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Cognitive Control: Social Evolution and Emotional Regulation

Matt J. Rossano

Department of Psychology, Southeastern Louisiana University

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Abstract

This commentary argues that theories of cognitive control risk being incomplete unless they incorporate social/emotional factors. Social factors very likely played a critical role in the evolution of human cognitive control abilities, and emotional states are the primary regulatory mechanisms of cognitive control.

Keywords: Attentional biasing; Componential; Emotional regulation; Social complexity

A text word search of the cognitive control target articles reveals that the word ''emotion'' occurs only four times, all in Stout's article (Stout, 2005); while the word ''social'' occurs only once outside of Stout's article. The importance of emotion as a regulatory mechanism has been recognized by numerous researchers (e.g., Cosmides & Tooby, 2000; Damasio, 1994, 2003; Johnson-Laird & Oatley, 1992; Tooby & Cosmides, 2008) and the critical role of the social environment in cognitive evolution is equally well acknowledged (Cheney & Seyfarth, 2007; Dunbar, 1998; Geary, 2005). This suggests that theories of cognitive control are likely to be seriously incomplete unless they incorporate relevant social/emotional factors. Using Stout's evolutionary approach as a starting point, this commentary highlights the role of emotion as a regulatory mechanism of cognitive control as well as the social selection pressures critical to the evolution of human cognitive control abilities.

Stout provides evidence that cognitive control involves two dissociable but interrelated brain systems—one dedicated to affective regulation and another to motor/behavioral control. Critically, the affective regulation system includes circuits for processing social/emotional signals. Stout further argues that the demands of later Acheulean hand axe construction likely required an advancement in cognitive control capacities. In other work, Stout (2005) has highlighted the intensively social nature of this type of tool construction

Correspondence should be sent to Matt J. Rossano, Department of Psychology, Southeastern Louisiana University, Hammond, LA 70402. E-mail: mrossano@selu.edu

using the adze-making of the Langda villagers of West Papua, Indonesia as an ethnographic model. When traditional people make tools similar to Acheulean hand axes, it is embedded within a larger social context carrying important cultural, symbolic, and religious significance. Whatever cognitive control processes are involved in stone tool construction, they are importantly linked to the social context of their expression.

This ethnographic evidence is complemented by comparative evidence from nonhuman primates: In the field, the social context plays a vital role in how attention is allocated and what responses are selected. For example, vervets carefully attend to and model the problem-solving actions of related females but not unrelated males (van de Waal, Renevey, Favre, & Bshary, 2010). Similarly, when in the company of three or more males, female chimpanzees respond aggressively to threatening sounds. However, when two or fewer males are present, they silently retreat (Hauser, 2000, pp. 159–160).

These are but a few examples supporting the hypothesis that the social world very likely represented the most demanding venue for our ancestors' deployment of cognitive control. Getting along with others, learning from others, manipulating and cooperating with others were the chief selective forces shaping our ancestors' cognitive control abilities. The close connection between the social context and one's emotional state raises the possibility that emotions were one of the targets of social selection pressures because emotions facilitate cognitive control. Female chimpanzees select a different response when in the company of males because they are in a different emotional state compared to when they are surrounded by females.

This is certainly true of humans. When angry or excited, humans visually attend to and selected images pertaining to rewards. When fearful, they attend to and select threatening images (Ford et al., 2010). The authors of this research suggest that both anger and excitement motivate approach behaviors aimed at exploiting potential opportunities for rewards. However, they may do so using different social tactics: Anger facilitates reward acquisition through social competition, whereas excitement does so through cooperation. The increased complexity of the human social world very likely selected for more sophisticated emotional states because those states enhance cognitive control capacities, allowing humans to better manipulate what others' thought about us.

For example, chimpanzees appear to be vengeful but not spiteful (Jensen, Call, & Tomasello, 2007). In other words, their moralistic retaliation is generally directed at others who have caused them direct harm, not necessarily at those who have violated fairness norms. This is in sharp contrast to humans who readily inflict personally costly punishments on norm violators. Righteous anger, vindictiveness, and spitefulness appear to be uniquely human social emotions leading to moralistic forms of aggression that signal to others our commitment to enforcing fair behavior. Similarly, shame in humans appears to take on varied and uniquely human forms depending on the social context of one's ''failure'' (Fessler, 2007).[1]

Emotions exert their regulatory control by adaptively coordinating various and potentially conflicting cognitive subsystems (e.g., Cosmides & Tooby, 2000; Tooby & Cosmides, 2009). This coordination is most critical at decision points in the ongoing information processing stream where limited cognitive resources must be directed at particular signals, interpretative inferences, or action patterns from among an array of competing alternatives

(Johnson-Laird & Oatley, 1992). Natural selection would have favored emotional states linked to overall patterns of perceptual, inferential, memorial, and behavioral activity most likely to produce favorable fitness outcomes under various environmental (social) conditions.

If emotions are ''choice-point biasing mechanisms'' then, consistent with componential approaches to cognitive control, one ought to be able to tease apart how and when different emotional states direct specific control processes. For example, the Ford et al. (2010) study found evidence that fear increased attention to threats without affecting reward processing. A reverse pattern was true for excitement. Thus, these emotions involved reciprocal patterns of attentional biasing, suggesting that the specific regulatory effects of different emotions are separable and distinct, and amenable to manipulation and study.

Among the target articles, Lenartowicz et al. address the issue of the extent to which hypothesized cognitive control functions are realized in neurological systems. They find evidence for a largely right-lateralized control function involving working memory and response inhibition. Negative emotional states are known to be more strongly right- than left-lateralized especially in the ventromedial prefrontal cortex (see Damasio, 2003, p. 62). A reasonable hypothesis would be that certain negative emotional states (e.g., fear and anger) trigger context-adaptive control functions associated with working memory (e.g., task maintenance) and response inhibition. Likewise, the performance monitoring function discussed in Alexander and Brown's PRO theory would be emotionally driven—that is, different emotional states (e.g., satisfaction, confusion, frustration) would prompt the system to maintain, strengthen, or potentially alter a goal representation.

Other more general implications of this approach may be that (a) we are never in a non-emotional state, and (b) the lack of a coherent emotional state (either through boredom or fatigue) is the arch-enemy of cognition control.

Note

1. The complexity of an emotion may also have important cognitive control implications. Fessler (2007) argues that in humans shame has evolved into two forms: (a) a simpler ancestral form shared with nonhuman primates triggered by the recognition of subordinate status; (b) a more complex recent form that involves the recognition of having failed to live up to shared moral standards. Subordinate shame implies that attention is focused on one's place in the social hierarchy. Moral shame implies that attention is focused on how others' view the self relative to a commonly held moral framework and on the need for reputational repair. Both ''theory of mind'' and expanded working memory capacity (needed to hold one's action, the moral standard, and others' perspective on the self simultaneously in consciousness) would probably be a necessity for moral shame, but not subordinate shame. By contrast, evolutionarily older and ''simpler'' emotions such as fear or anger would likely be less resource intensive and have potentially fewer varied effects on attentional processes and other aspects of cognitive control.

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