



Contrasting Screen-Time and Green-Time: A Case for Using Smart Technology and Nature to Optimize Learning Processes

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INTRODUCTION

Tablets and smartphones (i.e., mobile technology) as learning tools for school use is on the rise worldwide (Norris and Soloway, 2015). The technology is reported to impact positively on learning outcomes (Major et al., 2017), by facilitating contextual and situated learning (Brown and Mbat, 2015). For instance, mobile devices are thought to stimulate personalized and informal learning by corroborating and adapting to the interests, preferences, and competencies of learners (Traxler and Wishart, 2011), while affording personal publishing and sharing (Mbat, 2017).

However, exposure to screens may also have more undesirable side-effects of concern to formal and informal learning. In so-called iPad schools where books are switched for iPads in class, play during break-time shifts from physical to more sedentary activities (Schilhab, 2017a). Crudely put, engagement with the external world of concrete phenomena and spontaneous events is switched for engagement with the mediated world of smart technology, where children watch and share YouTube videos, read Wikipedia, and are exposed to vast amounts of information from others (Holloway et al., 2013; Duarte Torres et al., 2014).

Hence, along with the increased use of mobile technology come attentional and cognitive shifts pertaining to the learning and development of the individual (e.g., Ward et al., 2017). Numerous studies have demonstrated that smart technology use influences attentional and cognitive processes in unexpected ways. For instance, it has been reported that devoting attention to mobile phones voluntarily or involuntarily changes the content and dynamics of conversations (Turkle, 2015), resulting in shallower content (Przybyliski and Weinstein, 2013) and lower levels of reported empathic concerns among interlocutors (Misra et al., 2016). It has also been argued that smart technology's capacity as information store has profound consequences on how we manipulate and memorize learned material (Sparrow et al., 2011; Barr et al., 2015; Dong and Potenza, 2017), although the actual effects on learning are also disputed (Aagaard, 2015; Heersmink, 2016). In meta-cognitive research, on-screen readers performed worse than print readers when tested in connection with self-regulated reading of expository texts (Ackerman and Goldsmith, 2011), suggesting that screen reading alters the recruitment of mental efforts (Lauterman and Ackerman, 2014).

In comparison, the natural world seems to engage attentional and cognitive processes differently. Following Attention Restoration Theory (ART, e.g., Kaplan, 1995) in opposition to screen watching (e.g., television), *unthreatening* greenish outdoor environments typically accessible to both urban and country dwellers stimulate by so-called soft fascination (Kaplan and Berman, 2010). Please note that *threatening* greenish outdoor environments may have more intrusive, yet desirable cognitive

effects (e.g., Kahn et al., 2009). Accordingly, resting in green environments enhances so-called executive functioning (Bratman et al., 2012) in use when concentrating and thinking, and is therefore central for academic success (Diamond, 2013). Arguments for exposing students to nature are partly based on this effect (Matsuoka, 2010; Kuo et al., 2017). Although the restorative effect of soft nature on cognitive functioning, as proposed by ART, is persuasive with respect to promoting nature interventions in school, another much more profound effect of relevance to success in school and life not addressed by ART has gone largely unnoticed.

We advocate that the mental work occurring *during* restoration of executive functioning, so-called mind wandering, e.g., off-task thoughts that occur either with or without intention (Smallwood and Schooler, 2006), is crucially important in its own right. Given that screen watching and screen use is more likely to affect attentional and cognitive processes by hard fascination (Kaplan and Berman, 2010), to an extent that sometimes renders mobile technology use addictive (e.g. Rosen et al., 2013; Billieux et al., 2015), thus tapping into self-regulatory processes (Schilhab, 2017b), nature's facilitating effect on mind wandering becomes noteworthy.

In what follows, we (a) highlight how nature-induced soft fascination leaves room for spontaneous thoughts, which are under increased pressure from the mobile technology-induced hard fascination and more controlled thoughts and (b) emphasize the need for research relating green environments, open monitoring and divergent thinking.

ATTENTION

Forming part of executive functions (Engle, 2002; Posner et al., 2013), attentional control is closely related to success in school (Diamond, 2011). James (1892) famously distinguished between *involuntary* and *voluntary* attention, also known as stimulus-dependent and directed attention (e.g., Chun et al., 2011). The former refers to attention that requires no effort, such as when something dangerous, pleasurable or novel occurs (e.g., Sood and Jones, 2013) whereas the latter refers to the kind of attention employed when something is not particularly interesting and therefore requires a good deal of mental effort (Kaplan and Berman, 2010). Thus, stimulus-dependent attention often depends on external sense activity that drives learning automatically and *bottom-up*, whereas directed attention is independent of stimulus characteristics and works *top-down* (Wilson, 2002).

As noted by Kaplan and Berman (2010), James (1892, p. 88) pointed to "strange things, moving things, wild animals, bright things, pretty things, metallic things, words, blows, blood, etc. etc. etc." as engaging stimulus-dependent attention. In this understanding, mobile technology seems entirely unmatched in its ability to "call" up the attention of its user. Mobile technology affords immediate access to pleasure, and unexpected and novel stimuli and thus taps heavily into our attentional resources (Lee et al., 2014; Li et al., 2015) combatting e.g. social anxiety and boredom (Elhai et al., 2017) or feeding attentional impulsiveness

(Roberts et al., 2015). Even long-term attentional effects, the so-called phantom vibration and phantom ringing hallucinations, seem to occupy the mind of heavy mobile technology users (Lee et al., 2014; Tanis et al., 2015).

NATURE-INDUCED SOFT FASCINATION

Conversely, natural stimuli seem to capture attentional processes in an opposing way, although it is worth noting that "untrammeled" and unmanaged wild nature is likely to have different attentional effects (Davis and Gatersleben, 2013). ART suggests that non-threatening natural environments are experienced with less cognitive effort, because they are "softly fascinating" with no elements that compete with each other for attentional focus (Kaplan, 1995). ART predicts that perceiving natural stimuli will allow finite cognitive capacities, such as focusing attention, to restore, alleviating the individual from cognitive fatigue that is experienced when these capacities are overused (Kaplan, 1995; Berman et al., 2008). Indeed, there is an existing research base that supports the notion that exposure to nature can be beneficial to cognitive processes (for review, see Ohly et al., 2016).

We suggest that non-threatening natural environments that softly fascinate have positive effects on cognition through the facilitation of spontaneous thought processes.

According to ART, nature-bound stimuli are less likely to signify a sense of immediate danger or otherwise pull attention along particular thought paths. Hence, engaging with nature-bound stimuli involves comparably fewer symbolic associations than engaging with smart technology. A pond full of carp signifies nothing or very little beyond itself. Carp swimming just "are"—the observation does not trigger a sense of danger, hard fascination difficult to disengage from or intentions to act, whereas a picture of carp as in advertisements normally signifies or stands for something different that instigates serial thought processes calling upon directed attention. It is likely that the "closed signification," which is the fact that nature's stimuli point to themselves and not away from themselves to something beyond, provides nature with the strength to decelerate or even obliterate thought processes (Schilhab, 2017c).

In a study that illustrated how the brain processes natural and non-natural stimuli differently, Berto et al. (2008) used eye-tracking technology to investigate how participants viewed two types of scenes. They found that viewing natural scenes was associated with greater exploration and fewer fixations; however, when viewing urban scenes, participants were more likely to fixate on certain stimuli. Greater scene exploration suggests greater fascination that is not cognitively demanding, whereas frequent and longer fixation suggests that attention is more readily captured by these stimuli that they are more cognitively demanding to process (Berto et al., 2008).

Being in a safe natural environment, where the surrounding stimuli have no intrinsic threat, goal, or task associated with them, may benefit non-perceptual cognitive processes important for learning. An environment with no goal-directed or task-positive stimuli may also be associated with activation of

task-unrelated neural networks, such as the default mode network (DMN) (Andrews-Hanna et al., 2014). The DMN is associated with autobiographical memory and mind-wandering and has been shown to be separately involved in the maintenance phase of working memory alongside task-positive networks (Piccoli et al., 2015). Maintaining and remembering newly acquired information is one of the most commonly demonstrated cognitive benefits of exposure to natural stimuli (Ohly et al., 2016). Moreover, the cognitive load in working memory tasks can be predictive of the impact of natural stimuli, where the harder the task conditions, the greater the cognitive restoration associated with exposure to nature (e.g., Dadvand et al., 2015). This suggests that the harder the brain is working to shield memorized information from external and internal distraction, the greater the impact a natural environment will have on restoration of this and associated abilities.

DIVERGENT THINKING

The reduced pull on thought processes facilitates more self-generated thoughts where the mind “move[s] hither and thither without fixed course or certain aim” (Christoff et al., 2016, p. 719). Such episodes are considered adaptive since they allow individuals to, for instance, prepare for future events, to sustain a sense of self-identity and to re-interpret social encounters (Andrews-Hanna et al., 2014).

Spontaneous thought processes associated with the reduced external pull on thoughts also loosely resemble divergent thinking processes stimulating creative thinking and abilities to think “out of the box” (Colzato et al., 2012)¹.

This might suggest that in contrast to smart technology use, nature-bound stimuli are more likely to endorse so-called open monitoring mind states prevalent in certain meditative traditions (Tang and Posner, 2009; Howell et al., 2011; Lebeda et al., 2016). Following Hommel and Colzato (2017), focused-attention meditation (FAM) differs from open-monitoring meditation (OMM) and have different and sometimes even opposite impacts on cognitive processes. Whereas FAM traditionally trains directed attention capacities by sustained attention on a specific object, OMM “sustains attentive monitoring of anything that might occur in experience without focusing on any explicit object” (ibid. p. 115; see also Lutz et al., 2008).

¹For a straightforward description of divergent and convergent thinking see Jones and Estees (2015, p. 474) who define divergent thinking tasks as generally focused on generating several possible “imaginative” answers, whereas convergent thinking tasks generally entail a narrowing of possible solutions to one optimal answer.

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In the current context, we suggest that nature-bound stimuli are likely to induce open-monitoring mental states that typically promotes the divergent thinking style that allows many new ideas to be generated (Leong et al., 2014; Colzato and Hommel, 2017; Colzato et al., 2017). Studies examining the impact of acute moderate and intense physical exercise on convergent and divergent thinking in athletes and non-athletes (S Colzato et al., 2013) or the effect of walk (Keinänen, 2016; Zhou et al., 2017) could form the backdrop for a future research design to test the impact of nature-bound vs. mobile technology-bound stimulation (for the distinction between the effect of the outdoors and physical activity, see Oppezzo and Schwartz, 2014).

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Based on these ideas, we suggest that exposure to a natural environment or natural stimuli, may be seen as a useful and relevant intervention strategy to counteract the effect of exhausted cognitive capacities associated with overuse of smart technology. Coupling periods of smart technology use with periods of exposure to a natural environment may be optimal for learning.

Given the increasing use of mobile technology worldwide we also need to identify how technology can be used to encourage more children to get outside (Schilhab, 2018). The consequences of using smart technology within natural environments are not yet known although new research on the effect of Pokémon Go may provide some early indications (LeBlanc and Chaput, 2017; Ruiz-Ariza et al., 2018). Thus, future studies should investigate both how natural stimuli may counteract exhausted cognitive capacities and the effects of mixing nature-bound and technology-bound stimulations when mobile technologies are used in nature experiences.

AUTHOR CONTRIBUTIONS

TS, MS, and PB: conceived of the study; TS and MS: contributed conception of the study; TS: wrote the first draft of the manuscript; MS: wrote sections of the manuscript. All authors contributed to manuscript revision, read and approved the submitted version.

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