Psychological Inquiry, 24: 341–348, 2013

ISSN: 1047-840X print / 1532-7965 online
DOI: 10.1080/1047840X.2013.850148

Routledge
Taylor & Francis Group

Supernormal: How the Internet Is Changing Our Memories and Our Minds

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We are creatures of flesh and blood, living in a world of bits and bytes—a world shaped by the Internet. With the simple touch of a button or swipe of a finger, we can instantaneously access vast amounts of information (e.g., Ashton, 2009). A few more keystrokes, and we can interact with friends 10 time zones away (e.g., Thurlow, Lengel, & Tomic, 2004). Just a few more, and we may complete the transition to a digital life, transferring our identities from our physical bodies to online avatars (e.g., Bessière, Seay, & Kiesler, 2007). Perhaps because of its pervasive influence, it's often difficult to imagine a world without the Internet. We know there was a time when encyclopedias represented the pinnacle of information storage and communicating with faraway friends required a trip to the post office (or at least to the mailbox), but such a time feels far removed from the present moment.

However, as Sparrow and Chatman (this issue) point out, the current era of digitally mediated information, communication, and exploration is a new one, a mere "blip on the timescale of human evolution" (p. 273). The Internet first made its way from private laboratories to the public sphere less than 20 years ago (Leiner et al., 2012), and many definitive elements of the Internet are newer still (e.g., Google, founded in 1998; Wikipedia, founded in 2001). For millions of years of evolution (e.g., Tattersall, 2001), "social networks" referred not to thousands of Facebook friends but to small groups of daily interaction partners (Dunbar, 1993) and information search consisted not of typing keywords into Google but of seeking out personally known experts (Wegner, 1995). Our basic cognitive architecture developed in this environment—one far removed from the present Internet Age—and most likely has not changed in the last 20 years (e.g., Bowlby, 1969; Tooby & Cosmides, 1990).

When old cognitive tendencies and new technologies meet—when the world of flesh and blood collides with the world of bits and bytes—the Internet may act as a "supernormal stimulus," hijacking preexisting cognitive tendencies and creating novel outcomes. Supernormal stimuli meet or exceed long-enforced selection criteria, but are generally foreign to the environments in which these criteria developed; as a result, these new stimuli often elicit greater responses than any naturally occurring stimuli. The Internet may produce supernormal stimulus effects in many domains; for example, relatively unidirectional Internet-based communication such as blogging and tweeting may capitalize on the intrinsic rewards associated with social sharing (Tamir & Mitchell, 2012) while protecting individuals from costs associated with social anxiety (e.g., Leary & Kowalski, 1997), and experimenting with alternate identities online (e.g., Yee, 2006) may allow people to fulfill intrapsychic needs (such as the need for power; McClelland, 1961) without incurring interpersonal costs (e.g., Brewer, 1991).

Internet-related supernormal stimulus effects may be particularly powerful in the domain of memory. Research on transactive memory indicates that incoming information is distributed between both internal and external storage devices (e.g., Wegner, 1986; Wegner, Giuliano, & Hertel, 1985). People may store information in their own minds, or they may offload responsibility for this information to external storage devices such as friends, family, books, or—most recently—the Internet. For much of human history, the criteria used for distributing responsibility (e.g., expertise, accessibility) ensured that memories were spread throughout social groups. However, the Internet—a supernormal stimulus—seems to outperform all other external storage devices, potentially leading people to offload responsibility for the vast majority of information to this single digital resource. My research explores how this shift toward digital information storage—and away from biological information storage (both in terms of utilizing other people and utilizing one's own memory)—may have large-scale and long-term effects on the way people remember and process information.

Transactive Memory

Transactive memory systems maximize both the amount of information available to individuals and the efficiency with which this information is stored (e.g., Wegner, 1995). People cannot possibly know everything. However, by offloading the responsibility for specific types of information to others, they gain the capacity to both acquire increased depth of knowledge in a few domains of personal expertise and access the information held by a broad range of others, each with similarly advanced knowledge in his or her domains of expertise. When it comes to most topics, people ensconced in a transactive memory system do not need to know much at all—they simply need to know who knows it; content knowledge (e.g., "How do I fix this car's radiator?") can often be replaced by location knowledge (e.g., "Who do I know that knows about car repairs?").

The cognitive processes underlying the division of mental labor within transactive memory systems operate according to efficiency-related selection criteria. The structure of these systems is generally defined according to two key principles: relative expertise and access to information (Wegner, Erber, & Raymond, 1991). Group members intuitively offload responsibility for information to those individuals with the highest levels of relative expertise and/or access to information in a relative domain and assume responsibility for the domains in which they are experts and/or insiders. Although these principles often guide the division of information without the need for explicit discussion, they are not perfect; any apparent shortcomings of this intuitive system based on expertise and access—for example, a particular type of information that tends to fall through the cracks—can subsequently be remedied through a third principle: explicitly negotiated responsibilities (Wegner et al., 1991).

Transactive memory systems are most useful if all members of the system are readily available (e.g., Wegner, 1986). Whereas expertise and access to information guide the division of responsibility once an individual becomes part of a transactive memory system, availability may help determine whether someone will be invited into the system in the first place. No matter how expertly trained or in-the-know someone is, this person's wealth of knowledge is worthless if it is temporarily unavailable—for example, if he or she is out of town on business or squabbling with another member of the memory system. Information may also become permanently unavailable. When a transactive memory partner passes away, any knowledge that has not been shared with other members of the memory system may be lost forever. Even the most efficiently functioning transactive memory system cannot escape the implications of mortality.

Supernormal Stimuli

Supernormal stimuli hijack the cognitive processes associated with the selection of maximally adaptive stimuli. The underlying processes remain the same, but their output is altered by the introduction of some novel stimulus that outperforms all naturally occurring stimuli in domains related to selection. For example, gray geese return scattered eggs to their nests by rolling them uphill, and generally show preferential care for larger eggs; because larger eggs tend to be more viable than small eggs, this size preference is usually adaptive (Romanoff & Romanoff, 1949). However, if an impossibly large artificial egg—one the size of a football—is placed next to a goose's normal-sized egg, the goose will neglect its own egg in favor of the oversized imposter (Lorenz, 1937). Similarly, songbirds that select on the basis of egg color will ignore their own pale speckled eggs in favor of brightly colored dummy eggs, even when these eggs are so large that the birds repeatedly slide off and have to hop back on (Tinbergen, 1951).

The tendency to respond to exaggerated stimuli—even when doing so is maladaptive—may be due to selection asymmetry when responding to naturally occurring stimuli (Staddon, 1975). Many selection stimuli are constrained by biological factors on one end of a continuum but not the other; eggs, tails, and other size-related stimuli may be subject to upper, but not lower, limits. If increased size is generally associated with fitness and organisms do not have experience with overly large stimuli in the wild, these organisms will tend to respond to impossibly exaggerated stimuli. Research provides support for this asymmetric selection hypothesis, indicating that many selection preferences are focused not on absolute values but on relative ones (e.g., Andersson, 1982; Hanson, 1959); organisms do not preferentially respond to a specific egg size, tail length, or shade of plumage, but simply to the stimulus that is furthest along the continuous gradient associated with fitness or reward.

Supernormal stimuli are often the product of experimental manipulation. For geese, songbirds, sticklebacks, and butterflies, this is a good thing; they are unlikely to incur costs related to supernormal stimulus effects unless an ethologist decides to have a little fun at their expense. Humans, however, are not so lucky. As people experiment with their own environments, they may create supernormal stimuli that hijack human selection processes—and be unable to escape the allure of these exaggerated cues. Artificial breasts mimic qualities associated with reproductive value (e.g., Jasieńska, Ziomkiewicz, Ellison, Lipson, & Thune, 2004; Marlowe, 1998) and are preferred over natural breasts, even though their signals of fertility are deceptive (Doyle & Pazhoohi, 2012). Highly processed "junk foods" act on adaptive tendencies to seek out sugar and fat (Birch, 1999) but provide these substances in obscenely large quantities (Barrett, 2007). When people create supernormal stimuli in an attempt to fulfill their own deep-rooted selection tendencies, the exaggerated qualities of these stimuli may ultimately result in negative consequences, ranging from unsuccessful reproduction attempts to morbid obesity.

The Internet is Supernormal

Like breast implants or potato chips, the Internet seems to be a man-made supernormal stimulus, hijacking the cognitive processes underlying the formation of transactive memory systems. Research on the "Google Effect" suggests that the Internet meets people's selection criteria for transactive memory partners and is entrusted with encoding, storing, and producing information (Sparrow, Liu, & Wegner, 2011). In one experiment, people who believed that trivia statements were being stored (or "remembered") by a computer failed to encode these statements within their own memories—even when they were explicitly instructed to do so; this suggests that people may intuitively and automatically offload responsibility for information to the Internet, and that this tendency is so strong that even explicit instructions to do otherwise are ineffective. A second experiment suggests that people do not just expect the Internet to encode and store information, but also look first to the Internet when they need to retrieve this information (thus completing the encoding/storage/retrieval cycle). When researchers asked participants difficult questions, words related to Internet search (Google, Yahoo) produced significantly more Stroop interference than general brand-related words (Nike, Target), indicating that the experience of not knowing something primed people to think of the Internet. Taken together, these experiments suggest that people use the Internet like a human transactive memory partner: They offload responsibility for information to this external storage device, and look to it when information is needed.

But the Internet may be more than just another memory partner; it may be treated as an informational catch-all, reducing the amount of information stored both in other external sources (e.g., human transactive memory partners) and internally (i.e., in individuals' own memories). Admittance to transactive memory systems is largely determined by availability, and responsibility for information is generally determined according to relative expertise and access to information. The supernormal stimulus of the Internet excels according to all three criteria.

First, the Internet is virtually omnipresent; access points populate homes and offices, and smartphones allow many people to carry a portal to the Internet with them wherever they go. Retrieving information stored on the Internet is as simple as inputting the right search string, and people need not worry that the Internet has gone on vacation or misplaced a relevant memory. Moreover, the Internet is not subject to mortality, the ultimate form of unavailability; information stored online does not run the risk of disappearing from the transactive memory system.

Second, the Internet almost always has relatively higher expertise in a given area than any one individual. The Internet, at its best, is a continuously updated, peer-reviewed, compendium of knowledge (Arbesman, 2012). Accessing the Internet can be like tapping into a field of *actual* experts, as opposed to simply asking the individual in one's transactive memory structure that has the highest level of *relative* expertise.

Third, the Internet contains not only a remarkable depth of information (i.e., expertise) but also a similarly remarkable breadth of information (i.e., access). In human transactive memory networks, access to information is almost always incomplete; not all information can be gathered and stored within a circle of friends and family. However, the Internet contains information originally produced by a massive network of individuals, allowing access to information that could never be gathered by a traditional transactive memory system.

Transactive memory systems maximize cognitive efficiency. In human transactive memory systems, this entails both dispersing responsibility for information across multiple transactive memory partners (allowing for both greater breadth and depth of knowledge) and requiring each individual member of the system to assume responsibility for certain domains of information (ensuring that all members not only benefit from, but contribute to, the system). The principles of expertise and accessibility generally help to maximize cognitive efficiency by ensuring proper distribution of responsibility between all members of the transactive memory system. However, the superiority of the Internet over human transactive memory partners according to each division criterion may change the outcomes of these guiding principles. In the pursuit of efficiency, the cognitive processes underlying the formation of transactive memory systems may lead individuals to offload responsibility for the vast majority of information to the Internet, rather than spreading this responsibility over a large network of individuals; these cognitive processes may also reduce the amount of information that individuals store internally, both because this information is less likely to be needed by an ever-shrinking social informational network and because this information would be redundant with information already stored online. When exposed to the supernormal stimulus of the Internet, the cognitive processes that have traditionally led to the formation of distributed transactive memory systems may lead people to depend almost exclusively on this digital transactive memory partner. When presented with new information, people's first impulse may not be to outsource this information to friends, colleagues, or lovers (i.e., human transactive memory partners), or to remember this information themselves, but to let this information pass them by, with the assumption that it has been (or will be) "remembered" by the Internet.

The Internet is Non-Normal

In some ways, the Internet seems to be an exaggerated version of a human transactive memory partner; it is supernormal. In other ways, however, the Internet is completely unlike a human partner; it is *non-normal*. The Internet is seemingly omniscient, omnipresent, and unobtrusive; together, these qualities may lead people not just to offload responsibility for information to the Internet but to fail to realize that they are doing so. When two people form a transactive memory system, it seems clear that each is sharing information with an external entity; the very act of physically asking another person for information draws attention to the fact that this information is coming from outside the self. However, the Internet does not draw attention to itself as an external entity—it provides information quickly, virtually invisibly, and without any of the extraneous physical cues inherent in human-to-human interactions. Recent research suggests that the non-normal (i.e., nonhuman) qualities of the Internet may cause people to fail to distinguish between information stored online and information stored in their own minds (Ward, 2013); when people use the Internet, they may take ownership of both Internet-related outcomes (e.g., retrieving a specific piece of information) and Internet-related attributes (e.g., possessing the capacity to remember and process information more generally). These two effects of blurred boundaries between the self and the Internet go hand in hand, but speak to distinct aspects of this phenomenon; the former states, "I *did* this," whereas the latter states, "I *am* this."

A recent series of experiments revealed that people who had recently accessed the Internet both took credit for high levels of performance enabled by the Internet and assimilated characteristics of the Internet into their self-concepts. Participants in these experiments were first asked to complete a trivia quiz either with or without the help of the Internet. Following this quiz, they were asked to complete a scale assessing Cognitive Self-Esteem (CSE)—a measure of people's beliefs about their own ability to remember and process information—and predict how well they would do on a second quiz of similar difficulty, to be completed without any external resources (including the Internet). Participants who used the Internet to complete the first quiz reported higher levels of CSE than those who had not, suggesting that they were more likely to view attributes associated with the Internet as being self-descriptive (Galinsky, Ku, & Wang, 2005). Participants who used the Internet, relative to those who did not, also predicted that they would receive higher scores on a second trivia quiz to be taken *without* the Internet; this suggests that they believed their performance was due to their own abilities, as opposed to the help of the Internet—people failed to distinguish between internal and external influences on performance (e.g., Chance, Norton, Gino, & Ariely, 2011). The differences between Internet users and nonusers persisted even when controlling for perceived performance using a false feedback paradigm.

The effects of Internet use on self-perceptions—in terms of both mental attributes (i.e., CSE) and causal explanations (i.e., predictions of future performance)—can be traced to the unique, non-normal characteristics of this transactive memory partner. For example, Internet search may often be faster than searching one's own memory; as a result, using the Internet to look up information may cause people to mistake recognition memory for recall memory and "confirm" that they know what they never actually knew. When people were able to use the Internet using a standard high-speed connection, they displayed the typical effects of Internet use on self-perceptions. However, when they were forced to use an artificially slowed Internet browser, these effects disappeared. Data suggest that increasing the time between deciding to "check" for information on the Internet and receiving this information may often cause people to realize that they never could have produced this information themselves. Highlighting the distinction between information stored online and information stored internally eliminates artificially inflated self-perceptions stemming from accessing the Internet—but typical patterns of Internet use often seem to obscure this distinction.

When people access externally stored information on the Internet, the non-normal characteristics of this transactive memory partner may blur the boundaries between the self and this digital memory partner. Accessing information online leads people to believe that they possess Internet-related attributes and are responsible for Internet-related outcomes; when connecting to the Internet as a transactive memory partner, people may not only offload responsibility for the majority of information to this external storage device, but also fail to realize that this information is stored externally rather than internally. When the cognitive processes underlying the formation of transactive memory systems come into contact with the supernormal stimulus of the Internet, people may tend to remember less while ironically believing that they remember more.

Negative Implications for Memory and Information Processing

Incorporating the Internet into one's transactive memory system may have negative implications for how people remember and process information. Because the Internet outperforms the human mind as an information storage device, people may replace their biological memory banks with digital forms of information storage. And because the Internet is unobtrusive, people may experience overconfidence in their own memories as they fail to distinguish between internally and externally stored information. Taken together, these effects may interfere with people's motivation and ability to form new memories and process incoming information.

Internet-related changes in the structure of transactive memory systems may impair the encoding of new memories by preventing the development of metamemory. To the extent that people are unable to distinguish between internally and externally stored memories, Internet users may feel like they know everything that the Internet knows. As a result, they may fail to develop metamemoryor accurate insight into what they do and do not know (Nelson & Narens, 1990). Metamemory typically seems to develop over time, as people gain experience with situations requiring them to assess the contents of their own memories. Evidence for this developmental trajectory comes from studies comparing children and adults (e.g., Samuel, 1978). For example, if adults are asked to produce a list of previously studied items from memory, there is a correlation between recall position (e.g., the first item remembered, the second item remembered, etc.) and accuracy, such that items recalled earlier are more likely to be correct; this suggests that adults know what they do and do not know. Children asked to complete the same task do not show this correlation between recall position and accuracy; the pattern (or, rather, lack of pattern) of their free-recall responses suggests that they have little insight into what they do and do not know. Constant access to Internet-based information may interfere with the development of metamemory both because people do not need to keep track of what they do and do not know (they can access externally stored information as fast or faster than internally stored information) and because the unobtrusive nature of the Internet prohibits people from distinguishing between internal and external memories. These deficits in metamemory may have downstream effects on the encoding of new memories, as they undermine the selection process by which incoming information is deemed worthy of memorization (e.g., Craik & Lockhart, 1972).

Offloading responsibility for information to the Internet may also impair future memory formation by preventing the construction of schema necessary for encoding new memories. Knowledge about a particular domain provides the structure for encoding additional information within that domain (e.g., Alba & Hasher, 1983); thus, if the majority of information related to a given domain is stored online, people may lack the schematic structure necessary for forming new memories related to that domain. We are currently investigating the possibility that chronically offloading responsibility for certain types of information prevents people from remembering and processing new information within that domain (Ward & Lynch, 2013). If this is the case, it may be that overreliance on the Internet as a transactive memory partner reduces people's *ability* to create new memories, not just their motivation for doing so.

Overconfidence in one's own knowledge, as a result of habitual Internet use, may reduce motivation to seek out new information—and possibly even motivate people to *avoid information*. People often seek out knowledge in order to reduce uncertainty (Alba & Hutchinson, 2000) or as a result of curiosity (Menon & Soman, 1999); however, individuals who are already confident in their own knowledge may not be subject to these search-related motivations. Artificially elevated confidence in one's own knowledge may also lead to active avoidance of new information. People are generally motivated to preserve their own positive self-perceptions (e.g., Allport, 1955; Taylor, Collins, Skokan, & Aspinwall, 1989; Tesser, 1988) and to selectively seek information consistent with their preexisting beliefs (e.g., Frey, 1986; Jonas, Schulz-Hardt, Frey, & Thelen, 2001; Schulz-Hardt, Frey, Luthgens, & Moscovici, 2000). Research on the illusion of explanatory depth suggests that people who overestimate their understanding of causal mechanisms, products, or concepts may be motivated to avoid exposure to new information because this information may shatter their unwarranted confidence in their own understanding (Fernbach, Sloman, St. Louis, & Shube, 2012). The combination of overconfidence and a desire to maintain positive self-perceptions may cause people to resist exposure to new information and flee from incoming information if this input begins to expose the gap between their self-perceived mastery over a given domain of knowledge and their actual level of knowledge in that domain.

Despite their best efforts, the overconfident will doubtless encounter new information at some point. However, overconfidence may cause even this information to be shallowly processed. Research indicates that when people are exposed to new information, those with high levels of prior knowledge about a related topic tend to learn less than those with lower levels of prior knowledge. The tendency of those who know more to learn less can be explained by inattention during the encoding phase of memory; because these people believe that they are already knowledgeable, they fail to attend to and remember new information (Wood & Lynch, 2002). A similar process may occur for those believe the have high levels of prior knowledge, even when this belief is illusory. If this is the case, then overconfidence as a result of habitual reliance on the Internet is doubly damning: Not only do people incorrectly believe that they have high levels of prior knowledge, but they also fail to process new information.

Positive Implications for Memory and Information Processing

Offloading information to the Internet may also have positive effects on memory and information processing. The Internet is a supernormal stimulus—it is superior to other external information storage devices (such as humans) according to the selection criteria of availability, expertise, and access to information. It outperforms human transactive memory partners in terms of both storing and producing information. It provides access to vast amounts of information while minimizing the cognitive demands placed on the individual. These qualities of the Internet suggest that, in some ways, this supernormal stimulus is not only superior to traditional transactive memory partners according to dimensions used as selection criteria, but also according to dimensions related to the overall adaptiveness of offloading memory. Although most supernormal stimuli result in exclusively negative and/or maladaptive behavior, the combination utilization of the Internet as a transactive memory partner may have positive implications for the ways people process and remember information.

Reductions in cognitive demands as a result of offloading information to the Internet may grant individuals enhanced capacity for information processing as a result of an increased availability of cognitive resources. Offloading information to the Internet may enable people to solve problems more efficiently, think more creatively, and perform a wide variety of mental operations that would have been impossible without the additional cognitive resources released as a result of offloading information. People who are able to offload extraneous details onto a computer show increased ability to solve problems requiring creative problem solving (Sparrow, 2013), and similar positive effects may be found in other domains that rely on manipulating information in novel and/or complex ways. Perhaps the availability of the Internet as an omnipresent source of information opens the door for a new kind of intelligence, one based not on knowledge per se but on the ability to locate and process externally stored ideas using internal cognitive resources.

Offloading information to the Internet may also have positive implications for memory per se, as storing information online prevents common memory distortion effects. These memory distortions would afflict all information assigned to a human transactive memory partner (whether that part is the self or some other person). Given that the cognitive processes underlying the formation of transactive memory systems are working to maximize efficiency, however, these processes should lead people to preferentially offload memories online instead of storing them internally or trusting them to a human transactive memory partner. Internally stored memories are subject to memory distortions (e.g., Loftus & Hoffman, 1989), and the severity of these distortions seems to increase over time (e.g., Seamon et al., 2002) and with slow, offline processes such as those that are active during sleep (Payne et al., 2009). It is important to note that these distortions occur not just for autobiographical memories but also for nonautobiographical episodic and semantic memories (e.g., Roediger & McDermott, 1995)—that is, the type of memories that may be habitually offloaded to the Internet. To the extent that people rely on the Internet for information storage and recall, reliance on this digital transactive memory partner should reduce memory distortions and increase the accuracy of recalled information.

Conclusion

The Internet, this new supernormal stimulus, is not changing the *way* we think, but it may be changing the outcomes of these ways of thinking. As people turn from their old transactive memory partners—friends, family, and neighbors—to the Internet, they may offload more and more information while losing sight of the distinction between information stored in their own minds and information stored online. This shift in the outcome—but not the architecture—of the cognitive processes underlying the formation of transactive memory systems may cause Internet users to both assimilate characteristics of the Internet into their own self-perceptions and misattribute Internet-related outcomes to the self; they may believe that they are particularly good at thinking about and remembering information, despite the fact that the responsibility for "remembering" information is falling ever more heavily on the shoulders of the Internet.

This shift in the allocation of information, and the subsequent disconnection between actual and perceived knowledge, may have both positive and negative effects on memory and information processing. It may prevent memory distortions but simultaneously prevent memory formation. It may free up resources for innovative information processing but simultaneously impair our motivation to seek and attend to new information. The Internet may be a "game changer," but it has changed the game not by altering the rules but introducing a new playing piece—and it seems like this piece can change the game for either the better, or the worse. Continuing research can illuminate the possibilities and pitfalls that arise from the combination of long-standing memory-related cognitive processes with this new and still-developing technology; perhaps even more important, it can provide guideposts, marking the way to a future defined not by losing our minds but by augmenting them with the awesome power of the Internet.

Acknowledgments

I thank my doctoral advisor, Dan Wegner, for being one of the kindest, funniest, and most reliably insightful humans I have ever known. He was, and will continue to be, a brilliant example of a life defined by

joy, curiosity, and an inexplicable affinity for beagle-pusses.

Note

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References

Alba, J. W., & Hasher, L. (1983). Is memory schematic? *Psychological Bulletin*, *93*, 203–231.

Alba, J. W., & Hutchinson, J. W. (2000). Knowledge calibration: What consumers know and what they think they know. *Journal of Consumer Research*, *27*, 123–156.

Allport, G. W. (1955). *Becoming: Basic considerations for a psychology of personality*. New Haven, CT: Yale University Press.

Andersson, M. (1982). Female choice selects for extreme tail length in a widowbird. *Nature*, *299*, 818–820.

Arbesman, S. (2012). *The half-life of facts: Why everything we know has an expiration date*. New York: Current.

Ashton, K. (2009). The 'internet of things' thing. *RFID Journal*. Retrieved from http://www.itrco.jp/libraries/RFIDjournal-That%20Internet%20of%20Things%20Thing.pdf

Barrett, D. (2007). *Waistland: The r/evolutionary science behind our weight and fitness*. New York: Norton.

Bessière, K., Seay, A. F., & Kiesler, S. (2007). The ideal elf: Identity exploration in World of Warcraft. *Cyberpsychology and Behavior*, *10*, 4.

Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition*, *19*, 41–62.

Bowlby, J. (1969). *Attachment and loss, Vol. 1: Attachment*. New York: Basic Books.

Brewer, M. B. (1991). The social self: On being the same and different at the same time. *Personality and Social Psychology Bulletin*, *17*, 475–482.

Chance, Z., Norton, M. I., Gino, F., & Ariely, D. (2011). Temporal view of the costs and benefits of self-deception. *PNAS, 108*, 15655–15659.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*, 671–684.

Doyle, J. F., & Pazhoohi, F. (2012). Natural and augmented breasts: Is what is not natural most attractive? *Human Ethology Bulletin*, *27*(4), 4–14.

Dunbar, R.I.M. (1993). Co-evolution of neocortex size, group size, and language in humans. *Behavioral and Brain Sciences*, *16*(4), 681–735.

Fernbach, P. M., Sloman, S. A., St. Louis, R., & Shube, J. N. (2013). Explanation fiends and foes: How mechanistic detail determines understanding and preference. *Journal of Consumer Research*, *39*, 1115–1131.

Frey, D. (1986). Recent research on selective exposure to information. *Advances in Experimental Social Psychology*, *19*, 41–80.

Galinsky, A. D., Ku, G., & Wang, C. S. (2005). Perspective-taking and self-other overlap: Fostering social bonds and facilitating social coordination. *Group Processes and Intergroup Relations*, *8*, 109–124.

Hanson, H. M. (1959). Effects of discrimination training on stimulus generalization. *Journal of Experimental Psychology*, *58*, 321–334.

Jasieńska, G., Ziomkiewicz, A., Ellison, P., Lipson, S., & Thune, I. (2004). Large breasts and narrow waists indicate high reproductive potential in women. *Proceedings of the Royal Society of London B*, *271*, 1213–1217.

Jonas, E., Schulz-Hardt, S., Frey, D., & Thelen, N. (2001). Confirmation bias in sequential information search after preliminary decisions: An expansion of dissonance theoretical research on selective exposure to information. *Journal of Personality and Social Psychology*, *80*, 557–571.

Leary, M. R., & Kowalski, R. M. (1997). *Social anxiety*. New York: Guilford.

Leiner, B. M., Cerf, V. G., Clark, D. D., Kahn, R. E., Kleinrock, L., Lynch, D.C., et al. (2012). *Brief history of the Internet*. Retrieved from http://www.internetsociety.org/sites/default/files/Brief_History_of_the_Internet.pdf

Loftus, E. F., & Hoffman, H. G. (1989). Misinformation and memory, the creation of new memories. *Journal of Experimental Psychology: General*, *118*, 100–104.

Lorenz, K. (1937). On the formation of the concept of instinct. *Natural Sciences*, *25*, 289–300.

Marlowe, F. (1998). The nobility hypothesis: The human breast as an honest signal of residual reproductive value. *Human Nature*, *9*, 263–271.

McClelland, D. C. (1961). *The achieving society*. Eastford, CT: Martino Fine Books.

Menon, S., & Soman, D. (1999). *Managing consumer motivation and learning: Harnessing the power of curiosity for effective advertising strategies* (Working Paper No. 99–100). Cambridge, MA: Marketing Science Institute.

Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings, *The Psychology of Learning and Motivation*, *26*, 125–173.

Payne, J. D., Schacter, D. L., Propper, R., Huang, L., Wamsley, E., Tucker, M. A., et al. (2009). The role of sleep in false memory formation. *Neurobiology of Learning and Memory*, *92*, 327–334.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*, 803–814.

Romanoff, A. L., & Romanoff, A. J. (1949). *Avian egg*. New York: Wiley & Sons.

Samuel, A.G. (1978). Organizational vs. retrieval factors in the development of digit span. *Journal of Experimental Child Psychology*, *26*, 308–319.

Schulz-Hardt, S., Frey, D., Luthgens, C., & Moscovici, S. (2000). Biased information search in group decision making. *Journal of Personality and Social Psychology*, *78*, 655–669.

Seamon, J. G., Lee, I. A., Toner, S. K., Wheeler, R. H., Goodkind, M. S., & Birch, A. D. (2002). Thinking of critical words during study is unnecessary for false memory in the Deese, Roediger, and McDermott procedure. *Psychological Science*, *13*, 526–531.

Sparrow, B. (2013). *The upside of information accessibility: Offloading details enhances creative problem solving*. Unpublished manuscript.

Sparrow, B., Liu, J., & Wegner, D. M. (2011). Google Effects on memory: Cognitive consequences of having information at our fingertips. *Science*, *333*, 776–778.

Staddon, J. E. R. (1975). Limitations on temporal control: Generalization and the effects of context, *British Journal of Psychology*, *66*, 229–246.

Tamir, D. I., & Mitchell, J. P. (2012). Disclosing information about the self is intrinsically rewarding. *Proceedings of the National Academy of Sciences U S A*, *109*, 8038–8043.

Tattersall, I. (2001). Evolution, genes, and behavior. *Zygon*, *36*, 657–666.

Taylor, S. E., Collins, R. L., Skokan, L. A., & Aspinwall, L. G. (1989). Maintaining positive illusions in the face of negative information: Getting the facts without letting them get to you. *Journal of Social and Clinical Psychology, 8*, 114–129.

Tesser, A. (1988). Toward a self-evaluation maintenance model of social behavior. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (pp. 181–227). New York: Academic Press.

Thurlow, C., Lengel, L., & Tomic, A. (2004). *Computer mediated communication: Social interaction and the Internet*. Thousand Oaks, CA: Sage.

Tinbergen, N. (1951). *The study of instinct*. Oxford, UK: Clarendon Press.

Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of ancestral environments. *Ethology and Sociobiology*, *11*, 375–424.

Ward, A. F. (2013). *One with the Cloud: Why people mistake the Internet's knowledge for their own* (Unpublished doctoral dissertation). Harvard University, Cambridge, MA.

Ward, A. F., & Lynch, J. G. (2013). [Longitudinal effects of transactive memory processes on financial literacy]. Unpublished raw data.

Wegner, D. M. (1986). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185–208). New York: Springer-Verlag.

Wegner, D. M. (1995). A computer network model of human transactive memory. *Social Cognition*, *13*, 319–339.

Wegner, D. M., Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality and Social Psychology*, *61*, 923–929.

Wegner, D. M., Giuliano, T., & Hertel, P. (1985). Cognitive interdependence in close relationships. In W. J. Ickes (Ed.), *Compatible and incompatible relationships* (pp. 253–276). New York: Springer-Verlag.

Wood, S. L., & Lynch, J. G. (2002). Prior knowledge and complacency in new product learning. *Journal of Consumer Research*, *29*, 416–426.

Yee, N. (2006). The demographics, motivations and derived experiences of users of massively-multiuser online graphical environments. *PRESENCE: Teleoperators and Virtual Environments*, *15*, 309–329.