IDEAS IN ECOLOGY AND EVOLUTION 15: 12–16, 2022
doi:10.24908/iee.2022.15.2.e

Received 5 May 2022; Accepted 13 May 2022

Political and Social Issues - Editorial

Screen adaptation theory for humans

Christopher J. Lortie

Christopher J. Lortie (chris@ecoblender.org), Department of Biology, York University, Toronto, ON, Canada M3J 1P3 and *Liminal Collective*

Abstract

Screens are an ineliminable component of contemporary society for most humans. Consequently, tools and ideas that provide a heuristic and support for conceptually mitigating and balancing the costs of screen times at an individual level are critical. Here, screen adaptation theory (SAT) is proposed as a shorthand tool to frame the wealth of research examining human-screen interactions. Screens are best conceptualized as a place. Adaptation (to screens) are acquired or cultivated traits that enable us to not only survive with screens but potentially thrive—provided that we leverage research on costs *and* benefits. Adaptive behavioral traits suggest that we approach these interactions with purposeful intent. Finally, the theory associated with humans with screens is rich and interdisciplinary. We must design and adopt principles from theory relevant to our work, leisure, and individual choices to use screens as we move from tolerance to adaptation.

Keywords

adaptation, cognition, digital, ecology, evolution, place, screens, theory, traits

Introduction

Screens are ubiquitous. Conservatively, it is estimated that nearly 80% of North Americans are online using the internet and that over 3.5 billion people globally routinely access information online as of 2020 (Union 2022). Summary statistics on screen use, daily phone pickups, social media interactions, and the duration that humans engage with screens is variable depending on the data source but nonetheless compelling, substantive, and suggestive of significant commitments to screen time (Attygalle et al. 2020, Neophytou et al. 2021, Oswald et al. 2020). We go to screens for many non-leisure purposes including learning (Castro et al. 2020) and professional interactions such as collaboration and knowledge work (Chen et al. 2018). People also engage substantially for social purposes through screens in contemporary society (Cheng et al. 2021). It is tempting to treat screens as a pathology, and a major component of all primary research on screens and humans, and particularly, synthesis science such as meta-analyses conceptualize screen time as fundamentally negative (Canadian Paediatric Society 2017, Farashi et al. 2022, Ophir et al. 2021, Tapia-Serrano et al. 2022, Vohr et al. 2021). It is not entirely productive or necessarily instructive to focus predominantly on the costs of screen time because we are unlikely to extricate ourselves from screen use. There are also benefits (Camargo et al., 2020, Ebner and Gegenfurtner 2019). This is not to understate the costs including nature deficit disorder (Louv 2008, Novotný et al. 2020, Wang et al. 2021) and numerous other disorders (Nagata et al. 2022, Santos et al. 2022). It does, however, suggest that there is critical need to provide a simple idea/framework for screens for individual consideration when reviewing evidence and approaching their use for personal and professional endeavors digitally.

Screen adaptation theory

Ecological and evolutionary theory have a long and successful history of modeling interactions between organisms with one another and their respective environments. Adopting a similarly holistic approach to

progress and integrated fusion from other disciplines (Aarssen 1997, Grime 1993), it is reasonable to propose an eco-evolutionary heuristic for people and screens. This framework of thinking can be described as screen adaptation theory (acronym, SAT). The assumption is that it is a valuable asset for humans to use strategic conceptualizations when interacting with screens and other digital devices as technological development continues (and rapidly outpaces research). We are admittedly absurd in our pursuit of meaning (Aarssen 2018), but we can co-opt some of our tendencies to live in our heads (and on our screens) to frame ideas about technology and how we as humans develop and interact with technology such as screens. The assumption here is thus that a heuristic, i.e., any tool that supports problem solving (Romanycia and Pelletier 1985), is needed for individual screen-time decisions. There is evidence in many fields, including judgement and risk assessment, that a simple heuristic can improve judgement for people (Finucane et al. 2000). A rational cognitive theory is provided based on first principles. Aside, screen adaptation is also a light double entendre because, in media, this term describes the translation of works from writing, art, graphic novels, plays, etc. to a digital—and at times, modified or mediated—experience on screens that can influence both the message and consumption process or experience for a given person.

Screens are a place. We must conceptualize time and attention devoted to a screen as a visit to a place. Digital interactions are a real experience and thus a place that we go to for interpersonal interactions, research, or work. Literally, using a mobile device of any form to 'go to work' and not framing as 'doing work' or 'visiting friends' versus 'browsing social media' is critical. The commute is nearly non-existent, but the consequences are real. When you use a screen, you go somewhere in some capacity. The divide between virtual and physical spaces is much more permeable than assumed—not just for children in modeling reality constructs (Strouse and Samson 2021). We exist in physical and digital landscapes in tandem with different habitats, highs and lows, challenges and risks, and all are absolutely real from a phenomenological paradigm that conceptualizes people-environment interactions through the lens of experience (Giuliani 2008, Guccinelli 2020). Perception is also strongly mediated by attention (Perrone-Bertolotti et al. 2020), and it is always an active process of filtering and actualization (Odell 2019). There is also an important indirect implication of screens as a place—it provides ecology (Odell 2019). When we anchor a digital touchpoint as a visit to place, we can begin to consider the quality of the habitat, the interactions within the ecosystem, the sign of the outcomes with other agents (personal and computational) including predation/ competition/facilitation/parasitism, and we can highlight some of the key processes that drive and limit function of personal performance and well-being (Balaman and Pekarek Doehler 2022). We can also develop testable hypotheses, individually and collectively, to examine the relevance of these places (Betts et al. 2021). Digital nomadism, or digital work from different places, also explicitly examines the overlay of where we work and where/how we go to work digitally to better perform, balance competing priorities, and to promote hypothesis-design thinking for the role of space on our productivity (Nash et al. 2021, Shawkat et al. 2021). The ecology of place is not a new idea (Beattie and Manning 1997), but herein, it provides a novel framework for interactions with screens through potential context and a landscape that can have time, geography, and concrete representation (Rainham et al. 2010). Furthermore, all digital landscapes have a personal, social, and technological dimension that we cannot afford to overlook.

Adaptation is not tolerance. Tolerance is the capacity of organisms, including humans, to process extrinsic limiting drivers from the environment or stressors and continue to persist locally in a system but with reduced performance (Sanders 1983). In eco-evolutionary theory, this cost is modeled with reduced relative fitness (Parker et al. 1999). Adaptation is much more relevant to SAT because the goal should be to leverage screens for benefit —not endure them. Herein, adaptation is thus best defined as acquired, individual-level traits that typically promote higher performance or at least survival (Bock 1980, Gould and Lewontin 1979). An adaptationist programme is one that works to favor traits that enable adaptation including performance (Sanderson 2008) to not only survive the negative effects of screens on our physiology, psychology, and biology but to thrive. The internet in particular is an information engine that drives changes in the markets, sociality, and health domains. Screens and the internet decentralize knowledge and provide tools for science and culture to be more open. However, we must work individually to track and explore traits that enable us to be more versatile in negotiating meaning and purpose in this larger, and distributed, network of interactions much beyond typical group sizes that we most likely experience in person (or throughout evolutionary timeframes). Behavioral traits with respect to screen use strongly interact with traits associated with physical and cognitive wellbeing in humans including body mass index (Nagata et al. 2022), cognition (Wang et al. 2021), and sleep (Tapia-Serrano et al. 2022). Specifically, amplifying behavioral traits that support better practices for screens through stacking micro-habits, i.e. simple daily rules that limit use or focus on explicit functional use for screens (Shnayder-Adams and Sekhar 2021), promote an adaptationist programme for digital interactions.

Importantly, this amplification does not necessarily end with the individual. It can unfold through a process of biocultural evolution wherein (as interpreted by

Aarssen 2022) evolving psychologies and evolving cultures are blended. Taken together, this process generates a shared meme pool that accumulates changes informed by technology. Shared practices positively amplified by memes thereby lead to an adjusted gene pool and thus specific behavioural traits associated with effective technology use and development—which in turn generate further adjustment in the meme pool, and so on iteratively. Accordingly, SAT postulates that screens are nudging these accumulated and complex collective changes through variation in the social elements of screen time decisions. This scaffolds into the final component of SAT; how to use theory for this global challenge to humanity.

A theory is an ecosystem of ideas that explains and invokes principles. Theory in science is constructed with testable, related hypotheses with a relatively high likelihood of scientific support (Lehmann 1950). In education and other knowledge disciplines, it is a strongly supported narrative to interpret evidence or put even more simply, tell a reasonable story (Kubli 2001). Collectively in ecology for instance, integrated theories can function as coherent units that enable us to understand and infer processes for complex systems (Shrader-Frechette and McCoy 1990). Human-screen interactions are one such novel and contemporary complex system that justifies more direct, conceptual evidence-informed theory development. The breadth and diversity of theory relevant to human-screen interactions is nonetheless extensive. Theory is thus most effectively sourced depending on the specific challenge or opportunity mediated through screens. Cognitive load, attention switching, executive function, education, learning, memory, and reading all connect people to their screens. This is a non-exhaustive list. There are over 6500 primary research papers listed on The Web of Science as of 2022 and 110 published, peer-reviewed synthesis publications on these topics including meta-analyses and systematic reviews (frequencies estimated using combinations of terms such as cognition and digital, screens, or electronic). This wealth of published knowledge can inform the thinking and framework for adaptation and choice.

Two examples are useful to illustrate the capacity for theory to support individual heuristics and positive mental models. On the cost side, a dose-response model has been proposed for screen effects on children and supported in the 120,000 children tested (Liu et al. 2016). A dose-response model is one wherein the magnitude of an effect or potential continuous causal factor predicts (linearly or non-linearly) a response or variable associated with a key performance outcome for an organism. This theory can underpin screen time decisions, and the World Health Organization adopted this framework in 2019 in making recommendations for screen use for children by age and for set durations (i.e. no more than 1 hour per day for younger children, https://www.who.int/news/item/24-04-2019-to-grow-up-healthy-children-need-to-sit-less-and-play-more). Individually, we can use SAT similarly. A second, more balanced benefit theory was developed in this vein by The Canadian Pediatric Society. This report recommended a theory-based heuristic to promote health and development including adaptation in an increasingly digital world (Canadian Paediatric Society 2017). It is best summarized as the '3M' theory with each component supported by scientific evidence. Minimize, mitigate, and mindfulness. Firstly, minimize screen time whenever possible. Time is finite. Attention is never interchangeable. There are always trade-offs. Digital places are substitutes for direct physical spaces that offer health benefits. Secondly, mitigate screen effects through adaptation including co-viewing with peers/family, selecting digital places and tools that are active and interactive, work synchronously even digitally, develop micro-habitats such as no screens before bed and no phone first thing in the morning, and use a designated space to keep electronics, such as no screens where you sleep. Finally, mindfulness for screen use is also well articulated. State purpose, label the place you visit with a screen, pay attention to messaging, block times for screens, never leave screens on as an ambient background environment, and track attention with cognitive loads (Canadian Paediatric Society 2017). This evidence and theory align logically with SAT—place, adaption, and high-level theory will enable survival and furthermore, thriving, if screen use is planned and effectively managed for performance and purpose. Thriving has been documented for learning remotely (Ebner and Gegenfurtner 2019) and computer-supported collaboration (Chen et al. 2018) for instance when these principles are incorporated. There are many other aligned theories including goal-theoretics in social science (Owenz and Fowers 2020), scaffolding in education (Jumaat and Tasir 2014), neurological ophthalmology (Sheppard and Wolffsohn 2018), and experiential nature engagement (Wang et al. 2021). All provide opportunities to train and strength key human systems for digital work through a SAT heuristic.

Implications

Screen adaptation theory proposes that treating screens as a place provides context and thus ecology to these human-digital interactions. Adaptation is the potential trait set that one cultivates to promote offsetting the costs of screen use with benefits including even higher relative performance levels for some online contexts. Theory herein are the principles sourced from multiple disciplines, as needed, to support a functional adaptationist programme individually, and novel mental architecture growth. Our contemporary biology does not

need to be our destiny. Many theories have coherence with SAT, including a dose-response model for costing, and a minimize, mitigate, and mindfulness paradigm for building new and more meaningful connections with technology and one another. Integrating and mapping theory onto decision and judgement associated with screens was thus successful in these case studies. Specifically: *mitigate* through place (always choose where you work in real and digital space; label screen time with function and purpose); *minimize* (through actively up-regulating beneficial behavioral traits through habits, rules, and selective attention); and *mindfulness* (consistently stating and revisiting purpose) will nudge people from tolerance to adaptive choices. We must design our digital experiences and interactions using an ecology of place paradigm with trait mediation because context enables personal and collective evolution. These accumulated changes need to be cognizant and wise.

References

Aarssen, L.W. 1997. On the progress of ecology. Oikos 80: 177–178. CrossRef

Aarssen, L.W. 2018. Meet *Homo absurdus*--the only creature that refuses to be what it is. Ideas in Ecology and Evolution 11: 90–95. CrossRef

Aarssen, L.W. 2022. What We Are: The Evolutionary Roots of Our Future. Cham, Switzerland: Springer-Nature.

Attygalle, U.R., Hewawitharana, G., and C.J. Wijesinghe. 2020. Migraine, attention deficit hyperactivity disorder and screen time in children attending a Sri Lankan tertiary care facility: are they associated? BMC Neurology 20: 275. CrossRef

Balaman, U. and S. Pekarek Doehler. 2022. Navigating the complex social ecology of screen-based activity in video-mediated interaction. Pragmatics 32: 54–79. CrossRef

Beattie, T. and K. Manning. 1997. The Ecology of Place: Planning for Environment, Economy, and Community Island Press, Washington, DC.

Betts, M.G., Hadley, A.S., Frey, D.W., Frey, S.J.K., Gannon, D., Harris, S.H., et al. 2021. When are hypotheses useful in ecology and evolution? Ecology and Evolution 11: 5762–5776. CrossRef

Bock, W.J. 1980. The definition and recognition of biological adaptation. American Zoologist 20: 217–227. CrossRef

Camargo, C., Zen Tempski, P., Freitas Busnardo, F., Arruda Martins, M., and R. Gemperli. 2020. Online learning and COVID-19: a meta-synthesis analysis. Clinics (Sao Paulo) 75: e2286. CrossRef

Canadian Paediatric Society, D.H.T.F.O.O. 2017. Screen time and young children: Promoting health and development in a digital world. Paediatrics and Child Health 22: 461–468. CrossRef

Castro, O., Bennie, J., Vergeer, I., Bosselut, G., and S.J.H. Biddle. 2020. How sedentary are university students? A systematic review and meta-analysis. Prevention Science 21: 332–343. CrossRef

Chen, J., Wang, M., Kirschner, P.A., and C-C. Tsai. 2018. The role of collaboration, computer use, learning environments, and supporting strategies in CSCL: A meta-analysis. Review of Educational Research 88: 799–843. CrossRef

Cheng, J., Burke, M., and B.D. Gant. 2021. Country differences in social comparison on social media. Proceedings of the ACM on Human-Computer Interaction 4: 1–26. CrossRef

Ebner, C. and A. Gegenfurtner. 2019. Learning and satisfaction in webinar, online, and face-to-face instruction: A meta-analysis. Frontiers in Education 4: 92. CrossRef

Farashi, S., Bashirian, S., Khazaei, S., Khazaei, M., and A. Farhadinasab. 2022. Mobile phone electro-magnetic radiation and the risk of headache: a systematic review and meta-analysis. International Archives of Occupational and Environmental Health. CrossRef

Finucane, M.L., Alhakami, A., Slovic, P., and S.M. Johnson. 2000. The affect heuristic in judgments of risks and benefits. Journal of Behavioral Decision Making 13: 1–17. CrossRef

Giuliani, M.V. 2008. Environmental research and phenomenological approach. Conference Proceedings for Urban diversities, biosphere and well-being, July 28-August 1, 2008.

Gould, S.J. and R.C. Lewontin. 1979. The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. Proceedings of the Royal Society B 205: 581–598. CrossRef

Grime, J.P. 1993. Ecology sans frontières. Oikos 68: 385–392. CrossRef

Guccinelli, R. 2020. Identity disorders and environment. A Phenomenological Model of Delusion. Pages 132-146 *in* H.R. Sepp, editor. Phänomenologie und Ökologie.

Jumaat, N.F. and Z. Tasir. 2014. Instructional scaffolding in online learning environment: A meta-analysis. Pages 74–77 *in* 2014 International Conference on Teaching and Learning in Computing and Engineering. CrossRef

Kubli, F. 2001. Can the theory of narratives help science teachers be better storytellers? Pages 6–12 *in* F. Bevilacqua, E. Giannetto and M.R. Matthews, editors. Science Education and Culture. Springer, Dordrecht. CrossRef

Lehmann, E.L. 1950. Some principles of the theory of testing hypotheses. Annals of Mathematical Statistics 21: 1–16. CrossRef

Liu, M., Wu, L., and S. Yao. 2016. Dose–response association of screen time-based sedentary behaviour in children and adolescents and depression: a meta-analysis of observational studies. British Journal of Sports Medicine 50: 1252. CrossRef

Louv, R. 2008. Last Child in the Woods. Algonquin Books, Chapel Hill, North Carolina.

Nagata, J.M., Cortez, C.A., Cattle, C.J., Ganson, K.T., Iyer, P., Bibbins-Domingo, K., and F.C. Baker. 2022. Screen time use among US adolescents during the COVID-19 pandemic: Findings from the adolescent brain cognitive development (ABCD) study. JAMA Pediatrics 176: 94–96. CrossRef

Nash, C., Jarrahi, M.H., and W. Sutherland. 2021. Nomadic work and location independence: The role of space in shaping the work of digital nomads. Human Behavior and Emerging Technologies 3: 271–282. CrossRef

Neophytou, E., Manwell, L.A., and R. Eikelboom. 2021. Effects of excessive screen time on neurodevelopment, learning, memory, mental health, and neurodegeneration: a scoping review. International Journal of Mental Health and Addiction 19: 724–744. CrossRef

Novotný, P., Zimová, E., Mazouchová, A., and A. Šorgo. 2020. Are children actually losing contact with nature, or is it that their experiences differ from those of 120 years ago? Environment and Behavior 53: 931–952. CrossRef

Odell, J. 2019. How to do nothing: resisting the attention economy Melville House. NY, USA.

Ophir, Y., Rosenberg, H., and R. Tikochinski. 2021. What are the psychological impacts of children's screen use? A critical review and meta-analysis of the literature underlying the World Health Organization guidelines. Computers in Human Behavior 124: 106925. CrossRef

Oswald, T.K., Rumbold, A.R., Kedzior, S.G.E., and V.M. Moore. 2020. Psychological impacts of "screen time" and "green time" for children and adolescents: A systematic scoping review. PLoS ONE 15: e0237725. CrossRef

Owenz, M.B. and B.J. Fowers. 2020. A goal-theoretic framework for parental screen-time monitoring behavior. Journal of Family Theory & Review 12: 335–349. CrossRef

Parker, E.D., Forbes, V.E., Ritter, C., Barata, C., Admiraal, W., Levin, L., et al. 1999. Stress in ecological systems. Oikos 86: 179–184. CrossRef

Perrone-Bertolotti, M., El Bouzaïdi Tiali, S., Vidal, J.R., Petton, M., Croize, A.C., Deman, P. et al. 2020. A real-time marker of object-based attention in the human brain. A possible component of a "gate-keeping mechanism" performing late attentional selection in the Ventro-Lateral Prefrontal Cortex. Neuroimage 210: 116574. CrossRef

Rainham, D., McDowell, I., Krewski, D., and M. Sawada. 2010. Conceptualizing the healthscape: Contributions of time geography, location technologies and spatial ecology to place and health research. Social Science & Medicine 70: 668–676. CrossRef

Romanycia, M.H.J. and F.J. Pelletier. 1985. What is a heuristic? Computational Intelligence 1: 47–58. CrossRef

Sanders, A.F. 1983. Towards a model of stress and human performance. Acta Psychologica 53: 61–97. CrossRef

Sanderson, S.K. 2008. Adaptation, evolution, and religion. Religion 38: 141–156. CrossRef

Santos, R.M.S., Mendes, C.G., Marques Miranda, D., and M.A. Romano-Silva. 2022. The association between screen time and attention in children: A systematic review. Developmental Neuropsychology 1-18. CrossRef

Shawkat, S., Rozan, M.Z.A., Salim, N.B., and H.M.F. Shehzad. 2021. Digital nomads: A systematic literature review. Pages 1–6 *in* 2021 7th International Conference on Research and Innovation in Information Systems (ICRIIS). CrossRef

Sheppard, A.L. and J.S. Wolffsohn. 2018. Digital eye strain: prevalence, measurement and amelioration. BMJ Open Ophthalmology 3: e000146. CrossRef

Shnayder-Adams, M.M. and A. Sekhar. 2021. Micro-habits for life-long learning. Abdominal Radiology 46: 5509–5512. CrossRef

Shrader-Frechette, K.S. and E. McCoy. 1990. Theory reduction and explanation in ecology. Oikos 58: 109–114. CrossRef

Strouse, G.A. and J.E. Samson. 2021. Learning from video: A meta-analysis of the video deficit in children ages 0 to 6 years. Child Development 92: e20–38. CrossRef|

Tapia-Serrano, M.A., Sevil-Serrano, J., Sánchez-Oliva, D., Vaquero-Solís, M., and P.A. Sánchez-Miguel. 2022. Effects of a school-based intervention on physical activity, sleep duration, screen time, and diet in children. Revista de Psicodidáctica (English ed.) 27: 56–65. CrossRef

Union, I.T. 2022. Individuals using internet as percent of population. The World Bank Data 1: 1–2.

Vohr, B.R., McGowan, E.C., Bann, C., Das, A., Higgins, R., Hintz, S., et al. 2021. Association of high screen-time use with school-age cognitive, executive function, and behavior outcomes in extremely preterm children. JAMA Pediatrics 175: 1025–1034.

Wang, C., Geng, L., and J.D. Rodríguez-Casallas. 2021. The role of nature-deficit disorder in the associations between Mobile phone overuse and well-being and mindfulness. Current Psychology: A Journal for Diverse Perspectives on Diverse Psychological Issues. CrossRef