This manuscript will appear in *Perspectives in Psychological Science*, most likely in the May, 2012 issue. Please cite accordingly.

Running Head: (CONSTRUCTIVE INTERNAL REFLECTION AND THE BRAIN)

"REST IS NOT IDLENESS"[†]: IMPLICATIONS OF THE BRAIN'S DEFAULT MODE FOR HUMAN DEVELOPMENT AND EDUCATION

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[†]John Lubbock, *The Use of Life* (1894), ch. IV: Recreation

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KEYWORDS:

Reflection, memory, prosocial emotion

ACKNOWLEDGEMENTS:

We thank Denny Blodget, Ginger Clark, Antonio Damasio, David Daniel, Kaspar Meyer, Robert Rueda, Gale Sinatra, Jonathan Smallwood, Xiaofei Yang and anonymous reviewers for their comments on an earlier version of the manuscript. This work was supported by an NIH grant (P01 NS19632) to A. Damasio and H. Damasio, by the Brain and Creativity Institute Research Fund, and by the Rossier School of Education and the Office of the Provost at the University of Southern California to MHI-Y. V.S. was supported in part by a Valentine Award for graduate studies at the Psychology Department of USC.

Abstract

When people wakefully rest in the fMRI scanner, their minds wander, and they engage a so-called “default mode” of neural processing (DM) that is relatively suppressed when attention is focused on the outside world. Accruing evidence suggests that DM brain systems activated during rest are also important for active, internally-focused psychosocial mental processing, for example when recalling personal memories, imagining the future, and feeling social emotions with moral connotations. Here we review evidence for the DM and relations to psychological functioning, including associations with mental health and cognitive abilities like reading comprehension and divergent thinking. We call for research into the dimensions of internally-focused thought, ranging from free-form daydreaming and off-line consolidation to intensive, effortful abstract thinking, especially with socio-emotional relevance. We argue that the development of some socio-emotional skills may be vulnerable to disruption by environmental distraction, for example from certain educational practices or overuse of social media. We hypothesize that high environmental attention demands may bias youngsters to focus on the concrete, physical and immediate aspects of social situations and self, which may be more compatible with external attention. We coin the term “constructive internal reflection” and advocate educational practices that promote effective balance between external attention and internal reflection.

Clinicians and teachers often discuss the benefits of "down time" and reflection for making sense of one's experiences and decisions about future behavior. For example, many experiential education programs emphasize the importance of time for introspection, and interventions and therapies that teach skills for quiet reflection and mindfulness produce benefits especially for social and emotional functioning (CASEL Briefs, 2007; Cohen, 2006; Semple, Lee, Rosa, & Miller, 2010), but also for academic achievement (Brackett, Rivers, Reyes, & Salovey, 2010). Why should this be, and how can developmental, clinical and educational psychologists better conceptualize the role of off-line and reflective processing for human development? Conversely, how might researchers think in new ways about the impacts of high environmental attentional demands on learning and socio-emotional development, including, for example, demands from entertainment media, from the challenges associated with urban settings, or in the classroom?

Emerging conceptions of brain functioning reveal that neural networks responsible for maintaining and focusing attention into the environment appear to toggle with a so-called "default" mode of brain function (DM) that is spontaneously induced during rest, daydreaming, and other non-attentive but awake mental states (Smallwood, Obonsawin, & Heim, 2003). Further evidence from social and affective neuroscience suggests the importance of brain systems implicated in the DM for active, internally-focused psychosocial mental processing, for example in tasks involving self-awareness and reflection, recalling personal memories, imagining the future, feeling emotions about the psychological impact of social situations on other people, constructing moral judgments, and others (Buckner, Andrews-Hanna & Schacter, 2008; Spreng & Grady, 2010; Spreng, Mar & Kim, 2009). Studies examining individual differences in the brain's DM connectivity, essentially measures of how coherently the areas of the network coordinate during rest and decouple during outward attention, find that people with stronger DM connectivity at rest score higher on measures of cognitive abilities like divergent thinking, reading comprehension, and memory (Li, et al., 2009; Song, et al., 2009; van den Heuvel, Stam, Kahn, Hulshoff Pol, 2009; Wig, et al., 2008). Taken together, these findings lead to a new neuroscientific conception of the brain's functioning "at rest"—namely, that neural processing during lapses in outward attention may be related to self and social processing and to thought that transcends concrete, semantic representations, and that the brain's efficient monitoring and control of task-directed and non-task directed states (or of outwardly and inwardly directed attention) may underlie important dimensions of psychological functioning. These findings also suggest the possibility that inadequate opportunity for children to play and adolescents to quietly reflect and to daydream may have negative consequences—both for social-emotional well-being and for their ability to attend well to tasks.

Despite the potential implications, however, psychological scientists are largely unaware of or have underappreciated the relevance of this actively growing body of neural findings, and cognitive neuroscientists interested in development and education have largely focused on the immediate, negative effects of attention lapses on task-directed performance (for example, Kane, et al., 2007; McVay & Kane, 2010; Smallwood, Beach, Schooler, & Handy, 2008; Smallwood, Fishman, & Schooler, 2007). Therefore, our goals in this article are: (1) to introduce psychological scientists to recent advances in understanding the functioning of the brain and mind during lapses in outward attention; (2) to generate an early hypothesis from the neuroscience findings concerning the effects of consistently high external attention demands in schools and leisure environments on socio-emotional development in children and adolescents;

(3) to propose preliminary examples of productive connections between this hypothesis and current educational and developmental psychological research findings, in order to demonstrate the utility of the neural findings for psychologists; and (4) to advocate educational practices that promote more effective balance between children's needs for external attention and internal reflection. The overarching premise of the article is that although daydreaming and other lapses in outward attention lead to poor performance on concentration-requiring tasks in the moment, skills for reflecting during lapses in outward attention, and time for safely indulging mind-wandering, may be critical for healthy development and learning in the longer term.

Looking out, and looking in: The discovery of complementary brain networks

Neuroscience studies over the past several decades have revealed that contrary to early theories, attention is not a general property of the whole brain but the product of specific networks that contribute to various aspects of processing. Decades of study have differentiated three systems responsible for monitoring and responding to the environment around us and for focusing our mental processing on incoming stimuli: alerting, orienting, and executive control (see Corbetta & Shulman, 2002; Fan, McCandliss, Sommer, Raz, & Posner, 2002; Posner & Petersen, 1990). These functions, which rely heavily on lateral frontal and parietal regions, are important for cognitive development, and interventions that support children in strengthening skills related to these aspects of attention improve cognitive and academic performance in a variety of domains (Posner & Rothbart, 2005; Smallwood, Fishman, & Schooler, 2007; Stevens, Lauinger, & Neville, 2009).

But, what does the brain do when not engaged in a focused, goal-directed task? Newly emerging theories of the brain's functional architecture reveal that the attention networks described above are part of a broader complement of brain networks that can roughly be conceptualized as supporting two alternating systems. One of these networks is "task positive;" its recruitment is associated with active engagement in goal-directed tasks involving attention into the world and evaluating the salience of external stimuli (Seeley, et al., 2007). This network supports what we will call the "looking out" system. Another network, known variously as the "task negative" or "resting" network, has been associated with the brain's "default mode" of operation (Buckner & Vincent, 2007; Raichle, et al., 2001). This network comprises mainly regions along the midline of the brain, in both the parietal and the frontal lobes, along with more lateral regions in the inferior part of the parietal lobe and the medial part of the temporal lobe (see Figure 1). During neuroimaging experiments, the activity in these regions is heightened most reliably during passive rest (Greicius, Krasnow, Reiss, & Menon, 2003), induced by paradigms such as asking participants to stare for several minutes at a plus sign shown in the center of their field of vision, or to relax with eyes open or closed. We will call this the "looking in" system. (Note on nomenclature: we use the term "network" to describe sets of brain regions whose activity is functionally coordinated. We use the term "system" to describe the psychologically relevant capacities that are supported by the brain "network.")

The past decade of neuroscience research has revealed that as one network is increasingly engaged, the other is decreasingly engaged (Esposito, et al., 2006; Fox, et al., 2005). It is thought that the toggling of these networks reflects a shift from a state of external monitoring and focus on goal-directed activity ("looking out") into a more free-form, internally directed, stimulus-independent mental state ("looking in"; see Smallwood, Brown, Baird, & Schooler, 2011 for a related argument). Recent research suggests that these networks' efficiency and co-regulation improves as the brain matures through childhood (Fair, et al., 2008) but that the rudiments of this

functional organization are present in childhood (Supekar, et al., 2010; Thomason, et al., 2008), infancy and possibly even prenatally (Doria, et al., 2010; Fransson, et al., 2007; but see Fransson, Åden, Blennow, & Lagercrantz, 2011).

In addition, it is likely that the networks that support systems for "looking in" and "looking out" are co-dependent and co-regulate one another—the functioning of one, both in the moment and over the longer term, appears to impact and predict the functioning of the other. There is a growing body of neuroscience studies showing that the quality of DM brain activity during rest impacts the quality of subsequent neural and behavioral responses to environmental stimuli, and that momentary and longer-lasting complementary fluctuations in these networks are important for perception, attention and goal-directed cognition (see Northoff, Duncan, & Hayes, 2010 for a review; Spreng, Stevens, Chamberlain, Gilmore, & Schacter, 2010). For example, in a neuroimaging experiment in which participants alternated blocks of resting with looking at images and listening to sounds, the more effectively the DM regions were activated during rest and deactivated while attending to the images and sounds, the more brain activation there was in sensory cortices during the image and sound presentations (Greicius & Menon, 2004). Longitudinal studies also suggest that there is considerable variability in the strength of DM connectivity among adults, and that although patterns of activity during rest are relatively stable in adulthood (Beason-Held, Kraut, & Resnick, 2009), training introspection (for example through meditation) can alter the functioning of DM networks as well as improve skills for sustained attention on a task (for example, Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Brewer et al., 2012, in press; Chiesa, Calati, & Serretti, 2010; Hölzel, et al., 2007; Jha, Krompinger, & Baime, 2007; Tang, et al., 2007).

Relations to individual differences in socio-emotional functioning

The efficiency with which a brain toggles between activity associated with DM and outward attention, as well as the strength of functional connectivity between DM regions during "rest", seem also to be associated with neural and psychological health, especially around social and emotional functioning. Atypicalities in DM functioning have been related to social-emotional symptoms in schizophrenia (Whitfield-Gabrieli, et al., 2009), autism (Cherkassky, Kana, Keller, & Just, 2006; Kennedy, Redcay, & Courchesne, 2006), attention deficit disorder (ADD; Castellanos, et al.; Tomasi & Volkow, 2012; Uddin, et al., 2008), anxiety disorders (Etkin, Prater, Schatzberg, Menon, & Greicius, 2009; Zhao, et al., 2007), depression (Greicius, et al., 2007), and other conditions. The differences in DM functioning among these populations seem to relate consistently to the hallmark symptoms of the disorder. For instance, autism is associated with atypically low levels of functional connectivity between DM regions during rest; these findings are thought to reflect a paucity of social and psychological thought and emotion (Kennedy & Courchesne, 2008). People with schizophrenia, by contrast, show heightened activation and hyper-connectivity in the DM network that are insufficiently attenuated during outward attention (Bluhm, et al., 2007; Garrity, et al., 2007; Zhou, et al., 2007); this pattern is thought to produce a heightened propensity toward mentalizing and a blurring of boundaries between one's own and others' minds that contributes to disordered thought when coupled with schizophrenics' excessive alertness to the external environment (Whitfield-Gabrieli, et al., 2009).

Relations to individual differences in cognitive functioning

Tantalizing new evidence suggests that certain aspects of DM functioning during "rest" and during tasks are related to intelligence in adults as indexed by standardized IQ scores, to reading and memory abilities, and to performance ability on attention-demanding cognitive

tasks. For example, studies have found that when people with higher IQ scores "rest" in the fMRI scanner, the DM connectivity in their brains, especially for long-range connections, is stronger than that measured in the brains of people with average IQs (Li, et al., 2009; Song, et al., 2009). The main finding concerns not the *amount* of activation in DM regions but the functional coordination or extent of "cross-talk" between DM regions. In participants with higher IQs, there is more efficient communication and coordination between frontal and parietal DM regions during "rest," which is thought to underlie better cognitive abilities for making connections between disparate pieces of information (van den Heuvel, et al., 2009).

With regard to reading and memory ability, findings are related to efficient toggling between the complementary networks. In reading studies, clearer functional segregation during "rest" between DM regions and a key brain region specialized for reading (the left fusiform gyrus, not part of the DM) is associated with reading skill among adults; this clear segregation is not yet mature in children aged 8-14 (Koyama, et al., 2011). In memory studies, better long-term recall is associated with greater deactivation of DM regions involved in encoding and recall, specifically the hippocampus and its neighboring parahippocampal gyrus, during simple cognitive tasks compared to during "rest" (Wig, et al., 2008). Failure to adequately deactivate another DM region, the posteromedial cortices, during a task requiring outwardly focused attention is also associated with memory declines in older adults (Miller, et al., 2008).

Finally, measures of efficient down-regulation of DM network activity during external attention-demanding tasks have been found to predict cognitive performance on these tasks in real time. For example, in an experiment using deep-brain electrode recording during simpler and more complex visual search tasks, magnitude of moment-to-moment suppression in DM networks increased with the complexity of processing required and predicted subjects' performance (Ossandon, et al., 2011).

To summarize, although the main focus in attention research relevant to development and education to date has been on "looking out" into the environment, for example, the facility with which a child filters out distractions and maintains focus on a task (Posner & Rothbart, 2005; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005), the neuroscience findings reviewed here suggest that: (1) the quality of neural processing that supports the system for "looking out" is tied to the quality of neural processing that supports the system for "looking in," and to individuals' abilities to move between these two modes efficiently; (2) the quality of neural processing during "looking in" is related to socio-emotional functioning, as well as to other dimensions of thought that transcend the 'here and now.' Yet, the implications of these neural findings for psychological development in naturalistic environments like schools have not been studied. The next section provides an overview of the psychological operations that have been related to activity in DM brain regions in adults, in order to begin a conversation among psychological scientists about the dimensions of thought associated with lapses in outward attention and developmental implications. We focus on socio-emotional functioning to highlight the interdependence of the neural networks that support attentive mental states and states that may promote meaning-making and socio-emotional well-being.

What does the mind do when the brain is "at rest"?: Memories, prospections, emotions and the mental "self"

As any normal human being can attest, when a person disengages from externally oriented goal-directed behavior, her mind is not idle—instead, she can become absorbed in a dynamic stream of free-form thought that is associated with mind wandering, spontaneous

recollection of previous memories, production of hypothetical scenarios and future plans, and other personal and social thoughts and imaginings (Andreasen, et al., 1995; Smallwood & Schooler, 2006). When considered this way, it is no wonder that some sectors of the brain are highly active during neuroimaging paradigms meant to induce "rest." The mind is not idle in the absence of externally-focused, goal-directed tasks—instead, the relative lapse in perceptual vigilance provides an opportunity to mentally wander far from the current physical context, maintaining just enough attention to engage automatic behaviors and to monitor the environment for interruptions, while indulging thoughts, fantasies and memories about the social world and the psychological self.

Interestingly, in addition to studies reporting signature DM activations during non goal-directed activities like "rest" in the fMRI scanner, there is now a growing list of neuroimaging studies that report activations in DM regions during goal-directed tasks involving introspective, socio-emotional and self-referential processing or simulation. For instance, activation in DM regions has been found for activities like feeling compassionate for a young mother with cancer or inspired by her determination (Immordino-Yang, McColl, Damasio, & Damasio, 2009), imagining how your own opinions would change if you awoke one day as the opposite sex (Tamir & Mitchell, in press), evaluating moral scenarios, for example, scenarios depicting treatment of wartime prisoners (Harrison, et al., 2008), and recalling memories for personal experiences (see Wagner, Shannon, Kahn, & Buckner, 2005, for a review).

Notably, processing related to cognitive perspective taking or traditional theory of mind functions, or that related to evaluating the more concrete and immediate physical and cognitive aspects of social situations, is *not* especially associated with DM regions (see Waytz & Mitchell, 2011 for a related argument). Instead, DM regions seem to be recruited for processing that pertains less to factual knowledge from one's memory or deduction about another's knowledge state and more to simulation and evaluation of abstract social, emotional and moral implications of one's own or others' knowledge states. For example, several studies have implicated the dorsomedial prefrontal cortex (dmPFC) in judgments about psychological traits and emotional qualities of the self and close others (Blakemore & Frith, 2004; Jenkins & Mitchell, 2011; Kelley, et al., 2002; Kitayama & Park, 2010; Mitchell, Banaji, & Macrae, 2005; Northoff, et al., 2006), an effect which can be modulated by in-group/out-group racial comparisons (Mathur, Harada, & Chiao, 2011, in press) and by cultural conceptions of interdependent versus independent self (Markus & Kitayama, 1991; Harada, Li, & Chiao, 2010). Involvement of the inferior/posterior sector of the posteromedial cortices (PMC), the most centrally connected "hub" of the DM network (Hagmann, et al., 2008), has been related to self-awareness (Buckner, Andrews-Hanna, & Schacter, 2008) and auto-biographical self (Damasio & Meyer, 2009), and has been consistently implicated in episodic and personal memory retrieval (Wagner, et al., 2005; Immordino-Yang & Singh, 2011), daydreaming (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009), moral judgment tasks (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001), and social emotions about others' mental qualities and circumstances, like admiring another's virtuous commitment to those less fortunate or feeling compassion for someone who has lost a loved one (Immordino-Yang, et al., 2009). By contrast, tasks that require simply recognizing and labeling an emotional facial expression from a picture, or emotionally reacting to a person's skillful performance or physical injury, do not recruit this network (and in fact may suppress its activation since they require outward attention; Immordino-Yang, et al., 2009; Sreenivas, Boehm, & Linden, 2012).

Taking this evidence together, we find that brain regions involved in the DM appear to be specifically recruited and specialized for processing abstract, episodic information relevant to the psychological, affective and subjective aspects of the self and other people, both in everyday contexts and for more complex moral, socio-emotional, prospective and retrospective functions. This description is necessarily broad—after all, DM activation could be said to underlie half of what the mind does. Our aim in providing this description is to give psychological scientists a sense of the dimensions of thought associated with lapses in outward attention, for comparison with those associated with heightened outward attention (for example, sensory perception and vigilance to the physical context, cognitive processing of situationally relevant tasks, motor control and coordination of actions, perception of social and emotional stimuli [but not deep reflection on their meaning], recalling semantic or factual information, etc.). This comparison is important because, judging from what is being learned of brain functioning, activating the neural platform that supports mental processes associated with DM regions may be relatively incompatible with externally focused attention or vigilance into the environment, especially while control systems for monitoring and alternately engaging inward focus and outward attention are immature. Our hope is that in distilling the neural findings we have provided a starting point for appreciating the breadth of their applicability. The next section grounds these ideas with a naturalistic example, in order to narrow the focus onto a new hypothesis for development.

An example of spontaneous "looking in" during social learning

Consider the reaction of one college-age participant, "John," during a one-on-one social emotion-induction interview in which he was told a true story meant to induce compassion. The story is about a young boy who grew up in a small industrial city in China during an economic depression that often left him hungry. The boy's father had died just after his son's birth, leaving his mother to work long hours as a laborer. John is shown a video clip in which the boy's mother describes how, one winter afternoon, she found a coin on the ground and used it to buy warm cakes for her son, who had been all day at school with nothing to eat. The mother recounts how her son had been so hungry, yet he had offered her the last cake, which she declined by lying that she had eaten already. After the video, the experimenter asks John how this situation makes him feel, to which John responds:

> "This is the one [true story from the experiment] that's hit me the most, I suppose. And I'm not very good at verbalizing emotions. But… um… I can almost feel the physical sensations. It's like there's a balloon or something just under my sternum, inflating and moving up and out. Which, I don't know, is my sign of something really touching… [pause] And, so, the selflessness of the mother… and then also of the little boy. You know, having these wonderful cakes that he never gets to have, and still offering them to her… and then her turning them down, is… uh… [long pause] It makes me think about my parents, because they provide me with so much and I don't thank them enough, I don't think… I *know* I don't. So, I should do that." (adapted from Immordino-Yang, 2011)

In answering the straightforward question of how this story makes him feel, John reveals a common pattern in which deliberations leading to a complex reaction to a social situation begin with a general report of feeling emotionally touched or moved ("hit"), sometimes accompanied by visceral sensations ("a balloon..under my sternum"). Even though John does not seem to really know yet what emotion he is having ("I'm not very good at verbalizing"), he notices the emotional power of the story based on feeling physiological "signs". But he does not stop there.

Instead, after briefly reviewing the relevant actions from the story (who gave whom what to eat), and their meaning based on what he knows about the situation (there is a shortage of food, so sharing food implies "selflessness"), John pauses. He appears to briefly withdraw from the interaction with the experimenter and blankly gaze into his lap. Then, he emerges with a report of having spontaneously evaluated his own relationship with his parents. It appears that by evaluating the emotional implications of another boy's situation, John seems to have learned to better appreciate his own.

How does this example pertain to the argument at hand? John's reaction to the compassion-inducing story nicely demonstrates how new insights and understandings are actively, dynamically constructed (Fischer & Bidell, 2006; Fischer & Immordino-Yang, 2002)—learners build from prior knowledge and work to actively accommodate new information to make sense of the current situation. It also demonstrates the value of a reflective pause in moving from considering the concrete, action-oriented, context-specific details of *this* situation (knowing what happened and why) to constructing an understanding of the broader and longer-term emotional implications for one's own or *any* situation (in John's case, what the actions mean for the protagonists' psychological qualities, and how recognizing these qualities leads him to express greater appreciation of his own parents' sacrifices for him). Interestingly, our neural data support the interpretation that John's pauses are a behavioral manifestation of DM neural activity. Our current analyses reveal that the more a participant reflectively pauses in the social emotions interview, the more cognitively abstract and complex his or her answers (i.e. the higher the construal level; Pavarini, Schnall, & Immordino-Yang, under review), the more DM activity s/he will later show when feeling emotions with moral connotations in the MRI scanner, and the stronger the participants' DM connectivity during rest (Immordino-Yang, Pavarini, Schnall, & Yang, in preparation). In the next section, we focus on two developmental implications of the findings: (1) that time and skills for constructive internal reflection are beneficial for emotional learning and well-being; and (2) that inordinately biasing children's and adolescents' attention into the external world may undermine the development of abilities to think about the abstract, moral and social-emotional aspects of situations, information and self. Put another way, we hypothesize that consistently imposing high attention demands on children, either in school, through entertainment, or through living conditions, may rob them of opportunities to advance from thinking about "what happened" or "how to do this" to constructing knowledge about "what this means for the world and for the way I live my life." For instance, it could lead teenagers to admire a skillful sports player but not the mental fortitude of, say, a courageous civil rights leader.

What does this mean for children?: Toward the hypothesis that healthy psychological development requires opportunities and skills for "looking in"

One implication of the DM findings is that the brain seems to honor a distinction between the processing of information about concrete, physical, and immediate circumstances, facts and procedures, and abstract information about mental, hypothetical and longer-term circumstances and implications. Given that deliberating on abstract social-emotional and hypothetical circumstances seems to be associated with the "looking in" system, we hypothesize that these kinds of thinking may be particularly vulnerable to disruption by external distraction, especially while attentional monitoring and control are immature. Had the experimenter above interrupted John during his reflective pause, would he have made the conceptual leap from considering the story to evaluating his own relationship with his parents? If John had grown up under conditions

that did not support time for safe internal reflection, would he have failed to fully develop this skill? We do not know the answers to these questions. But, given the accumulating neural evidence, it seems reasonable to conjecture that important skills for reflection and for building personal meaning may depend heavily upon psychological functions associated with activity in DM brain networks, and may therefore be curtailed if environmental attention demands and distractions are consistently overly high.

Preliminary connections to education

Although education research on learning and achievement have not been framed to highlight transitions to internally focused attention, there are hints that teaching skills for productive internal, self-directed processing in schools may be beneficial both for socio-emotional well-being and for academic skills (see also Yeager & Walton, 2011; Immordino-Yang & Sylvan, 2010). For example, high school students encouraged before a test to write in a journal about their beliefs about the implications of their test performance for their life more broadly overcame anxiety and performed better (Ramirez & Beilock, 2011). Similarly, envisioning advantageous possibilities for one's future identity and connecting these possibilities to current behavioral choices have been found to powerfully improve school performance and motivation (Oyserman, Terry, & Bybee, 2002), but the efficacy of these activities is heavily dependent on students' subjective interpretation of their experiences (Destin & Oyserman, 2009; Hatcher & Bringle, 1997). In elementary school-aged children, emotional well-being, self confidence, and academic achievement are bolstered for students taught to take a "meta-moment" in which they remove themselves from distracting circumstances, reflectively evaluate their memories and feelings, envision an ideal "self," and then make an appropriate plan (Brackett et al., 2010).

Together, these interventions may improve academic performance, compared to various control interventions without a socioemotional focus, in part because they set up neuropsychological circumstances optimally conducive to extracting the emotional meaning of situations, to connecting this meaning to personal memories, and to imagining a better future course of action. Of course, students should not be encouraged to waste time or to dwell on inconsequential or irrelevant private musings during work time. Doing so clearly decreases productivity (Smallwood, Fishman, & Schooler, 2007). Still, the DM research reviewed here suggests that for students to optimally engage attentively to tasks, they may also require skills and opportunities for high-quality knowledge consolidation. Considering the neural and psychological evidence together suggests that *adequate developmental opportunity for appropriate lapses in outwardly directed attention, and potentially even for high-quality introspective states, may be important for well-being and for optimal performance on focused tasks, as the quality of thought during "looking in" and "looking out" may be interdependent.* Because of this, *it may be that educational experiences and settings crafted to promote balance between "looking out" and "looking in," in which children are guided to navigate between and leverage the brain's complementary networks skillfully and in which teachers work to distinguish between loss of attentive focus and engaging a mindful, reflective focus, will prove optimal for development.* Put another way, leaving room for self-relevant processing in school may help students *own* their learning, both the process and the outcomes.

Emerging evidence on the effects of heavy social media use

The prevalence of digitally-mediated communication and entertainment among youths has dramatically increased in recent years, and texting is reputedly superseding all other forms of

friendship interaction among teens in developed nations (Pew Research Center, 2010; 2011). This shift in technology use has caused widespread concern about how heavy reliance on digitally mediated communication may affect development. Are children losing skills for face-to-face social interaction, and how would this loss of skill manifest psychologically?

Although there is very little published research to date addressing these questions, cumulative evidence on DM functioning would suggest a relatively straightforward implication. If youths overuse social media, if they spend very little waking time free from the possibility that a text will interrupt them, we would expect that these conditions might predispose youths toward focusing on the concrete, physical and immediate aspects of situations and self, with less inclination toward considering the abstract, longer-term, moral and emotional implications of their and others' actions. One recent study of more than 2300 young adults (Canadian college students aged 18-22) tested related hypotheses and found results that accord remarkably with these predictions (Trapnell & Sinclair, 2012). The study found that high levels of social texting among research participants were weakly but consistently positively associated with out-group prejudice and materialism, for example, with reporting lower positivity toward indigenous Canadians and that physical attractiveness is an important personal value. Conversely, high levels of texting were consistently negatively associated with measures of moral reflectiveness, for example, with motivation to promote social equality or justice in the community, and with perceived importance of living with integrity.

Although it is not clear in this study whether texting caused the moral changes or whether youths with particular social dispositions gravitate toward heavy use of texting, there are hints that the effects might be causal. Trapnell and Sinclair (2012) also found that an increase in texting over the five years of the study (2007-2011) paralleled a decrease in reported reflectivity. A separate experimental manipulation study by Abraham, Pocheptsova and Ferraro (in preparation) found that after being asked to draw and describe their cell phone, participants showed temporary decreases in prosocial behavior (as measured by willingness to donate time or resources to a charity for the homeless), but increases in perceived social connectedness. Another small-scale study reported that among youths, higher texting frequency was associated with finding friendships less "fulfilling" (Angstermichael & Lester, 2010). The somewhat alarming implication, still not directly tested, is that if youths are habitually pulled into the outside world by distracting media snippets, or if their primary mode of socially interacting is via brief, digitally transmitted communications, they may be systematically undermining opportunities to reflect on the moral, social, emotional, and longer-term implications of social situations and personal values. This situation could potentially alter the perceived quality of their social relationships, and over time might bias identity development toward focusing on concrete or physical abilities, traits and accomplishments.

Of note, in our opinion the preliminary findings described here should not be taken as de facto evidence that access to technology is necessarily bad for development or weakens morality. After all, texting is another (digital) tool that is only as good as the user's purposes or goals. If texting is used to change momentary, context specific behavior, for example to remind individuals with health problems to engage in particular health-related behaviors, evidence suggests that it can be remarkably effective (Cole-Lewis & Kershaw, 2010). Instead, these data should be taken as an early warning of the possibility that overusing technologies that reduce social communication to short snippets that continually interrupt the receiver, and that restrict communication to less reflective content, could be harmful. "High texting" youths in the

Trapnell and Sinclair (2012) study sometimes reported receiving or sending upward of 300 non-work-related texts per day, which is more than twice the average reported by the Pew Research Foundation (2011).

Of course, the flip side of the coin might also be true: if used well, access to these same technologies could promote social reflectiveness and moral responsibility by facilitating communication between people who are far from each other, and who would not otherwise have opportunities to interact, in order to foster empathic understanding of world situations and cross-cultural perspectives. For example, in the Iranian election protests of 2009-2010, rapid-fire social media are thought to have been instrumental both for the organization of the political movement and for garnering international empathy for protesters (Kamalipour, 2010). For another example, primary schools with a global curricular focus by necessity employ digital media to connect classrooms oceans apart, so that students can share experiences and beliefs with students from different cultural backgrounds (Süssmuth, 2007; see also http://www.iearn.org). In the end, the question will not be as much about what the technology does to people, as it will be about how best to use the technology in a responsible, beneficial way that promotes rather than hinders social development.

Meaning-making and the brain: Forging an interdisciplinary research focus on constructive internal reflection

Taken together, the neurobiological research suggests a need to conceptualize and study processes of knowledge-building that may be supported during internally focused thought and vulnerable to disruption by external input. The findings suggest that these processes may span from relaxed mind-wandering and daydreaming to intense and effortful internal focus. Relaxed daydreaming is potentially important for deriving and sifting through the social and emotional implications of everyday situations and relationships, and connecting them to personal experiences and future goals (see also Baird, Smallwood, & Schooler, 2011); effortful internal focus is potentially important for making meaning of new information and for distilling creative, emotionally-relevant connections between complex ideas. We use the term "*constructive internal reflection*" to describe this range of skills and behaviors in the hope that future research will flesh out and validate the dimensions of internally focused thought and their relation to psychological constructs such as attention, memory, abstract concepts, identity formation, critical thinking and socio-emotional development.

Future research could also address the possibility of individual differences in thinking during "rest" in the scanner, to explore the naturalistic thought patterns that individuals call up as they daydream idly or reflect purposefully, and relations to social behavior and other developmental outcomes. For a classic example, work by Mischel and others on self-control in children demonstrates the beneficial effects of strategic abstraction on the ability to delay immediate gratification (Mischel, Ebbesen, & Zeiss, 1972; Mischel, Shoda, & Rodriguez, 1989). Famously, 4-year-old children who were able to distract themselves from eating a marshmallow when left alone with it, in order to successfully wait fifteen minutes to obtain a promised additional marshmallow (or other treat), later grew into more academically and socio-emotionally competent adolescents and more successful adults than children who were unable to delay their gratification for a later reward (Mischel, Shoda, & Peake, 1988; Moffitt, et al., 2011). Interestingly, though, differences in the thought strategies 4-year-old preschool children used to avoid eating the treat were associated with how long they were able to wait: children who distracted themselves and avoided looking at the marshmallow did relatively well. But, children

who instead imagined future and hypothetical possibilities, for example focusing on how delicious the second marshmallow would taste, or imagining that the marshmallow in front of them was a cloud, delayed the longest (for reviews, see Mischel, Shoda, & Rodriguez, 1989; Mischel, et al., 2011).

Building from these findings, in launching a research focus on constructive internal reflection, our recommendation is that the new research build from work on the primacy of meaning-making for human development—beginning with classic work by Frankl (1946/2006), Bruner (1990), Kegan (1982), Mezirow (2000) and others, and continuing with more modern work (see Park, 2010 for a review). This work collectively recognizes the importance of revisiting and reorganizing one's memories to reconcile them with current experiences, in order to purposefully move forward with a productive, fulfilling life. These researchers' theories also universally recognize the role of internal reflection in this reconciliation process. But we would contend that neuroscientific studies hold the potential to offer a new view of this psychological landscape, as well as new tools to probe it—suggesting explanations and mechanisms for *why* meaning-making requires reflection, as well as an early hypothesis about how development may be reshaped under conditions of systematically high environmental attention demands.

In conclusion, a new research focus is needed to formulate and explore the implications of the brain's DM functioning for psychological development. This research would more deeply probe the conditions under which internally and externally focused attention become active, as well as how the development of mechanisms for monitoring and shifting between these modes is shaped by experience, context and biological predispositions. As therapists, teachers and parents who discuss the benefits of "down time" well know, as does anyone who has had a creative insight in the shower: rest is indeed not idleness, nor is it a wasted opportunity for productivity. Rather, constructive internal reflection is potentially critical for learning from one's past experiences and appreciating their value for future choices, and for understanding and managing ourselves in the social world.

REFERENCES

Abraham, A., Pocheptsova, A. & Ferraro, R. (in preparation). The effect of mobile phone use on prosocial behavior.

Andreasen, N. C., O'Leary, D. S., Cizadlo, T., Arndt, S., Rezai, K., Watkins, G. L., et al. (1995). Remembering the past: Two facets of episodic memory explored with positron emission tomography. *Am J Psychiatry, 152*(11), 1576-1585.

Angstermichael, A., & Lester, F. (2010). An exploratory study of students' use of cell phones, texting and social networking sites. *Psychological Reports, 107*(2), 402-404.

Baird, B., Smallwood, J., & Schooler, J. W. (2011). Back to the future: Autobiographical planning and the functionality of mind-wandering. *Consciousness and Cognition, 20*(4), 1604-1611.

Beason-Held, L., Kraut, M., & Resnick, S. (2009). Stability of Default-Mode Network Activity in the Aging Brain. *Brain Imaging and Behavior, 3*(2), 123-131.

Blakemore, S. J., & Frith, U. (2004). How does the brain deal with the social world? *Neuroreport, 15*(1), 119-128.

Bluhm, R. L., Miller, J., Lanius, R. A., Osuch, E. A., Boksman, K., Neufeld, R. W., et al. (2007). Spontaneous low-frequency fluctuations in the BOLD signal in schizophrenic patients: anomalies in the default network. *Schizophr Bull, 33*(4), 1004-1012.

Brackett, M. A., Rivers, S. E., Reyes, M. R., & Salovey, P. (2010, in press). Enhancing academic performance and social and emotional competence with the RULER feeling words curriculum. *Learning and Individual Differences*.

Brefczynski-Lewis, J. A., Lutz, A., Schaefer, H. S., Levinson, D. B., & Davidson, R. J. (2007). Neural correlates of attentional expertise in long-term meditation practitioners. *Proceedings of the National Academy of Sciences, 104*(27), 11483-11488.

Brewer, J.A., Worhunsky, P.D., Gray, J.R., Tang, Y.-Y., Weber, J., Kober, H. (2012, in press). Meditation experience is associated with differences in default mode network activity and connectivity. *Proceedings of the National Academy of Sciences.*

Bruner, J. (1990) Acts of Meaning: Four Lectures on Mind and Culture. Cambridge, MA: Harvard College.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: Anatomy, function, and relevance to disease. *Year in Cognitive Neuroscience 2008, 1124*, 1-38.

Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in Cognitive Sciences, 11*(2), 49-57.

Buckner, R.L., Vincent, J.L. (2007). Unrest at rest: Default activity and spontaneous network correlations. *NeuroImage 37*(4), 1091-1096.

CASEL Briefs (2007). *Background on Social and Emotional Learning (SEL)*: Collaborative for Academic, Social, and Emotional Learning. http://www.casel.org.

Castellanos, F. X., Margulies, D. S., Kelly, C., Uddin, L. Q., Ghaffari, M., Kirsch, A., et al. (2008). Cingulate-precuneus interactions: a new locus of dysfunction in adult attention-deficit/hyperactivity disorder. *Biol Psychiatry, 63*(3), 332-337.

Cherkassky, V. L., Kana, R. K., Keller, T. A., & Just, M. A. (2006). Functional connectivity in a baseline resting-state network in autism. *Neuroreport, 17*(16), 1687-1690.

Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., & Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *Proceedings of the National Academy of Sciences, 106*(21), 8719-8724.

Chiesa, A., Calati, R., & Serretti, A. (2010). Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings. *Clinical Psychology Review*.

Cohen, J. (2006). Social, Emotional, Ethical, and Academic Education: Creating a Climate for Learning, Participation in Democracy, and Well-Being. *Harvard Educational Review, 76*(2), 201-237.

Cole-Lewis, H., & Kershaw, T. (2010). Text messaging as a tool for behavior change in disease prevention and management. *Epidemiologic Reviews, 32*(1), 56-69.

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3*(3), 201-215.

Damasio, A., & Meyer, K. (2009). Consciousness: An overview of the phenomenon and of its possible neural basis. In S. Laureys and G. Tononi (Eds.), *The Neurology of Consciousness* (pp. 3-14). London: Elsevier.

Doria, V., Beckmann, C. F., Arichi, T., Merchant, N., Groppo, M., Turkheimer, F. E., Counsell, S. J., Murgasova, M., Aljabar, P., Nunes, R. G., Larkman, D. J., Rees, G., Edwards, A. D. (2010). Emergence of resting state networks in the preterm human brain. *Proceedings of the National Academy of Sciences, 107*(46), 20015-20020.

Esposito, F., Bertolino, A., Scarabino, T., Latoffe, V., Blasi, G., Popolizio, T., et al. (2006). Independent component model of the default-mode brain function: Assessing the impact of active thinking. *Brain Research Bulletin, 70*(4-6), 263-269.

Etkin, A., Prater, K. E., Schatzberg, A. F., Menon, V., & Greicius, M. D. (2009). Disrupted amygdalar subregion functional connectivity and evidence of a compensatory network in generalized anxiety disorder. *Arch Gen Psychiatry, 66*(12), 1361-1372.

Fair DA, Cohen, A. L., Dosenbach, N. U., Church, J. A., Miezin, F. M., Barch, D. M., Raichle, M. E., Petersen, S. E., Schlaggar, B. L. (2008). The maturing architecture of the brain's default network. *Proceedings of the National Academy of Sciences, 105*(10), 4028-4032.

Fan, J., McCandliss, B., Sommer, T., Raz, A., & Posner, M. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience, 14*(3), 340-347.

Fischer, K. W., & Bidell, T. (2006). Dynamic development of action and thought. In W. Damon & R. Lerner (Eds.), *Handbook of Child Psychology, Vol. 1: Theoretical Models of Human Development* (6th ed., pp. 313-399). Hoboken, NJ: John Wiley &Sons.

Fischer, K. W., & Immordino-Yang, M. H. (2002). Cognitive development and education: From dynamic general structure to specific learning and teaching. In E. Lagemann (Ed.), *Traditions of scholarship in education*. Chicago: Spencer Foundation.

Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., Van Essen, D. C., & Raichle, M. E. (2005). The human brain is intrinsically organized into dynamic, anticorrelated functional networks. [Article]. *Proceedings of the National Academy of Sciences, 102*(27), 9673-9678.

Frankl, V. E. (1946/2006) Man's Search for Meaning. Boston, MA: Beacon Press.

Fransson, P., Åden, U., Blennow, M., & Lagercrantz, H. (2011). The functional architecture of the infant brain as revealed by resting-state fMRI. *Cerebral Cortex, 21*(1), 145-154.

Fransson, P., Skiold, B., Horsch, S., Nordell, A., Blennow, M., Lagercrantz, H., Aden, U. (2007). Resting-state networks in the infant brain. *Proceedings of the National Academy of Sciences, 104*(39), 15531-15536.

Garrity, A. G., Pearlson, G. D., McKiernan, K., Lloyd, D., Kiehl, K. A., & Calhoun, V. D. (2007). Aberrant "Default Mode" Functional Connectivity in Schizophrenia. *American Journal of Psychiatry, 164*(3), 450-457.

Gilbert, D. T., & Wilson, T. D. (2007). Prospection: Experiencing the future. *Science, 317*(5843), 1351-1354.

Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science, 293*(5537), 2105-2108.

Greicius, M. D., Flores, B. H., Menon, V., Glover, G. H., Solvason, H. B., Kenna, H., et al. (2007). Resting-state functional connectivity in major depression: abnormally increased contributions from subgenual cingulate cortex and thalamus. *Biological Psychiatry, 62*(5), 429-437.

Greicius, M. D., Krasnow, B., Reiss, A. L., & Menon, V. (2003). Functional connectivity in the resting brain: A network analysis of the default mode hypothesis. *Proceedings of the National Academy of Sciences, 100*(1), 253-258.

Greicius, M. D., & Menon, V. (2004). Default-Mode Activity during a Passive Sensory Task: Uncoupled from Deactivation but Impacting Activation. *Journal of Cognitive Neuroscience, 16*(9), 1484-1492.

Hagmann, P., Cammoun, L., Gigandet, X., Meuli, R., Honey, C. J., Wedeen, V. J., et al. (2008). Mapping the structural core of human cerebral cortex. *PLoS Biology, 6*(7), e159.

Harada, T., Li, Z., & Chiao, J. Y. (2010). Differential dorsal and ventral medial prefrontal representations of the implicit self modulated by individualism and collectivism: An fMRI study. *Social Neuroscience, 5*(3), 257 - 271.

Harrison, B. J., Pujol, J., Lopez-Sola , M., Hernandez-Ribas, R., Deus, J., Ortiz, H., et al. (2008). Consistency and functional specialization in the default mode brain network. *Proceedings of the National Academy of Sciences, 105*(28), 9781-9786.

Hölzel, B. K., Ott, U., Hempel, H., Hackl, A., Wolf, K., Stark, R., et al. (2007). Differential engagement of anterior cingulate and adjacent medial frontal cortex in adept meditators and non-meditators. *Neuroscience Letters, 421*(1), 16-21.

Immordino-Yang, M. H. (2011). Me, myself and *you*: Neuropsychological relations between social emotion, self awareness, and morality. *Emotion Review, 3*(3), 313-315.

Immordino-Yang, M., McColl, A., Damasio, H., & Damasio, A. (2009). Neural correlates of admiration and compassion. *Proceedings of the National Academy of Sciences, 106*(19), 8021-8026.

Immordino-Yang, M.H., Pavarini, G., Schnall, S. and Yang, X. (in preparation). Naturalistic behaviors during admiration for virtue, but not admiration for skill, predict activation in default-mode brain regions.

Immordino-Yang, M. H., & Singh, V. (2011, in press). Hippocampal contributions to the processing of social emotions. *Human Brain Mapping*.

Immordino-Yang, M. H., & Sylvan, L. (2010). Admiration for virtue: Neuroscientific perspectives on a motivating emotion. *Contemporary Educational Psychology, 35*(2), 110-115.

Jenkins, A.C. & Mitchell, J.P. (2011). Medial prefrontal cortex subserves diverse forms of self-reflection. *Social Neuroscience, 6*(3), 211-218.

Jha, A. P., Krompinger, J., & Baime, M. J. (2007). Mindfulness training modifies subsystems of attention. *Cognitive Affective & Behavioral Neuroscience, 7*(2), 109-119.

Kamalipour, Y. (2010) *Media, Power and Politics in the Digital Age: The 2009 Presidential Election Uprising in Iran.* Plymouth, U.K: Rowman and Littlefield.

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). For whom the mind wanders, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science, 18*(7), 614-621.

Kegan, R. (1982). *The Evolving Self.* Cambridge, MA: Harvard University Press.

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An event-related fMRI study. *Journal of Cognitive Neuroscience, 14*(5), 785-794.

Kennedy, D. P., & Courchesne, E. (2008). Functional abnormalities of the default network during self- and other-reflection in autism. *Social Cognitive Affect Neuroscience, 3*(2), 177-190.

Kennedy, D. P., Redcay, E., & Courchesne, E. (2006). Failing to deactivate: Resting functional abnormalities in autism. *Proceedings of the National Academy of Sciences, 103*(21), 8275-8280.

Kitayama, S., & Park, J. (2010). Cultural neuroscience of the self: Understanding the social grounding of the brain. *Social Cognitive and Affective Neuroscience, 5*(2-3), 111-129.

Koyama, M. S., Di Martino, A., Zuo, X.-N., Kelly, C., Mennes, M., Jutagir, D. R., et al. (2011). Resting-State Functional Connectivity Indexes Reading Competence in Children and Adults. *The Journal of Neuroscience, 31*(23), 8617-8624.

Li, Y., Liu, Y., Li, J., Qin, W., Li, K., Yu, C., et al. (2009). Brain anatomical network and intelligence. *PLoS Comput Biol, 5*(5), e1000395.

Markus, H., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*(2), 224-253.

Mathur, V., Harada, T., & Chiao, J. Y. (2011, in press). Racial identification modulates default network activity for same and other races. *Human Brain Mapping*.

McVay, J. C., & Kane, M. J. (2010). Does mind wandering reflect executive function or executive failure? Comment on Smallwood and Schooler (2006) and Watkins (2008). *Psychol Bull, 136*(2), 188-197; discussion 198-207.

Mezirow, J. (2000). *Learning as transformation: Critical perspectives on a theory in progress*. San Francisco, CA: Jossey-Bass.

Miller, S. L., Celone, K., DePeau, K., Diamond, E., Dickerson, B. C., Rentz, D., et al. (2008). Age-related memory impairment associated with loss of parietal deactivation but preserved hippocampal activation. *Proceedings of the National Academy of Sciences, 105*(6), 2181-2186.

Mitchell, J. P., Banaji, M. R., & Macrae, C. N. (2005). The link between social cognition and self-referential thought in the medial prefrontal cortex. *Journal of Cognitive Neuroscience, 17*(8), 1306-1315.

Mischel, W., Ayduk, O., Berman, M. G., Casey, B. J., Gotlib, I. H., Jonides, J., et al. (2011). 'Willpower' over the life span: Decomposing self-regulation. *Social Cognitive Affective Neuroscience, 6*(2), 252-256.

Mischel, W., Ebbesen, E. B., & Zeiss, A. R. (1972). Cognitive and attentional mechanisms in delay of gratification. *Journal of Personality and Social Psychology, 21*, 204-218.

Mischel, W., Shoda, Y., & Peake, P. K. (1988). The nature of adolescent competencies predicted by preschool delay of gratification. *Journal of Personality and Social Psychology, 54*, 687-696.

Mischel, W., Shoda, Y., & Rodriguez, M. (1989). Delay of gratification in children. *Science, 244*, 933-938.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., et al. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences, 108*(7), 2693-2698.

Northoff, G., Duncan, N. W., & Hayes, D. J. (2010). The brain and its resting state activity--Experimental and methodological implications. *Progress in Neurobiology, 92*(4), 593-600.

Northoff, G., Heinzel, A., de Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain--A meta-analysis of imaging studies on the self. *NeuroImage, 31*(1), 440-457.

Ossandon, T., Jerbi, K., Vidal, J. R., Bayle, D. J., Henaff, M. A., Jung, J., et al. (2011). Transient suppression of broadband gamma power in the default-mode network is correlated with task complexity and subject performance. *J Neurosci, 31*(41), 14521-14530.

Park, C. L. (2010). Making sense of the meaning literature: An integrative review of meaning making and its effects on adjustment to stressful life events. *Psychological Bulletin, 136*, 257-301.

Pavarini, Schnall, Immordino-Yang, (under review). Verbal and Nonverbal Indicators of Psychological Distance in Moral Elevation and Admiration for Skill.

Pew Research Center (2010, Dec. 20) *Global digital communication: Texting, social networking popular worldwide*. Retrieved February 22, 2012, from http://www.pewglobal.org/2011/12/20/global-digital-communication-texting-social-networking-popular-worldwide/

Pew Research Center (2011, Sept. 19) *Americans and text messaging.* Retrieved February 22, 2012, from http://pewinternet.org/Reports/2011/Cell-Phone-Texting-2011/Summary-of-Findings.aspx

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13*, 25-42.

Posner, M. I., & Rothbart, M. K. (2005). Influencing brain networks: implications for education. *Trends in Cognitive Sciences, 9*(3), 99-103.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences, 98*(2), 676-682.

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance in the classroom. *Science, 331*(6014), 211-213.

Rueda, M. R., Rothbart, M. K., McCandliss, B. D., Saccomanno, L., & Posner, M. I. (2005). Training, maturation, and genetic influences on the development of executive attention. *Proceedings of the National Academy of Sciences, 102*(41), 14931-14936.

Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., et al. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *Journal of Neuroscience, 27*(9), 2349-2356.

Semple, R., Lee, J., Rosa, D., & Miller, L. (2010). A Randomized Trial of Mindfulness-Based Cognitive Therapy for Children: Promoting Mindful Attention to Enhance Social-Emotional Resiliency in Children. *Journal of Child and Family Studies, 19*(2), 218-229.

Smallwood, J., Beach, E., Schooler, J. W., & Handy, T. C. (2008). Going AWOL in the brain: Mind wandering reduces cortical analysis of external events. *Journal of Cognitive Neuroscience, 20*, 458-469.

Smallwood, J., Brown, K., Baird, B., & Schooler, J. W. (2011). Cooperation between the default mode network and the frontal-parietal network in the production of an internal train of thought. *Brain Res*.

Smallwood, J., Fishman, D. J., & Schooler, J. W. (2007). Counting the cost of an absent mind: Mind wandering as an underrecognized influence on educational performance. *Psychonomic Bulletin & Review, 14*(2), 230-236.

Smallwood, J., Obonsawin, M., & Heim, D. (2003). Task unrelated thought: The role of distributed processing. *Conscious Cogn, 12*(2), 169-189.

Smallwood, J., & Schooler, J. W. (2006). The Restless Mind. *Psychological Bulletin, 132*(6), 946-958.

Spreng, R.N. & Grady, C.L. (2010) Patterns of Brain Activity Supporting Autobiographical Memory, Prospection, and Theory of Mind, and Their Relationship to the Default Mode Network. Journal of Cognitive Neuroscience 22, 1112-1123.

Spreng, R.N., Mar, R.A., Kim, A.S.N., 2009. The Common Neural Basis of Autobiographical Memory, Prospection, Navigation, Theory of Mind, and the Default Mode: A Quantitative Meta-analysis. Journal of Cognitive Neuroscience 21, 489-510.

Spreng, R. N., Stevens, W. D., Chamberlain, J. P., Gilmore, A. W., & Schacter, D. L. (2010). Default network activity, coupled with the frontoparietal control network, supports goal-directed cognition. *Neuroimage, 53*(1), 303-317.

Song, M., Liu, Y., Zhou, Y., Wang, K., Yu, C., & Jiang, T. (2009). Default network and intelligence difference. *Conference Procedings IEEE Eng Med Biol Soc, 2009*, 2212-2215.

Sreenivas, S., Boehm, S. G., & Linden, D. E. (2012). Emotional faces and the default mode network. *Neuroscience Letters, 506*(2), 229-234.

Stevens, C., Lauinger, B., & Neville, H. (2009). Differences in the Neural Mechanisms of Selective Attention in Children from Different Socioeconomic Backgrounds: An Event-Related Brain Potential Study. *Developmental Science, 12*(4), 634-646.

Supekar, K., Uddin, L. Q., Prater, K., Amin, H., Greicius, M. D., & Menon, V. (2010). Development of functional and structural connectivity within the default mode network in young children. *NeuroImage, 52*(1), 290-301.

Süssmuth, R. (2007). On the need for teaching intercultural skills. In M. Suárez-Orozco (Ed.), *Learning in the Global Era: International Perspectives on Globalization and Education*. Berkeley, CA: University of California Press.

Tamir, D. I., & Mitchell, J. P. (2010). Neural correlates of anchoring-and-adjustment during mentalizing. *Proceedings of the National Academy of Sciences, 107*(24), 10827-10832.

Tamir, D. I., & Mitchell, J. P. (2011). The Default Network Distinguishes Construals of Proximal versus Distal Events. *Journal of Cognitive Neuroscience 23*(10), 2945-2955.

Tang, Y. Y., Ma, Y. H., Wang, J., Fan, Y. X., Feng, S. G., Lu, Q. L., et al. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences, 104*, 17152-17156.

Thomason, M. E., Chang, C. E., Glover, G. H., Gabrieli, J. D. E., Greicius, M. D., & Gotlib, I. H. (2008). Default-mode function and task-induced deactivation have overlapping brain substrates in children. *NeuroImage, 41*(4), 1493-1503.

Tomasi, D., & Volkow, N. (2012). Abnormal functional connectivity in children with attention-deficit/hyperactivity disorder. *Biological Psychiatry, 71*(5), 443-450.

Trapnell, P., & Sinclair, L. (January, 2012). *Texting frequency and the moral shallowing hypothesis*. Poster presented at the Annual Meeting of the Society for Personality and Social Psychology, San Diego, CA.

Uddin, L. Q., Kelly, A. M., Biswal, B. B., Margulies, D. S., Shehzad, Z., Shaw, D., et al. (2008). Network homogeneity reveals decreased integrity of default-mode network in ADHD. *J Neurosci Methods, 169*(1), 249-254.

van den Heuvel, M.P., Stam, C.J., Kahn, R.S., Hulshoff Pol, H.E., 2009. Efficiency of functional brain networks and intellectual performance. *Journal of Neuroscience 29*(23), 7619-7624.

Wagner, A. D., Shannon, B. J., Kahn, I., & Buckner, R. L. (2005). Parietal lobe contributions to episodic memory retrieval. *Trends in Cognitive Sciences, 9*(9), 445-453.

Waytz, A., & Mitchell, J. P. (2011). Two Mechanisms for Simulating Other Minds. *Current Directions in Psychological Science, 20*(3), 197-200.

Whitfield-Gabrieli, S., Thermenos, H. W., Milanovic, S., Tsuang, M. T., Faraone, S. V., McCarley, R. W., et al. (2009). Hyperactivity and hyperconnectivity of the default network in schizophrenia and in first-degree relatives of persons with schizophrenia. *Proceedings of the National Academy of Sciences, 106*(4), 1279-1284.

Wig, G. S., Grafton, S. T., Demos, K. E., Wolford, G. L., Petersen, S. E., & Kelley, W. M. (2008). Medial temporal lobe BOLD activity at rest predicts individual differences in memory ability in healthy young adults. *Proceedings of the National Academy of Sciences, 105*(47), 18555-18560.

Yeager, D. S., & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research, 81*(2), *267-301*.

Zhao, X. H., Wang, P. J., Li, C. B., Hu, Z. H., Xi, Q., Wu, W. Y., et al. (2007). Altered default mode network activity in patients with anxiety disorders: an fMRI study. *European Journal of Radiology, 63*(3), 373-378.

Zhou, Y., Liang, M., Tian, L., Wang, K., Hao, Y., Liu, H., et al. (2007). Functional disintegration in paranoid schizophrenia using resting-state fMRI. *Schizophrenia Research, 97*(1-3), 194-205.

FIGURE CAPTION

Figure 1. Overview of the main brain regions comprising the "default mode" (DM) network, with brief descriptions of associated socio-emotional functions. The DM regions listed are relatively more active and show coordinated activity during wakeful "rest". The regions depicted are also involved in many other functions, including various cognitive association functions and aspects of homeostatic regulation and somatosensation, especially for the milieu of the internal body (i.e. the "guts"). The left side of the image is the front of the brain; the right and left hemispheres are split apart to show the medial surface. NOTE: These brain areas cannot be said to "do" the functions listed. Instead, they are especially "associated" with these functions, and as such are thought to play important roles within the complex networks of regions underlying the functions.

1. ventromedial prefrontal cortex (vmPFC): induction of social emotions; nonconscious induction of somatic responses like skin sweating associated with a sense of risk; modulation of the parasympathetic branch of the autonomic nervous system (important for calming of heart rate).

2. dorsomedial prefrontal cortex (dmPFC): representation of self in relation to others; predicting emotional outcomes of social interactions for self and close others; judging psychological and emotional qualities and traits; feeling emotions about others' mental situations.

3. anterior middle cingulate cortex (ACC): a centrally connected "hub" of the cortex, also heavily interconnected with somatosensory regions that feel the guts and viscera; error monitoring, emotion and empathy, feeling physical and social pain, modulation of the sympathetic branch of the autonomic nervous system (important for activation of heart rate, arousal).

4. posteromedial cortices (PMC): the most centrally connected "hub" of the cortex; high-level integrative representation of the physiological condition of the visceral "gut" body; construction of a subjective sense of self awareness; activated in social emotions, moral decision-making, episodic memory retrieval. Contains dorsal posterior cingulate cortex (dPCC), involved in attention monitoring/switching, and integration of information.

5. inferior parietal lobule (IPL): Involved in successful episodic memory retrieval; empathically simulating others' perspectives and the goals of others' actions.

6. hippocampus: formation and recall of long-term memories. (A seahorse-shaped structure that curls underneath the temporal lobe; not visible in these views.)

FIGURE 1