22 The role of control in emotion, emotion regulation, and empathy

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The ability to control the contents of our mind, and how those contents lead to behavior, is required in virtually every sphere of life. In this chapter I focus on two that involve emotion: on one hand, the use of control to regulate the experience and expression of our emotions—thereby enabling us to change what we feel—and on the other hand, the use of controlled processes to help us make sense of the emotions of others—thereby enabling us to change our perceptions of what others feel.

The starting premise is that neuroscience data can usefully inform knowledge of the mechanisms underlying these two uses of control. With that in mind, the chapter is divided into four parts. In the first, I sketch a current conception of how we exert control over our behavior and the neural systems that make this possible. In the second and third sections I apply these conceptions first to the study of emotion regulation, and second to the study of empathy. The final section considers the implications of this work for various areas of psychology.

Of two minds

Among the first questions to arise with respect to how we control our selves are: why is it so hard? And how does it work when it's effective? While these questions have been of long-standing interest to both lay and scientific audiences, contemporary psychology and neuroscience have begun to offer an intriguing two-part answer.

The first part concerns the basic psychological and neural processes that govern our behavior. Decades of work in experimental psychology and neuroscience have made clear that we are "of two minds" for pretty much everything we do, and especially when attempting to control our selves (Chaiken and Trope, 1999; Lieberman, Gaunt, Gilbert, and Trope, 2002; Loewenstein, Weber, Hsee, and Welch, 2001; Metcalfe and Mischel, 1999; Sloman, 1996).

On one hand, we are able to go on "autopilot," acting on the basis of a set of relatively, if not completely, automatic patterns of thought, feeling, and action. These relatively automatic patterns can be complex and adaptively executed (i.e., they are able to deal with some types of obstacles thrown in their way), but are often relatively circumscribed in the sense that they pertain to a specific set of cues and situations. The brain systems supporting these automatic patterns are both cortical and subcortical, and importantly include: (1) the amygdala, an almond shaped and sized cluster of subcortical nuclei important for detecting, encoding, and triggering responses to affectively arousing and especially potentially threatening stimuli (Ochsner and Gross, 2007; Phelps, 2006), and (2) the striatum, a larger set of subcortical nuclei, important for laying down and executing sequences of thought, affect, and action (Kober et al., 2008; Schultz, Tremblay, and Hollerman, 2000). Together, these two subcortical structures, and allied subcortical and (typically posterior) cortical systems enable us (a) to rapidly identify goal-relevant, and therefore affectively salient, stimuli and events and (b) to start responding to them. These evolutionarily older and relatively automatic systems guide our behavior much of the time, as our default mode of being in the world is to go with our habitual ways of thinking, feeling, and acting.

On the other hand, we are able to consciously monitor, set goals for, and exert control over our thoughts, feelings, and actions. This takes conscious and deliberate effort and has been shown to depend on regions of prefrontal cortex, one of the evolutionarily newest and most highly developed portions of the human brain (Miller, Freedman, and Wallis, 2002; Ochsner and Gross, 2005; Wager and Smith, 2003). Our abilities to inhibit pre-potent, but potentially inappropriate thoughts, feelings, and actions—in favor of more context-appropriate ones—has been shown to depend critically upon a number of distinct prefrontal regions, each of which may implement important control-related processes (Aron and Poldrack, 2006; Badre and D'Esposito, 2007; Badre and Wagner, 2007). Our control capacity is limited, however, as we have only a certain amount of resources available to devote to whatever responses need to be shaped, guided, or altered.

While this two-system view of the mind and brain is surely an oversimplification, it has permeated virtually every area of psychological and neuroscience research because it has great explanatory power. The basic notion is that we can explain what we think, feel, and do in terms of interactions between the response tendencies quickly queued up by the automatic system and the extent to which we are motivated, and have the resources, to use the controlled system to modify them (Chaiken and Trope, 1999; Lieberman et al., 2002; Loewenstein et al., 2001; Metcalfe and Mischel, 1999; Sloman, 1996).

The second part of the answer to the question of how we can control our minds has to do with the nature of the processes carried out by both the automatic and controlled systems. At a fundamental level, each system is interpreting information in the environment in a way that makes sense based on our prior history. While much of our histories are similar, there are individual variations. As such, for each person, in each situation, each system is making its own kind of interpretation of stimulus inputs, and together they guide you to subjectively construe the meaning of what's going on (Kosslyn et al., 2002; Ochsner, 2007a, 2007b). Or put another way, each type of system has a "belief" about what it is perceiving and promotes actions on the basis of that belief.

Putting these two parts together offers an answer as to why we can, and in some cases, cannot or do not, properly control our emotional selves. If most of the time we are on "autopilot", then the automatic system(s) will simply queue up emotional responses that make sense based on the way they interpret the current situation. In many circumstances, however, these interpretations might not be the most useful or appropriate. In the section below, we unpack the mechanisms used in two such situations—one where our own emotions might need to be regulated, and another in which our perceptions of another's emotions might need to be regulated—to understand how a core set of controlled processes may be deployed to exert conscious, deliberate, top-down control over our interpretations, appraisals, and/or construals of our emotional world.

Emotion and emotion regulation

Against this backdrop, it is relatively easy to see how one can use top-down forms of cognitive control to change the way one appraises the meaning of emotionally evocative stimuli, and thereby change one's emotional response. For the past decade, this has been the focus of research in my laboratory, as well as many other laboratories around the world. In general, we and others have found that one's initial emotional appraisal of the situation—guided by brain systems like the amygdala and striatum, described above—can be modified through the use of lateral and medial prefrontal systems that support the use of various kinds of cognitive control processes (Ochsner and Gross, 2005, 2008).

While it is clear that prefrontal systems can modulate subcortical systems in such a way that they increase, decrease, or maintain their activity in accordance with regulatory goals, exactly how they achieve these effects is not yet clear. Some of the prefrontal systems that are engaged by reappraisal—typically those on the ventral and orbital surface of the frontal lobes—have direct interconnections with the amygdala or striatum, and through these connections, may directly influence their activity (Cavada, Company, Tejedor, Cruz-Rizzolo, and Reinoso-Suarez, 2000; Ghashghaei, Hilgetag, and Barbas, 2007). But many of the more dorsal prefrontal regions engaged by reappraisal do not have direct interconnections with the systems that trigger emotional responses. Instead, they are interconnected with parietal and temporal regions that represent the location, size, shape, and general perceptual characteristics of the stimuli that elicit our emotions (Barbas, 1992; Barbas, Ghashghaei, Dombrowski, and Rempel-Clower, 1999; Goldman-Rakic, 1992). Together these frontal-posterior networks are thought to support specific higher-level control abilities like the retrieval of information from semantic memory, working memory, and selective attention.

These anatomical and functional facts suggest an alternate route by which reappraisal may exert its emotion modulatory effects: through the use of memory and attention systems—as well as language, which also depends on frontal-posterior networks—we can generate and maintain appraisals of emotionally evocative stimuli that are different than the ones initially generated bottom-up by subcortical appraisal systems. The idea is that reappraisal uses prefrontal systems typically used just for selective attention or memory to control the activation of spatial and object representations that comprise a new "percept" that is sent to subcortical emotion systems. The appraisals for these new "perceptual" inputs compete with the initial bottom-up appraisals of external stimuli. With sustained effort and attention, these inputs force a new appraisal of stimuli from the top-down.

While plausible and consistent with current data, this account has yet to be directly tested. That being said, it has interesting implications for understanding the development and breakdown of emotion regulatory abilities that we will consider in the final section of the paper. In the next section, we consider other ways that control can play another essential role in our emotional lives—in this case, aiding our empathic perception of other's emotions.

Empathy

"Empathy" is an umbrella term that refers to a constellation of related abilities. In psychological research, three are typically enumerated: first, the tendency to take on or share the feelings of others; second the ability to cognitively understand those feelings; and third the tendency to act pro-socially on the basis of those feelings (Decety and Batson, 2007; Zaki, Bolger, and Ochsner, 2008; Zaki and Ochsner, 2009).

In recent years, neuroscience research has begun to focus on the first two of these empathic abilities. The first—the ability to share the feelings of others (and their internal states more generally)—is thought to depend on premotor and sensory systems, including those for the perception of physical pain (Decety and Batson, 2007; Gallese, Keysers, and Rizzolatti, 2004). These systems are engaged relatively automatically both during first person sensory experience and during the third person observation of someone else having the same kind of experience. For example, frontal and parietal premotor systems (commonly referred to as the "mirror system") are engaged during both action execution and observation (Gallese et al., 2004; Keysers, Kaas, and Gazzola, 2011). Similarly, regions of the cingulate and insular cortex that received ascending spinal information about painful stimuli are engaged both during the direct experience of pain and when one sees or knows that someone else is in pain (Decety, 2009). The activation of systems for motor planning, pain, or affect more generally when you're observing others is thought to provide a relatively automatic and intuitive basis for understanding their behavioral intentions or affective state. The second ability—to cognitively understand the feelings of others—is thought to depend on a network of regions centered around the dorsal portion of the medial prefrontal cortex (and including the precuneus, superior temporal sulcus, and temporal poles) (Frith and Frith, 2006; Mitchell, 2009; Olsson and Ochsner, 2008). These systems are engaged when one explicitly reasons or makes attributions about mental states, including emotions, whether they're one's own or someone else's, current feelings or dispositional tendencies.

Most neuroscience research on empathy has focused on the use of one or the other of these two types of systems when one is passively perceiving or making simple judgments about another's emotional states, and, as a consequence, hasn't explored the questions of when or how control processes may be important for empathy (Zaki and Ochsner, 2009). Social cognition research suggests a potentially critical role for control in two types of situations: where the behavior of a social target is ambiguous, or where one is motivated to modify an initial impression on the basis of situational or contextual information (Chaiken and Trope, 1999). In either case, prefrontal control processes may be important for top-down appraisals that integrate with or modify bottom-up appraisals to help us identify the emotions of others.

Recently, we have investigated these two types of situations and found support for this idea. In one experiment, we asked participants to watch videos of targets talking about emotional events from their personal lives (Zaki et al., 2008; Zaki, Weber, Bolger, and Ochsner, 2009). Participants were asked to continuously rate the emotions experienced by targets, who themselves had provided ratings of their own emotions. Correlating these two ratings provided a measure of the accuracy with which participants empathically understood the emotions of targets. Importantly, targets in the videos provided multimodal (i.e., verbal and nonverbal), dynamic, and often subtle cues to their emotions—a situation that social cognition research would suggest should require the use of control systems to properly contextualize the meaning of each individual cue (e.g., realizing that a neutral face when talking about something sad might not mean that you don't have any feelings about it). We found that overall levels of accuracy tracked with activity in premotor systems involved in experience sharing, elements of the medial prefrontal network involved in explicit attributions, and additional prefrontal regions implicated in cognitive control.

While this provided initial evidence for our hypothesis, there also were intriguing individual differences in the extent to which individuals engaged each type of network, with some relying more on the experience sharing systems and others relying more on the systems for mental state attribution. We suspected that prefrontal control systems arbitrated the interactions between these two types of systems as participants figured out when they should rely on each type of emotion cue. Because this study was not designed to directly address this question, we conducted another study designed specifically to tackle it. In this study, participants viewed short silent video clips drawn from videos in the first study where targets were feeling strong positive or negative emotion (Zaki, Hennigan, Weber, and Ochsner, 2010). These clips were paired with captions that implied the targets were talking about topics that were either positive (e.g., a party) or negative (e.g., their dog died). When the two types of cues were in conflict (e.g., a video with nonverbal cues to positive emotion paired with a negative caption), we predicted that participants would need to engage control systems to figure out how to shift their attention towards, and rely on, one type of cue or the other. That's exactly what we found: On one hand, as participants' judgments reflected greater reliance on the nonverbal cues presented in the video, activation increased in premotor systems that support sharing of the intentions implied by targets actions. On the other hand, as participants' judgments reflected greater reliance on the contextual cues provided in the captions, activity increased in a medial prefrontal region that supports making explicit attributions. But most importantly, the extent to which a participant showed one or the other pattern of activation was predicted by functional connectivity with prefrontal and cingulate control systems, which seemed to "direct traffic" by shifting activation from one system to the other and shift judgments of target emotions accordingly.

Together, these data suggest new ways in which we can study the role of control systems in empathic understanding, empathic experience sharing, and the perception of others' emotions more generally. By studying perceptions of emotion in artificial contexts—e.g., by presenting only static and/or posed facial expression—prior work generally failed to show evidence of control system involvement (Zaki and Ochsner, 2009; Zaki and Ochsner, 2011). Our work, and some emerging work from other labs as well, suggests that a key to studying the role of control in empathy is to examine naturalistic contexts where control will be needed to direct attention to the various types of cues and targets present, and arbitrate between them.

Implications and future directions

If we are to make progress in our understanding of the mechanisms underlying our various emotional abilities, we will need to have theories that move beyond behavior-level descriptions of phenomena and move deeper into process- and neural-level descriptions of underlying mechanisms (Ochsner, 2007b; Ochsner and Gross, forthcoming). The goal of this chapter has been to give a taste of the research in two domains where this type of multi-level approach to understanding emotion is taking place. The first concerned our ability to exert control over and change our emotional responses. The second concerned our ability to exert control over and guide our empathic understanding of other people's emotions. In both cases, a domain-general set of prefrontal control systems was used to influence activation in different types of subcortical and posterior cortical systems that represent different types of domain-specific information related to one's own emotional response or the emotional responses exhibited by others. By biasing processing in systems related to triggering emotions, sharing the experiences of others, and/or making explicit attributions about them, prefrontal control systems enable us to shape and change our first person experience of our own emotions and our third person experience of others emotions.

This basic framework for understanding the role of control in emotion may be applied to understanding the full range of normal to abnormal emotional experience and expression. Within the normal range, it could be applied to understanding the development of emotion regulation and empathy from early in life to young adulthood, as well as how both change as we age, in terms of changes in the nature of and interactions between the systems described above. Outside the normal range of emotion this framework could be useful in examining emotion dysfunction in various kinds of clinical populations. For example, it could be applied to understand whether and how individuals with major depressive or borderline disorders have a dearth of positive and an abundance of negative emotion because they have problems with emotional reactivity, emotion regulation, or both (Johnstone, van Reekum, Urry, Kalin, and Davidson, 2007; Koenigsberg et al., 2009). It could be similarly applied to understanding how the deficits in empathy and emotion perception shown in individuals with Autism Spectrum Disorders arise from problems with systems for experience sharing, mental state attribution, or the use of control to shift between and integrate their processing (Zaki and Ochsner, 2009; Zaki and Ochsner, 2011).

Hopefully, some of the benefits of this type of multi-level, integrative approach to understanding emotion—and its relationship to control—have been highlighted by this chapter. Not only do neuroscience-informed theories of emotion regulation and empathy—and other affective phenomena more generally—cut across multiple levels of analysis, they also speak to and connect with more domains of research, and as a consequence may be more robust and enduring (Ochsner, 2007b). That being said, the day it still young for this approach to understanding emotion, and the framework we present here is at best a crude sketch in need of correction, revision, and expansion. So while we are enthusiastic about the promise of the approach and the framework it has built, we fully expect that future research will bring significant and welcome changes to both.

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