral) control condition, suggesting that positive mood states may motivate drinking as much as negative mood states.

Comorbidity between Alcohol Dependence and Mood and Anxiety Disorders

It is widely believed that individuals with primary psychiatric disorders often drink to excess in order to cope with psychological distress, self-regulating their psychic suffering via alcohol (i.e., "self-medication"). Notably, several population-based, nationally

representative studies support this hypothesis. For example, in the National Comorbidity Survey, Kessler et al. (1997) found that a prior lifetime anxiety or mood disorder substantially increased the likelihood of developing alcohol dependence, and this likelihood was greatly magnified for individuals with both anxiety and mood disorders. Specifically, for men/women, the odds ratio for developing alcohol dependence was 1.85/2.23 given a prior anxiety disorder alone, 1.83/2.72 given a prior mood disorder alone, 4.02/9.11 given a prior anxiety disorder + prior mood disorder, and 13.70/21.57 given a prior anxiety disorder + prior mood disorder + prior antisociality. Similarly, in the National Epidemiological Survey on Alcohol and Related Conditions (NESARC), Grant et al. (2004) found a moderate to strong association between alcohol dependence and affective disorders (odds ratios of 4.1 and 2.6 for "independent" [not alcohol-induced] mood and anxiety disorders, respectively) using past-year diagnoses. These data indicate that increasing levels of affective disturbance (especially when coupled with the high disinhibition associated with antisociality) are correlated with an increased likelihood of becoming alcohol dependent. Thus, mood and anxiety disorders may play an etiological role in the development of some forms of alcohol dependence.

Self-Reported Alcohol Motivations: Reasons for Drinking and Alcohol Outcome Expectancies

In contrast to psychiatric epidemiological studies that show robust associations between affective disorders and alcohol dependence, surveys of nonclinical samples typically show small, null, or negative correlations between drinking behavior and a range of trait and state markers of anxiety and depression (e.g., Greeley & Oei, 1999; Sher, 1987). This disjunction between clinical correlations (alcohol dependence with psychiatric disorders) and nonclinical correlations (drinking with anxiety, depression, neuroticism) suggests that affective disturbance needs to be extreme before it increases the risk of alcohol misuse (perhaps, so extreme as to overwhelm normal emotion regulation strategies). Despite this, it is clear that affect-based reasons for drinking are strongly associated with both alcohol consumption and alcohol problems in the general population (e.g., Cahalan, Cisin, & Crossley, 1969; Cooper, Frone, Russell, & Mudar, 1995). That is, individuals who report that they drink for emotional relief or to free themselves of their worries tend to consume alcohol heavily and to experience alcohol-related problems.

Reasons for drinking are clearly multidimensional. For example, Cooper (1994) found that a four-factor solution best described the structure of drinking motives with factors for (1) social reasons (e.g., "to be sociable"), (2) enhancement motives (e.g., "to get high," "because it's fun"), (3) coping motives (e.g., "to forget your worries," "because it helps when you feel depressed or nervous"), and (4) conformity motives (e.g., "to fit in"). Notably, enhancement and coping motives (but not social or conformity motives) were strongly associated with drinking, heavy drinking, and drinking problems. In a later study using population-based samples of adolescents and adults, Cooper et al. (1995) again found that the strongest predictors of drinking problems were enhancement and coping motives (although enhancement motives were more strongly associated with alcohol use). Notably, however, coping motives had a direct effect on alcohol problems, while the entire association between enhancement motives and drinking problems was mediated by alcohol use (i.e., there was no direct effect). These data suggest that drinking to regulate negative emotions is likely the strongest motivational correlate of problematic alcohol involvement.

A concept closely related to "reasons for drinking" is self-reported, alcohol outcome expectancies. Alcohol outcome expectancies can be defined as beliefs that people have about the affective, cognitive, and behavioral effects of drinking alcohol (Goldman, Brown, & Christiansen, 1987). Varying psychometric methods (e.g., exploratory and confirmatory factor analysis and multidimensional scaling) have been employed in the development of self-report expectancy measures designed to assess particular types of beliefs about drinking and to examine their relations with alcohol use and problems. Although the specific content of empirically derived factors varies across methods and measures, factors related to tension reduction, social and/or sexual facilitation, and enhanced cognitive or motor performance have been replicated across studies. Goldman, Del Boca, and Darkes (1999) suggest that outcome expectancies can be categorized along three basic dimensions: (1) positive versus negative expected outcomes (e.g., increased sociability vs. increased aggressiveness); (2) positive versus negative reinforcement (e.g., social facilitation vs. tension reduction); and (3) arousal versus sedation (e.g., stimulant vs. depressant effects).

Cross-sectional studies have consistently found associations between alcohol expectancies and both drinking behavior and drinking problems using diverse samples and methods. These studies suggest that drinking behavior is positively associated with positive outcome expectancies and negatively associated with negative outcome expectancies both cross-sectionally and prospectively. Moreover, these associations are robust across a variety of drinking patterns and remain significant (although weaker) after controlling for demographics and previous drinking behavior (Carey, 1995; Jones, Corbin, & Fromme, 2001). Outcome expectancies tend to develop in childhood (e.g., Anderson, Schweinsburg, Paulus, Brown, & Tapert, 2005), strengthen during adolescence (Smith, Goldman, Greenbaum, & Christiansen, 1995), and weaken during early adulthood (presumably, following extended experience with drinking; Sher, Wood, Wood, & Raskin, 1996).

While cross-sectional and longitudinal studies suggest expectancy/alcohol use associations, they do not imply causal relationships. Recent laboratory studies have addressed this issue by experimentally manipulating expectancies and observing subsequent changes in drinking behavior. For example, Roehrich and Goldman (1995) found that female undergraduates who had been primed with either alcohol-related words or an alcohol-related video drank significantly more beer in an ad lib "taste test" than undergraduates who were primed with neutral words or videos. Similarly, Carter, McNair, Corbin, and Black (1998) found that college students who were primed with positive, expectancy-related words (e.g., "confident" and "funny") drank significantly more than control subjects (primed with neutral words) while students who were primed with negative expectancy-related words (e.g.,"sick" and "dizzy") drank significantly less than control subjects in a beer-tasting test. In a slightly different type of study, Sharkansky and Finn (1998) found that subjects who were told that alcohol would impair their performance on an impending cognitive task chose to drink less than subjects who believed that alcohol would not affect their performance. Other experimental studies have yielded similar results (e.g., Stein, Goldman, & Del Boca, 2000). Current research is increasingly focusing on the relation of expectancies to more distal risk factors such as genetics (Prescott, Cross, Kuhn, Horn, & Kendler, 2004; Slutske et al., 2002) and personality (Anderson et al., 2005; Finn, Bobova, Wehner, Fargo, & Rickert, 2005; Sher et al., 1991), based on the hypothesis that expectancies represent a common final pathway of diverse biopsychosocial influences on alcohol use and misuse (Goldman, Darkes, & Del Boca, 1999; Sher, 1991).

Daily Diary Studies

Most survey studies of alcohol and affective phenomena are cross-sectional and rely on retrospective reports of both affective states and drinking. These studies are problematic for several reasons. First, retrospective studies are subject to reporting biases that may be especially pronounced for events that occur under the influence of alcohol. Second, while cross-sectional studies correlate average levels of drinking with average levels of emotion, they do not address within-person, drinking/mood relationships. Thus, these studies cannot examine alcohol/emotion associations on an incident-by-incident basis or examine whether individuals drink more on days that they feel stress or sadness (Carney, Armeli, Tennen, Affleck, & O'Neil, 2000). Finally, cross-sectional studies do not address questions about the temporal order of cause-and-effect relationships. Specifically, it is unclear whether the emotion or other affect of interest precedes or follows alcohol consumption. Although prospective panel studies resolve this issue to some degree, they fail to address shorter-term, dynamic associations between drinking and emotion that may change over the course of minutes or hours

In contrast, daily diary and ecological momentary assessment (EMA) studies allow researchers to examine continually changing behaviors while using naturalistic conditions and minimizing retrospection bias. In daily diary studies, participants are instructed to record events or feelings that occurred during the day on structured nightly recording forms. In EMA studies, subjects are prompted several times per day to record feelings or behaviors (e.g., drinking or affect), in real time, on electronic devices, such as palmtop computers. To date, there have been relatively few daily diary/EMA studies of drinking and emotional regulation. Those studies that do exist suggest that alcohol consumption is associated with both positive and negative affective states (Swendsen et al., 2000; Hussong, Hicks, Levy, & Curran, 2001; Carney et al., 2000; Armeli, Tennen, Affleck, & Kranzler, 2000b; Steptoe & Wardle, 1999; Armeli, Carney, Tennen, Affleck, & O'Neill, 2000a; Mohr et al., 2001; Todd, Armeli, Tennen, Carney, & Affleck, 2003). In addition, these studies suggest that alcohol consumption tends to both precede and follow strong emotion (Swendsen et al., 2000; Hussong et al., 2001).

Critically, affect is not related to alcohol consumption in all individuals. For example, some studies have found that relationships between negative emotion and alcohol consumption are stronger for men than for women (Swendsen et al., 2000; Armeli et al., 2000a). Other studies suggest that both drinking context (Mohr et al., 2001; Armeli et al., 2003) and neuroticism moderate the affect/alcohol use relationship (Carney et al., 2000; Armeli et al., 2003). Unfortunately, these types of moderator studies are rare and their results tend to be contradictory. On the whole, however, diary studies indicate that some individuals use alcohol to regulate emotions but that this phenomenon is dependent on situational and dispositional factors. Several research teams are currently attempting to characterize the joint influence of emotional, situational, and individual difference variables that bound this phenomenon

Relapse, Cue Exposure, and Emotion

Research on emotional states and alcoholic relapse dates back to the seminal work of Marlatt and Gordon who, in the early 1970s, created a five-category typology of reasons for alcohol relapse based on responses from 65 alcoholic patients. Specifically, Marlatt and Gordon (1980) found that self-reported relapse was often attributed to (1) frustration, (2) social pressure, (3) intrapersonal temptation, (4) negative emotional states, or

(5) other miscellaneous triggers. Though not consistently replicated (Longabaugh, Rubin, Stout & Zywiak, 1997) Marlatt and Gordon's (1980) work was notable in that it highlighted the importance of situational and emotional factors in predicting relapse and helped broaden the field from one that was exclusively disease focused (i.e., relapse as a response to craving and physiological withdrawal) to one in which relapse was conceptualized as the result of psychological, environmental, and physiological factors and where emotions play a prominent role. Since Marlatt and Gordon's (1980) original publication, numerous prospective and retrospective studies have documented associations between psychological distress and alcoholic relapse (Curran, Kirchner, Worley, Rookey, & Booth, 2002; Flynn, Walton, Curran, Blow, & Knutzen, 2004; Cornelius et al., 2003; Miller, Westerberg, Harris, & Tonigan, 1996; Hodgins, el-Guebaly, & Armstrong, 1995). These studies have found associations between relapse and both pretreatment (Curran et al., 2002) and posttreatment (Curran & Booth, 1999; Flynn et al., 2004) psychological distress. For example, Curran et al. (2002) found that outpatient addictions clients with severe depressive symptomatology were significantly more likely to prematurely terminate treatment than were outpatient addictions clients without depressive symptomatology. Moreover, other studies have found positive associations between emotional distress and temptation to drink (Velasquez, Carbonari, & DiClemente, 1999). In addition, recent data suggest that reductions in psychological distress during treatment predict better posttreatment substance use outcomes (Long, Williams, Midgley, & Hollin, 2000).

Laboratory studies of cue exposure have also found associations between negative mood induction and desire to drink. For example, Litt, Cooney, Kadden, and Guapp (1990) induced both negative and neutral moods in alcoholic inpatients over a period of 4 days using a hypnotic mood-induction technique. Results showed that "desire to drink" ratings were higher following negative, as opposed to neutral, moods. Other studies have yielded similar findings among inpatient alcoholics (Cooney, Litt, Morse, Bauer, & Guapp, 1997; Payne et al., 1992) and nonalcoholic heavy drinkers (Zack, Poulos, Fragopoulos, & MacLeod, 2003).

Another body of literature suggests that various affective states may interact with alcohol cues to increase risk for relapse. For example, Greeley, Swift, and Heather (1992) found that scores on the Depression Adjective Checklist predicted desire to drink in the presence of alcohol cues (exposure to an alcoholic drink) but not in the presence of neutral cues (exposure to a nonalcoholic drink). Similarly, Rubonis et al. (1994) found that desire to drink in response to alcohol cues was exacerbated by negative mood induction among male and female alcoholics. Using a somewhat different methodology, Zack, Toneatto, and MacLeod (1999) found that negative affective cues primed alcohol concepts in a lexical decision task more strongly in problem drinkers with high, as opposed to low, levels of distress. Other studies, however, have failed to find interactive effects of psychological distress and alcohol cues in the prediction of drinking and more focused research is needed to clarify the relationships between negative mood, alcohol exposure, and relapse (Cooney et al., 1997; Payne et al., 1992).

SUMMARY AND CONCLUSIONS

Throughout recorded history, alcohol has been recognized as a transformative substance that can produce profound emotional effects. In addition, modern research has shown that alcohol can affect brain systems that regulate cognition and emotion. Notably, alcohol's effects on emotion are strongly conditioned on dose, time course of intox-

ication, situational factors, underlying affective state, and individual differences associated with both constitutional variables and acquired experience. As a result, simple generalizations concerning alcohol/emotion relations are not possible. However, under conducive circumstances, alcohol can strongly reduce negative emotions and increase positive emotions. Unfortunately, these benefits are often accompanied by considerable costs such as short-term negative emotional consequences. In addition, chronic, heavy alcohol use often leads to tonic changes in emotional state that may further motivate drinking. From this perspective, alcohol dependence may be considered, in part, a disorder of emotional regulation.

There has been little research on the determinants of emotion-related drinking in everyday life. Many of the research strategies used in the past, especially survey studies of drinkers and psychiatric epidemiological studies of alcohol-related comorbidity, fail to resolve the temporal dynamics of emotions and drinking. This situation is rapidly changing with the emergence of EMA studies, although even these have not yet provided sufficiently detailed assessments to fully contextualize the instigation of a drinking episode, its course, and its emotional consequences. The use of palmtop computers has revolutionized our ability to study emotion and drinking relations in the field and with the addition of emerging technologies (e.g., transdermal alcohol sensors and unobtrusive real-time recording of physiological activity), we should be able to transfer some of the measurement sophistication of the laboratory to the field.

Finally, while our review focused exclusively on alcohol and emotions, it is clear that many individuals use other psychoactive substances, both licit and illicit, for emotion regulation. The preferential choice of the use of one substance over another is undoubtedly attributable to myriad influences concerning personal experience (e.g., Khantzian, 1990), personality (e.g., Sher et al., 1999), accessibility, and cultural and subcultural norms of use. There are clearly many similarities in both the effects of and motivations for using different substances, but one must be careful not to overgeneralize from one substance to another. Drugs differ not only in terms of their psychological effects (and underlying neuropharmacology) but, importantly, to the extent they interfere with important life tasks, their potential for acute harm versus more chronic health problems, and the degree to which they preempt alternative emotion regulation strategies both situationally and developmentally. We believe, however, the focus on alcohol is instructive because it is a substance that is used by a large proportion of individuals in diverse cultures worldwide (unlike many illicit substances), because it can have profound effects on emotions and cognition (unlike nicotine), and because there are complex interactions between drinking, intoxication, and social context.

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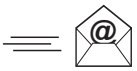

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