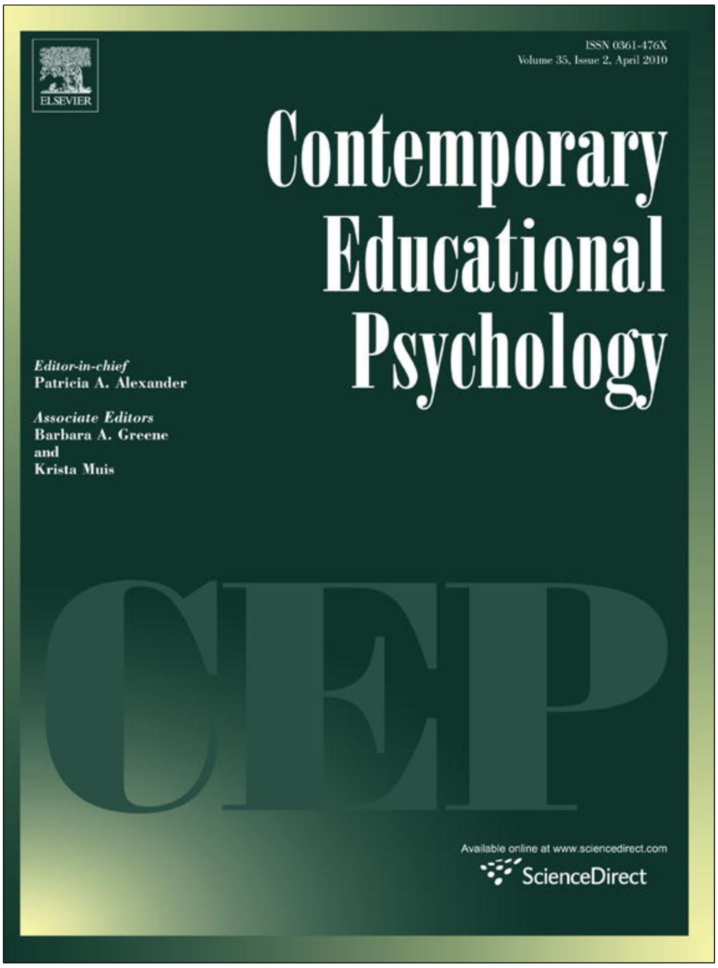
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Theoretical Analysis

Admiration for virtue: Neuroscientific perspectives on a motivating emotion

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ABSTRACT

Social emotions like admiration for another person's virtue are often associated with a desire to be virtuous one's self, and to engage in meaningful and socially relevant activities against any odds (Haidt & Seder, 2007). These emotions can profoundly inspire us, sometimes motivating our most significant life-course decisions. Yet despite the cognitive maturity and complexity of knowledge required to induce an emotion like admiration for virtue, our recent study of the brain and psychophysiological correlates of experiencing this emotion revealed significant involvement of low-level brain systems responsible for the feeling of the gut and the maintenance of basic life regulation (Immordino-Yang, McColl, Damasio, & Damasio, 2009). These findings contribute an interesting jumping-off point for reexamining the educational study of motivation states because they suggest that, contrary to current conceptions in educational research, nonconscious, low-level physiological processes related to survival and bodily sensation may be critical contributors to intrinsic motivation.

1. Introduction

Social emotions like admiration for another person's virtue play a critical role in interpersonal relationships and moral behavior, and often lead to a sense of heightened self-awareness that is profoundly motivating (i.e. the desire to be virtuous and to accomplish meaningful actions despite difficult obstacles; Haidt & Seder, 2007). Our recent study of the brain and psychophysiological correlates of experiencing admiration revealed that the feeling of this complex, culturally constructed, motivating emotion involves not only high-level "cognitive" systems, but also the neural systems for the feeling of one's own body, especially the gut and viscera (Immordino-Yang et al., 2009). The experience of this emotion was also associated with increased heart rate and increased blood flow to brain systems that operate outside of conscious control to regulate consciousness and basic biological survival, such as blood pressure and hormone regulation. These findings contribute an interesting jumping-off point for reexamining the educational study of motivation states, in that they suggest that, contrary to dominant conceptions in educational research, non-conscious, low-level physiological processes related to survival, consciousness, and their modulation by emotion may be critical contributors to motivation. In contrast, most current educational research on motivation examines only high-level processing of cognitive conceptions as contributors to motivation, e.g. self-report of perceived self-competence. In the end, it may be that considering processing associated with non-consciously controlled physiological processes in relation to processing of conscious, cognitive self-knowledge would afford educational researchers a new vantage point from which to investigate and understand the nature of motivation. Consistent with recent discoveries from neuroscience, this new vantage point would consider motivation as simultaneously cognitive and emotional, inherently embodied, and possessing both conscious and non-conscious dimensions.

2. Neural bases of emotion, social emotion and self

Basic emotions, such as anger, fear, happiness and sadness, are cognitive and physiological processes that involve an interplay of body and mind (Barrett, in press; Damasio, 1994/2005). As such, they utilize brain systems for body regulation (e.g. for blood pressure, heart rate, respiration, digestion), including for the maintenance of consciousness (e.g. in the brain stem), and body sensation (e.g. for physical pain or pleasure, for a racing heart or stomach ache). They also influence brain systems for cognition, changing thought in characteristic ways—from the search for escape strategies in fear, to the wish to seek revenge in anger, to acceptance and openness to others in happiness, to dwelling on something or someone lost in sadness. In each case, the emotion is played out in the mind, and can also be displayed through characteristic changes on the face and in the body. (Notably, these bodily and facial changes can be real, resulting in actual modulation of the body state or face, or simulated, wherein a person does not

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show the emotion outwardly in behavior but uses an "as if" mental process that recruits body-related brain systems; Damasio, 1999). These changes are in turn felt via neural systems for sensing and regulating the body, and the resulting feelings interact again with current thoughts, helping people to regulate and learn from their experiences. In other words, what affective neuroscience is revealing is that the mind is influenced by an interdependency of the body and brain through processes that can be organized into complex and variable but coherent constructions we call emotions, and that the relationship between the body and brain likely plays a critical role in motivating our individual thoughts and learning, both at the conscious and non-conscious levels (Immordino-Yang & Damasio, 2007).

However, while there is extensive evidence that the body and brain are interdependent during basic emotion states, the extent to which the feeling of complex social emotions relies upon this co-dependence is less well understood. In designing our experiment, we set out to investigate whether the feeling of this motivated emotion state, not merely recognizing this state in another person but actually subjectively experiencing it one's self, would recruit low-level brain systems that regulate and feel the body. For example, the neural correlates of a highly motivating social emotion like admiration for virtue would likely be extremely complex because they ought to involve high-level systems that support other aspects of cognition, for example regions involved in episodic memory retrieval, empathy, and perspective-taking in relation to the self (Gray, 1999; Zaki, Ochsner, Hanellin, Wager, & Mackey, 2007). And yet, would calling up complex, conscious knowledge about memories, plans, and their meaning be sufficient to sustain such a strongly motivated state? Or, would the feeling and regulation of such basic survival-related processes as respiration and heart rate modulation also become involved at a later stage of processing, in the phase of the emotion that corresponds to a desire for meaningful action? If these lower-level processes were especially activated late in the time course of the emotion experience, it would suggest that the motivating power of an emotion like admiration comes not simply from the conscious calling up of relevant knowledge in relation to one's own situation, but also from non-conscious processes related to the interdependence of the body and mind. It would lend support to the idea that our intense desire to socially survive and flourish by accomplishing meaningful actions in the social world derives its power by co-opting systems whose original purpose is to maintain basic survival through the maintenance of the body.

3. Inducing admiration for virtue: a combined neuroscientific and psychological approach

In our experiment, we tested hypotheses related to the idea that complex social emotions like admiration for virtue would engage not only neural systems related to representing cognitive knowledge, but also systems in the brain related to the regulation of consciousness and the feeling of the body. That is, we hypothesized that despite the complexity of the culturally-relevant knowledge required to fully induce the emotion of admiration for virtue, once this complex knowledge was called up, we would see also the activation of systems in the brain and brain stem that maintain basic survival and prepare the body for action. These would include such systems as those that modulate heart rate, blood pressure and hormone regulation, and those that feel the gut and viscera. Importantly for the discussion here, while we knew that the calling up of complex knowledge described above may be done consciously, the secondary (i.e. later and longer lasting) modulation of low-level systems related to the body could not be under conscious control or awareness.

To test our hypotheses, we involved 13 participants in a combined fMRI, psychophysiological recording, and psychological experiment with three phases. In the experiment, six women and seven men participated individually in a one-on-one, 2-hour videotaped interview in which they discussed with an experimenter true narratives about real people's lives, some of which involved recounting highly virtuous acts that are highly admirable. (Participants' mean age was 30.3 years, range was 19–57 years; for methodological details, see Supplementary Information for Immordino-Yang et al., 2009). For example, in one true story, a young blind German woman, despite all odds, learns fluent Tibetan language by ear, invents a computerized Tibetan Braille system to translate texts, and travels into the mountains of Tibet to open a school for blind children, to which she dedicates her life. For methodological reasons relating to fMRI (functional magnetic resonance imaging) analyses, other "control" narratives involved recounting stories that involved interesting but fairly commonplace social circumstances or achievements, such as the story of a high school student who organizes a drama production at her school and donates the proceeds to the school library. Participants were not told the specific emotion categories in the experiment, and were asked to be as honest and reflective as possible in their discussions of their feelings and thoughts about the stories.

After learning about stories such as these, experiment participants were scanned using fMRI while they viewed 5-second reminder versions presenting the crux of each of the stories, followed by a 13-second period of gray screen. Participants were asked to try to become as emotional as possible about each story, and to rate the strength of their real-time emotional response by pressing buttons. Psychophysiological data on heart rate change and respiration rate were also collected as corroborating measures of the participants' bodily changes in the scanner, and in order to identify the timing of the emotional response. After participants completed the scanning phase, which lasted approximately one hour, they were again individually interviewed about the experiences and thoughts they had had while in the scanning phase of the experiment.

Analysis of the data proceeded in several steps. First, videotaped pre- and post-scan interviews were examined by two independent raters, with the aim of identifying and removing from the fMRI analysis any trial corresponding to a narrative to which a participant did not react with the emotion established by prior piloting, e.g. a participant did not feel admiration for the virtue of the Tibetan woman described above or felt some strong emotion for the high school drama student. (Inter-rater reliability calculations on the whole data set revealed 96% agreement, with Cohen's kappa = 0.8). Next, participants' button press data were examined, so that fMRI results from admiration-inducing trials in which the participant reported feeling strong emotion could be contrasted with control trials in which the participant reported no strong reaction. (This is necessary in order to identify regions of the brain whose increased activity is associated with the emotion state, above what is necessary for basic social and body-regulatory processing.) Finally, the psychophysiological data were examined in order to determine the time course of participants' emotional responses to the narratives while in the scanner; once identified, the fMRI data corresponding to this time window were built into a general linear model that enabled us to contrast the patterns of brain response during the feeling of admiration for virtue with the patterns associated with reflecting on the non-emotional control stories. As is standard in fMRI research, we tested our hypotheses by examining whether there was significantly different blood flow in regions of the brain and brain stem associated with our hypotheses during the feeling of admiration for virtue as compared to the processing of interesting but not strongly emotion-inducing stories. We also conducted secondary analyses of the time course of the activation in a brain region important for the feeling of gut and viscera, the anterior insular cortex, and of the direction of "effective connectivity" or so-called "causal influence" between key homeostatic regions of the brain stem and the anterior insula. This final analysis allowed us to probe relationships between the time courses of activation in the two regions, to investigate whether the activation one region could be "driving" or "influencing" the other. (The anterior insula is a somatosensory region that feels the inside of the body, for example allowing a person to feel a stomach ache or a racing heart beat. This region has also been associated with the process of feeling emotion-related changes in the body, such as the "punched in the gut feeling" associated with learning bad news, or sense of disgust associated with unfair decisions. The middle portion of the brain stem contains densely packed and tightly arranged nuclei important for regulating bodily survival and consciousness; damage to the sectors of interest here leads to coma and/or persistent vegetative state.)

In examining the neural data, we found that our hypotheses were confirmed. Not only was a strong feeling of admiration for virtue associated with significantly greater activation in regions of the brain related to memory retrieval and other conscious processes, it was also associated with activation of non-consciously controlled regions that regulate the body and consciousness, including regions extending all the way into the brain stem (survival-relevant nuclei found far below the high-level cortices associated with conscious thought). What is more, activation in the anterior insular cortex, involved in feeling these bodily changes and relating them to learned behavioral choices, began on average 4–6 seconds later in the emotion process and was subsequently sustained. In contrast, activation in this area during less complex emotions unrelated to meaningful motivation, like empathy for another person's injured leg, happened almost immediately and died down relatively quickly, on average after a few seconds. (Note that the extent to which these changes in body-related neural processing pertain to real versus simulated bodily changes is the focus of current investigations.) Lastly, during less complex and less motivating emotions like compassion for pain and admiration for skill, we found that activations in key regions of the brain stem systematically preceded (i.e. were "driving") activations in the anterior insula (responsible for emotion-related feeling states). However, these same nuclei in the brain stem were being driven *by* the anterior insula during the intensely motivating feeling of admiration for virtue. (That is, the average direction of statistical "causal influence" between certain brain stem nuclei and the anterior insula was reversed in admiration for virtue compared to in other social emotions.) Together, these findings suggest that the feeling and representation of non-consciously induced bodily and emotional changes happens mainly after the cognitive processing necessary to induce admiration for virtue, and that this cognitive processing leads to a state of visceral self-awareness that prepares the body and mind for meaningful, motivated action.

4. Admiration for virtue: a motivating social emotion

Emotions such as admiration for virtue are intrinsically motivating—they incite people to act in ways that are meaningful for themselves and beneficial for society (Haidt, 2003). While the study of positive, social, elevating emotions of the sort that lead to some kinds of motivation has been largely neglected relative to the study of basic (mainly negative) emotions such as fear and disgust, there is a building movement investigating the functioning of positive, elevating emotions such as admiration and gratitude, both from a psychological and a neuropsychological perspective (Algoe, Haidt, & Gable, 2008; Bartlett & DeSteno, 2006; Zahn et al., 2008).

In our experiment, participants who felt a strong emotion of admiration for another person's virtuous accomplishments often spontaneously described in their discussions a strong desire to lead better lives themselves, and to accomplish noble deeds. Intriguingly, in addition to the neural signatures of episodic memory, social perspective-taking and various other high-level cognitive processes, the feeling of this motivational emotion state was associated with the recruitment of neural systems related to basic maintenance and sensation of the body, especially of the internal, visceral body (i.e. the "gut"), and systems related to maintenance of consciousness and self-awareness in the cortex and brain stem. Furthermore, analyses of the time courses of activation in these regions suggested that the motivated state associated with feeling admiration for virtue may be due in part to high-level cortical processing influencing the neural machinery in the brainstem that is associated with biological regulation and drives.

What was demonstrated, from a neuropsychological perspective, is that this motivated state, despite its complex cognitive origins, appears not to play out as a purely "rational" process engaged only at the level of the conscious mind. Instead, the feeling of this motivational emotion is deeply rooted in the very systems that keep us alive, that make us act, that organize and regulate the functioning of our body. This finding supports the notion that the body and mind are dynamically interrelated to motivate meaningful thought and action. From a psychological perspective, this finding, if replicated and extended to other emotions and situations, may hint at why strong social emotions, both positive emotions like admiration and negative emotions like hatred, have the power to motivate our decisions and actions, including our educational decisions and actions, so powerfully.

Relating this to educational research on motivation, what these data reveal is that experiencing this motivating emotion involves two kinds of processing: (1) high-level neural systems for consideration of the current circumstances in light of past learning, which leads to cognitive understanding and emotion induction, and (2) low-level systems that play out the readiness for action on the body and mind and give the cognitive process its motivating power. This distinction and the contribution of each system are essential. (Think of this as the difference between knowing that engaging in a certain action would be beneficial but not feeling any impetus to begin, versus the motivated behavior that ensues when a person knows what to do, feels the desire to do it, and satisfies this desire by continuing to persist in pursuit of the desired goal.) Without the cognitive appraisal, no emotion induction ensues; without the induction of low-level processes related to biological regulation and feeling of the body, especially the "gut," the cognitive appraisal has no motivating power, no "punch."

5. Educational research on intrinsic motivation: incorporating non-conscious and biological processes into cognitive models

Intrinsic motivation (at least the variety that is of greatest interest to educators) is a positive and socially contextualized process, and a process that is highly prized in educational environments. That is, educators are largely concerned with promoting learning behaviors that lead to successful academic outcomes, beneficial life choices, and ultimately to the production of socially responsible, engaged, life-long learners. Intrinsic motivation is known to be affected by a person's autonomy in relation to others, by a person's perception that he or she is likely to succeed at a task that is valued by others or by society (such as going to college), and by other equivalently emotional and social measures of relative self-efficacy (e.g. Forgas, Bower, & Moylan, 1990; Pintrich & Schunk, 2002). Although intrinsic motivation is by definition conjured within an individual person, educationally-relevant motivated states are nonetheless, in this sense, both socioemotional and personal (Dweck, 2000; Haidt & Morris, 2009; Pekrun, Goetz, Titz, & Perry, 2002). As such, data on social emotions like admiration can contribute to the study of intrinsic motivation by suggesting that intrinsically motivated states involve both high-level cognitive and affective processing that can be available to the conscious mind, and low-level homeostatic processing for the regulation and sensation of basic bodily survival mechanisms and drives.

However, nearly all of the current theories of intrinsic motivation in the field of education focus on cognitive processes, and in part because many of the critical components of these existing theories are generated from self-report and behavioral choice measures (Karabenick et al., 2007), the issue of conscious versus non-conscious processing has generally not been addressed. It is not that educational theories deny the existence of non-conscious contributors to motivation; rather, the lack of methods for systematically investigating these non-conscious contributors has lead to a strong bias in the field toward accounting for motivation in terms of conscious processes exclusively. While these theories are useful in predicting many aspects of student learning and performance in academic and other settings, they may be unable to provide a thorough explanation of the underlying processes that give rise to motivated behavior.

Take, for one of the best known examples, self-determination theory (SDT; e.g. Ryan & Deci, 2000). SDT and its components, in particular basic needs theory, predicts that when students feel autonomous and competent they will be more intrinsically motivated, and that when students are extrinsically rewarded for activities that they previously found engaging, intrinsic motivation and overall interest in the activity will decrease. The authors account for this relationship in part by explaining students' behavioral choices in terms of the satisfaction of basic psychological needs, an account that has been remarkably productive and successful. At the same time, it leaves implicit and unexplored the possible connection of psychological needs to the fulfillment of biological and bodily needs, and unanswered the potential contribution of non-conscious physiological processing and biological drives to the creation of an intrinsically motivated psychological state. The fundamental question of *why* psychological drives and needs exist and *how* they motivate our behavior and conscious choices remains. (See Izard, 2001, for a related discussion about the adaptive functions of emotions, but without a specific connection to education or intrinsic motivation.)

While Pintrich (2003) presciently suggested that future research on intrinsic motivation should build models that integrate non-conscious with conscious processes, the lack of interdisciplinary methods for studying relations among these processes has prevented the field from moving in this direction. One promising way to address these questions, we would argue, may be to develop novel methods to align conscious reports and measurements of behavioral choices with indexes of non-conscious psychological and biological mechanisms. We hope that our study of admiration for virtue takes one small step in this direction by incorporating qualitative interviews and neuroscientific data to induce and study one type of intrinsically motivated state. An expansion of theories of motivation to include a focus on non-conscious and emotion-related processes could yield new insights into student behavior, leading to testable, educationally relevant hypotheses. For example, incorporating a non-conscious emotional focus may help to explain why a student may "know" at the conscious level that he should engage in a particular learning behavior, but still not "feel" the impetus to begin or to persist. Conversely, the finding that emotions like admiration for virtue may recruit systems responsible for managing life regulation may give some insight into the power of psychological needs and drives by suggesting that they harness machinery meant to incite, enact and feel the biological drives that keep us physically alive.

To sum up, in light of new evidence from psychology and neuroscience, including the evidence on admiration that we present here, we argue that current educational theories of motivation might gain predictive and explanatory power were they expanded to account for the role of non-conscious processing related to regulation of biological drives and the feeling of the body—in essence, by considering the biological substrates of emotion and feeling as they motivate behavior and thought. This renewed focus on non-conscious processing in the domain of motivation would mark a departure from current approaches but would not be unprecedented in the history of thought on this topic, as briefly discussed below. Further, the combined focus on non-conscious and biological processes would be consistent with current trends in cognitive psychology and neuroscience, for example in the study of emotional processing (Phelps & Sharot, 2008), of certain aspects of social processing (Stanley, Phelps, & Banaji, 2008), or of automated and implicit knowledge (Clark, 2008; Eitam, Hassin, & Schul, 2008).

6. A historical perspective on the study of non-conscious motivational processes

While current educational theories of motivation do not focus on non-conscious processes, non-conscious processes have been part of some past theories of motivation. For example, early thinkers in the field of motivation such as Clark Leonard Hull (1884–1952) and Sigmund Freud (1856 –1939) placed great emphasis on biological drives and non-conscious processes (originally referred to as unconscious processes). In fact, Freud built an extensive theory of psychotherapy around this concept (e.g. Freud, 1915; Solms, 2004). Other contemporaries of his time were also interested in non-conscious processes, such as Hermann von Helmholtz (1821–1894) who noted that non-conscious processes are central to visual perception, and Friedrich Nietzsche (1844–1900) who focused on the power of non-conscious driving forces. However, Freud was the first to separate philosophical from scientific approaches to consciousness and to use data from his clinical work to support his theories. Freud's basic proposition was that human motivation is largely hidden from conscious reflection and that conscious thought is not the main source of motivation.

Freud's and other's theories on the role of non-conscious processes in motivation were largely rejected as behaviorism became the dominant school of thought in the 1930s–40s. Behaviorism, with its strong focus on observable behaviors, did not place weight on either conscious or non-conscious processes, because it focused on behavior rather than on understanding the mind. Although the cognitive revolution did lift the taboo on the discussion of consciousness in cognitive psychology, psychodynamic psychologists remained alone in arguing for the importance of non-conscious processes in guiding human motivation (see Westen, 1998, for a review).

In providing this brief historical overview, we are in no way advocating for a wholesale return to early approaches in which all human behavior and motivation could be explained in terms of non-conscious drives (e.g. Hull, 1943). Neither is our position that intrinsically motivated states relevant to education are the result of, an extension of, or a conscious interpretation of biological drives for survival-related behaviors. Instead, we are suggesting that intrinsically motivated states may get their psychological power by co-opting the machinery for biological drives and survival-related physiological processes. Because of this, further work is needed on the relations between (1) non-consciously controlled physiological processes responsible for regulating basic survival-related functions of the body and brain (e.g. heart rate, consciousness); (2) non-conscious cognitive processes directly related to the induction and experience of motivating emotions; and (3) conscious experiences of motivating emotions. There is now accumulating evidence that non-conscious processes play an important role in behavior and thought, and that cognition is embodied (e.g. Borghi & Cimatti, 2010). A movement in the field of educational motivation research to accommodate this information would parallel similar trends in cognitive psychology and neuroscience. In our view, it is through considering interactions between conscious and non-conscious processing in relation to physiological substrates that real progress will be made in the future study of motivation.

7. Implications for educational research on motivation: Using neuroscience to its best advantage

The time is ripe to build a connection between educational and cognitive neuroscientific research for the purpose of studying motivation. This is because the neuroscientific study of social and affective functioning is gaining unprecedented momentum, and there is now a substantial body of evidence about the neural processes supporting social and emotional systems in the brain (Immordino-Yang & Damasio, 2007; Mitchell, 2008). Recent discoveries in social and affective neuroscience reveal intriguing relationships in the brain between the physiological systems that support social interaction, those that support emotion, and those that support the feeling of the body, especially the gut (Hooker, Verosky, Germine, Knight, & D'Esposito, 2008; Lamm, Batson, & Decety, 2007; Singer, 2006). These relationships suggest that emotion and cognition, feeling and thinking, are fundamentally interrelated, and that motivated thought emerges as a function of the interaction between the body and the mind in social and cultural context (Immordino-Yang, 2008).

While this work remains as yet mainly unconnected to educational constructs such as motivation and self-efficacy, some of the processes that are being described in this body of research, such as the neural correlates of feeling admiration for virtue in our study, have unexplored but potentially interesting and novel implications for educational constructs like these. For example, returning to Ryan and Deci's (e.g. 2000) model in which autonomy is associated with intrinsic motivation, could it be that because autonomy is related to psychological self-awareness, and because self-awareness is associated with increased activity in neural systems related to the regulation and high-level representation of the visceral body (i.e. the inferior/posterior posteromedial cortices; see Immordino-Yang et al., 2009), that autonomy and intrinsic motivation are associated by way of their shared connection to neural processes that regulate and feel the body's internal condition (just as we hypothesize is the case during the feeling of admiration for virtue)? By contrast, it is notable that these neural processes are suppressed during contingency learning and other cognitive functions in which attention is directed into the environment, of the sorts that would be invoked during situations involving extrinsic reward. Taken together, this account could provide new hypotheses as to why intrinsic motivation is undermined by extrinsic reward, and new, testable implications for education.

Although detailing further specific implications would be premature, it is possible that an interdisciplinary neuroscientific approach to motivation could lead to a better understanding of, for instance, why there is often a disconnect between students' stated intentions and their actual behavior, why social processing seems so critical to the cultivation of the most profoundly motivating states (see Haidt & Morris, 2009, for a discussion of this in relation to the research presented here on admiration for virtue), how cultural biases in social interaction may alter the conscious interpretation and attribution of non-conscious processes and therefore the ensuing motivation, or why individual differences in motivation may exist and how they may relate to relationships between biological tendencies and personal history. Alternatively, such an approach may lead to new insights into how motivation relates to other affective and cognitive states relevant to achievement, such as engagement and interest (see Hidi, 2006, for a related discussion pertaining to "interest" as a biologically grounded motivational variable). This list is entirely speculative, of course, but because each of these motivation-relevant questions pertains to an interaction between non-conscious and conscious processing in accordance with biological predispositions and mechanisms, it aims to provide a sense of the possibilities.

To conclude, relating these findings back to the argument about the importance of considering non-conscious processing in the study of motivation, it is apparent that most current motivation research in education uses self-report measures and other measures of conscious processing, without a way to measure the contributions of more basic, non-consciously controlled body-related systems. In our experiment on the neural correlates of admiration, we have found a way to measure the contribution of these systems using neuroimaging, and the data suggest that their contribution is fundamental. Motivation is a state that appears to involve the body and the mind in a dynamic interaction that produces alertness, arousal, and a profound readiness to engage in meaningful action. As more is learned about the neural bases of these processes, fruitful connections to educational research may become increasingly apparent—provided that educational researchers and cognitive neuroscientists are in productive dialog.

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