Does Google Negative Impact Our Cognitive Ability?

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

When faced with a tricky question, what would you do to find the answer? If your immediate response is to Google it, then you are not alone. An international study revealed that over a third of participants google the answer without even trying to remember and a quarter immediately forget what they've found (Griffiths, 2015). While the benefits of Google's existence are well known, the impact that it has on our brains is contested. Several studies have shown that society's increasing dependence on the digital world has resulted in negative consequences such as decreased attention spans, increased anxiety, lower performance on cognitive tasks, and diminishing social skills. Still, some argue that Google is simply another form of a Transactive Memory System. This paper will discuss the impacts that search engines such as Google have had on our minds through the lens of the STS framework Technological Momentum.

Background

Search Engines

Search engines are extremely popular software programs that help people find the information that they are looking for online by using keywords or phrases ("What", n.d.). Companies such as Google, Bing, Yahoo, and AOL have become household names due to the effectiveness and quality of their search engines. People use search engine services daily to find information on topics such as current events, health concerns, products, government services, natural disasters, coworkers, peers, and a myriad of other topics of varying severity.

The process of online searching with Google involves three steps: crawling, indexing, and ranking (Brin & Page, 1998). Crawling is used to download the web pages and to ensure that they are up to date. Indexing refers to the creation of a cataloged database for the crawled web pages. Ranking is the ordering of results based on both the importance to users and weighted calculations done on each individual page for the query. The ranking system is usually done by internal calculations predetermined by the company based on several factors of varying weights that are also determined by the company.

Through the creation of these ranking algorithms, search engines have become one of the most popular online activities, only slightly less popular than email use (“Type”, 2020). This popularity, caused by the optimization of research and sharing of information through the ranking system, has resulted in a “strong bias towards links higher in position even if the abstracts themselves were less relevant,” (Pan et al., 2007) for users when deciding which links to click.

Due to the nature of ranking systems, each search engine may display slightly different results based on the individual weights assigned by the company. For example, Google takes into account over 200 factors before delivering their results to users (“Search,”, 2021), while other companies could base their results on a completely different set of factors. These ranking algorithms have given search engines the role of primary gatekeeper of online information. And to some degree, “gatekeeping is a necessity when parsing through massive quantities of available information” (Granka, 2010).

While the efficiency of search engines is a technical issue, it is important to remember that the creation of the search engine has also resulted in a form of search politics. The design of search engines "systemically exclude (in some cases by design and some accidentally) certain sites, and certain types of sites, in favor of others, systemically giving prominence to some at the expense of others" (Nissenbaum & Introna, 2006).

Transactive Memory Systems

In its broadest sense, Transactive Memory Systems (TMS) refers to a shared system for encoding, storing, and retrieving information (Wegner, Giuliano, & Hertel, 1985). Encoding is used to describe the creation of a memory trace. Storage deals with the maintenance and tracking of that memory trace. Retrieval refers to the accessing of the stored memory trace. Learning through discussions and collaboration, knowing other people's expertise, and knowing what others might know are examples of transactive memory processes (Shukla, 2020). With TMS, the information is divided up within a group "into different people's individual memories, and team members are only required to remember that chunk of information ("The Google Effect", n.d.).

STS Framework

The framework used for this analysis will be Technological Momentum (TM). TM is a theory, created by Thomas Hughes, that operates as the middle ground between both the Social Construction of Technology (SCOT) and Technological Determinism (TD). SCOT is a theory that claims that the advancement of technology is achieved through the acceptance and interpretation of various social groups (Kline & Pinch, 1996). In contrast, the TD framework

believes that our social structure and values are created through the advancement of technology (Winner, 2009). Technological Momentum combines the two by claiming that, for large technological systems, the relationship between technology and society is reciprocal and time-dependent. The theory states that as an artifact, or technological system, gains momentum or popularity and influence, over time, the artifact becomes more the shaper of the society around it, rather than shaped by the society (Hughes, 2009).

For example, consider the airplane. The first aircraft was created in 1903, but it was rarely used in its first few decades because it was deemed a risky activity (Harris, 2017). Its popularity began to pick up in 1918 when the US Post Office began conducting airmail routes that were operated by US Army pilots and aircraft (Cook, 1996). It began as a "rudimentary transcontinental infrastructure of navigational lights and airfields developed to support the nascent airmail service" (Cook, 1996). This system was able to deliver a parcel from New York to the West Coast in just two days compared to the five produced by railway services (Bilstein, 2020). This delivery system was extremely popular and caused Congress to pass the Air Mail Act of 1925, which authorized the US Post Office to "award routes and payments to private air carriers" (Cook, 1996). Shortly thereafter, the Air Commerce Act tasked the Secretary of Commerce with "fostering air commerce, issuing and enforcing air traffic rules, licensing pilots, certifying aircraft, establishing airways, and operating and maintaining aids to air navigation" and resulted in the establishment of a new Aeronautics Branch of the Department of Commerce ("brief", n.d). Similarly to Google, the creation of the airplane was prompted by a need recognized in society and as they became widely adopted by society, planes began to integrate

with and shape society, which resulted in the creation of new laws, infrastructure, and social norms that were centered around the technological system.

Arguably, no technology company is more responsible for shaping both the internet and modern life than Google (Verge, 2018). It started as a novel search engine and now manages eight products with more than 1 billion users each (Verge, 2018). Google has allowed students to incorporate information for research projects, allowed individuals to keep track of the stock market, and provided unique opportunities for people (Impact, n.d.). The phrase "Google it" has become a common expression used when people either need to learn new information or cannot remember something. Google has become a substitute for thinking and some may even say that it was designed specifically to think for us. But if we continue to believe that it was always meant to think for us, then we will not understand how its role and influence have evolved over time. Google was originally designed to be used as a resource to consolidate a conglomerate of information related to our search query, but over time it has gained momentum and now has changed the way in which we think (Brin & Page, 1998).

Research

Methods

To discuss the effects that Google has on our thought processes, I have used several accounts from experts in the field of cognitive psychology, behavioral research, and those who study the relationship between technology and society.

Most of the accounts cited a series of 4 experiments conducted by Sparrow et al. (2011). The research method was observational and the first experiment had a 2 within-subject design where subjects answered either an easy or hard question, followed by a modified Stroop task (a color-naming task with words presented in either red or blue) to test reaction times with computer and non-computer related words (including general and brand names for both word groups).

The second experiment tested whether participants remembered information that they expected to have later access to. Participants were tested in a 2 by 2 between-subject experiment by reading 40 memorable trivia statements that would normally be looked up online. Half were told that the computer would delete what they typed, while the other half believed that it would save what they typed. In addition, half of the participants in both groups were explicitly instructed to try to remember the information, and they were all told to write down as much as they could remember shortly after.

The third experiment was designed to test participants' memory of where to find information that one might look up online. Participants read and typed in memorable trivia, this

time in 3 within-subject conditions. A third of the questions displayed “Your answer has been saved”, a third showed “Your entry has been saved in the folder X” where X was one of six possible folders, and the final third displayed “Your entry has been erased”. Then they were given a recognition task with all 30 statements, some slightly altered and they had to identify whether or not they had seen that question exactly as it had been written before, whether or not it was saved, and if applicable, the specific folder that it was saved to.

The final experiment was to test if the participants could recall where to find information better than the content of the information itself. All of the participants expected trivia statements that they read and then typed to be saved into one of the six folders from the third experiment (but in this case, there was no trial run, and neither the names of nor the number of folders was explicitly called to the participant’s attention). Participants were then asked to recall as many of the statements as they could within a 10 minute period. Afterward, participants were given an identifying aspect of the statement that they read (and had been saved) and they had to answer with the folder name in which it was saved. For example, if the statement was “An ostrich’s eye is bigger than its brain”, the question would be “What folder was the statement about an ostrich saved in?”

Results

The results of the first experiment supported Sparrow et al's (2011) hypothesis that computer words were more accessible, giving them a longer color-naming reaction time when compared to non-computer words. After participants were asked a series of questions to which they did not know the answer, results show that computer words had an average reaction time of 712 ms with a standard deviation of 413 ms, while general words had an average time of 591 ms with a standard deviation of 204 ms. The results also show that after easy questions were asked, participants struggled slightly more color naming computer terms at an average time of 603 ms with a standard deviation of 193 ms than general terms (M = 559 ms, SD = 182 ms). This suggests that the computer may be primed when the concept is knowledge, in general, is activated (Sparrow et al., 2011). Results also reveal that when comparing specific search engine brand names such as Google and general consumer good brand names (Nike/Target), search engine brands cause more interference after both easy and difficult questions. This suggests that even when answers are known, not knowing the answer to general-knowledge questions primes a need to search for the answer and subsequently makes computer interference particularly acute.

The second experiment showed that overall those who believed that the computer was going to erase what they had typed had the best recall (Just Erase M = .31, SD = .04 and Erase and Remember M = .29, SD = .07) than both groups who were told that the computer would save what they typed (Just Saved M = .22, SD = .07 and Save and Remember M = .19, SD = 0.09). This supports previous findings on directed forgetting, showing that people tend to not recall information at the same rate when they believe that they will not need it later. It also shows that

participants did not make the same effort of remembering when they thought that they could just search up the statements that they had seen earlier.

The third experiment revealed that when asked if participants had seen this statement exactly as it had been written, those who believed the statements had been erased, had the best memory (erase M = .93, SD = .09). Those who believed it was saved generically and saved specifically to a folder were not far off, but noticeably lower (generically M = .88, SD = .12 and specifically M = .85, SD = .12). These results indicate that believing that the data will not be accessible in the future does indeed improve memory quality, but when participants were asked which folder specifically it was saved to, participants received much lower results (generically M = .30, SD = .20 and specifically M = .23, SD = .14).

The fourth experiment showed that overall, participants remembered where the statements were kept (M = .49, SD = .26) much better than they remembered the statements themselves (M = .23, SD = .14), which were designed to be very memorable when compared to the folder names.

Discussion

Now when it comes to answering whether or not Google has a negative impact on our cognitive processes, the answer is a resounding yes. But let's further discuss the Technological Momentum of Google.

As stated earlier, Google was created to satisfy a need, and with its groundbreaking PageRank ranking system, it quickly beat out its predecessors. PageRank rates the relevancy of

webpages to queries, based not only on whether the pages contain the search terms (which was the same strategy used by all search engines) but also by how many relevant pages link to it (Vaughan-Nichols, 2017). This provided much better results when compared to other search engines of the time and played a significant role in the initial popularity of Google.

With 91.9% of the total market share of search engines and more than 89 billion visits in December 2021, Google has grown to be so large and influential that Congress has begun to propose several legislations to regulate large tech companies (Mohsin, 2022). One is the American Innovation and Choice Online Act, which restricts large tech companies like Google, Yahoo, and Amazon from impeding the "capacity of a competing business user to access or interoperate with the same platform, operating system, or hardware or software features" (CRS, 2022). This bill restricts dominant platforms (defined by criteria including how many users they have and their market cap) from discriminating against other businesses that rely on its platform through the process of self-preferencing. So these companies will not be allowed to list their products in a higher position in their search ranking than third-party rivals (Feiner, 2022). Another is the Kids Internet Design and Safety Act (KIDS Act), which "prohibits operators of commercial online platforms that are directed to children from engaging in certain practices, including implementing features that encourage additional engagement with the platform, promoting certain types of content, and using certain advertising methods" (CRS, 2022). This act is intended to combat the negative mental and physical effects that children face when using platforms such as Google with potentially harmful algorithmic practices that promote harmful behaviors including self-harm, eating disorders, substance abuse, and unlawful products for minors ("Blumenthal", 2022). This technology, that was intended to satisfy a need, has had such

an impact on society that we are now creating laws and infrastructure specifically with it in mind.

Similar to the new regulations, the Google Effect, or digital amnesia, is another direct result that Google's momentum has had on our lives. The Google Effect is used to describe our tendency as humans to forget information that is readily available through the use of search engines such as Google ("Google", n.d). As evident in Sparrow et al's (2011) experiment, the effects of digital amnesia are that people quickly forget information that is easily found on the internet, but they remember where and how that information is found better.

Nicholas Carr, an American writer who focuses on the intersectionality between technology, economics, and culture; states that Google and other forms of media "supply the stuff of thought, but they also shape the process of thought" (2020). Carr cites a study conducted by scholars from University College London, which examined online research habits between two popular research sites that provide access to journal articles, e-books, and other sources of written information (2020). The study revealed that people using the sites exhibited "a form of skimming activity, hopping from one source to another and rarely returning to any source they'd already visited" (Carr, 2020). Users did not typically read more than one or two pages of an article or book before hopping onto another site. They might have saved a long article, but there was no evidence that they ever went back to actually read it. The authors of the study report:

> It is clear that users are not reading online in the traditional sense; indeed there are signs that new forms of "reading" are emerging as users "power browse" horizontally through

> titles, contents pages, and abstracts going for quick wins. It almost seems that they go online to avoid reading in the traditional sense. (Carr, 2020)

According to Maryanne Wolfe, a developmental psychologist at Tufts University and the author of *Proust and the Squid: The Story and Science of the Reading Brain*, reading is not an instinctive skill possessed by humans. It is a learned skill that must be developed and practiced. And the neural circuits that our brain uses while reading is largely affected by the medium we use to practice the craft. If the dominant medium advantages processes that are fast, multi-task oriented, and well suited for large volumes of information, similar to the digital medium, then so will our reading circuit. Wolfe agrees with UCLA psychologist Patricia Greenfield that the result of search engines on the brain is that "less attention and time will be allocated to slower, time-demanding deep reading processes, like inference, critical analysis, and empathy, all of which are indispensable to learning at any age" (Wolf, 2021).

This phenomenon has been observed in several studies around the world. Ziming Liu from San Jose State University has conducted several studies indicating that our new normal for reading is "skimming, with word-spotting and browsing through the text" (Wolf, 2021). Many readers now use an F or Z pattern when reading in which they sample the first line and then word spot through the rest of the text. Wolfe explains that when the reading brain skims like this, the time allocated to deep reading processes is decreased. In other words, this means that we don't have the time to grasp complexity, to understand another's feelings, to perceive beauty, and to create thoughts of the reader's own. Studies led by English literature scholar and teacher Mark Edmundson reveal that many college students "actively avoid the classic literature of 19th and

20th centuries because they no longer have the patience to read longer, denser, more difficult texts" (Wolf, 2021). Wolfe states that we should be less concerned about the cognitive impatience of college students and more so about the underlying cause: "the potential inability of large numbers of students to read with a level of critical analysis sufficient to comprehend the complexity of thought and argument found in more demanding texts" (Wolf, 2021). Norwegian psychologist, Anne Mangen, and her colleagues studied how reading comprehension of high school students through different mediums. The study consisted of asking two groups of students about a short story with universal student appeal; half read Jenny, Mon Amour on a Kindle, the other half on paperback. Results indicate that students who "read on print had superior reading comprehension than their screen-reading peers, particularly in their ability to sequence detail and reconstruct the plot in chronological order" (Wolf, 2021).

This worry is especially important due to the fact that the effects on reading comprehension and growth of empathy by our digital culture can be seen as early as fourth and fifth grade. Given that it's very likely that children's access to internet-based devices and search engines such as Google will continue to increase, these comprehension and memory effects are extremely significant and due to the nature of the brain, can be compounding. The development of a skimming mentality and distracted reading practices earlier in life would have a more lasting impact on our cognitive practices and empathetic responses and could affect an entire generation.

Common pushback for the negative impact that search engines cause is to describe the Google Effect as an extended form of a Transactive Memory System. Clive Thompson, a New York Times journalist who writes about science and technology, supports this belief. Thompson

believes that we have just come to treat search engines as we have treated our spouses, friends, and workmates; as a “handy device we use to compensate for our crappy ability to remember details” (Thompson, 2013). He believes that the way that we have relied on books, paper, and other people to remember the details for us, is the same way we rely on tools such as Google. But, unlike the patterns that research on search engines have revealed, reading books actually have positive results on cognitive ability within humans such as increased early educational achievement and a reduced risk of cognitive decline (Chang et al., 2020). Also in terms of shared memory systems, humans have a limited capacity of what we will remember, so both parties have to take part in the system. When using another individual or group of people, you are limited to their knowledge and capacity as well. With Google, there is no upper bound to what you can offload onto it. Humans could theoretically replace everything we ‘have’ to remember onto it, which unless usage patterns change, will limit the things a person remembers to just the things they are very passionate about.

Conclusion

The Google Effect means that we are changing the way in which we use our memory, we are not carrying less information in our heads than before. Younger generations are more likely to offload memory to outside sources, such as the internet and search engines such as Google. It has been shown to have caused reduced cognitive ability in areas such as reading comprehension, inference, critical analysis, and empathy. When dealing with the effects of the phenomenon, it is important to note that, due to the popularity of Google, the removal of the technology from society is unfeasible. Its momentum has already grown too big and it has

already become intertwined with everyday life. Now we must come up with solutions of how to combat and mitigate the cognitive processes that are strengthened by search engine use. Potentially, this may require a change in the way we teach and test. Framing our educational systems in a manner that can work to strengthen the processes that search engines work against may be the best way to halt the Google Effect.

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