Review

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Cognitive Effects of Digital Technology Use in Young Adults: A Scoping Review

Genç Yetişkinlerde Dijital Teknoloji Kullanımının Bilişsel Etkileri: Bir Kapsam Derlemesi

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ABSTRACT

Examining the cognitive effects of digital technology use in young adults will contribute to scientific knowledge and guide education and health. This scoping review aims to evaluate the cognitive effects of digital technology use in young adults as a result of the search conducted in DergiPark, Science Direct, Wiley Online Library, Medline Plus, DOAJ, PubMed, EBSCO, Scopus, Web of Science, IEEExplore, and ACM Digital Library databases without any time limitation. Twelve studies that meet the criteria were included in the review by the researchers. The included studies examined the cognitive effects of digital technology use in terms of memory, learning, and information processing in the included studies. Most studies showed that digital technology use creates adverse cognitive effects such as low recall accuracy, decreased neural activity in brain regions associated with memory, comprehension and transcribing issues about information, self-confidence problems during answering recall tests, forgetfulness about future events, and misinterpretation of the remembering process. According to the research findings, addiction to digital technology, trust in the process of recording information, cognitive effort shown in accessing and using information, and different methods used in recording information were determined as factors affecting the emergence of adverse cognitive effects. These results indicate that methodologically strong and comprehensive studies are necessary to understand the cognitive effects of digital technology use.

Keywords: Digital technology, digital amnesia, digital dementia, google effect, scoping review

ÖZ

Genç yetişkinlerde dijital teknoloji kullanımının bilişsel etkilerinin incelenmesi hem bilimsel bilgiye katkı sağlayacak hem de eğitim ve sağlık alanlarında yol gösterici olacaktır. Bu kapsam derlemesi, DergiPark, Science Direct, Wiley Online Library, Medline Plus, DOAJ, PubMed, EBSCO, Scopus, Web of Science, IEEExplore ve ACM Digital Library veri tabanlarında zaman sınırlaması olmaksızın yapılan tarama sonucunda genç yetişkinlerde dijital teknoloji kullanımının bilişsel etkilerini değerlendirmeyi amaçlamaktadır. Kriterleri karşılayan 12 çalışma araştırmacılar tarafından derlemeye dahil edilmiştir. Dahil edilen çalışmalar dijital teknoloji kullanımının bilişsel etkilerini hafıza, öğrenme ve bilgi işleme yönlerinden incelemiştir. Çoğu çalışma dijital teknoloji kullanımının doğru hatırlamada azalma, hafıza ile ilişkili beyin bölgelerindeki nöral aktivitenin azalması, bilgiyle ilgili anlama ve yazıya dökme sorunları, hatırlama testlerini cevaplarken kendine güvenip güvenmeme, gelecekle ilgili unutkanlık ve hatırlama sürecinin yanlış yorumlanması gibi olumsuz bilişsel etkilere yol açtığını göstermiştir. Araştırma bulgularına göre, dijital teknolojiye bağımlılık, bilgiyi kaydetme sürecine duyulan güven, bilgiye erişme ve bilgiyi kullanma sürecinde gösterilen bilişsel çaba ve bilgiyi kaydetmede kullanılan farklı yöntemler olumsuz bilişsel etkilerin ortaya çıkmasını etkileyen faktörler olarak belirlenmiştir. Bu sonuçlar, dijital teknoloji kullanımının bilişsel etkilerinin anlaşılabilmesi için metodolojik açıdan güçlü ve kapsamlı çalışmalara ihtiyaç duyulduğunu göstermektedir.

Anahtar sözcükler: Dijital teknoloji, dijital amnezi, dijital demans, google etkisi, kapsam derlemesi

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Introduction

Digital technology is a broad term that included our lives when the first computers emerged in the 1940s-50s. The National Library of Medicine (2020) defines digital technology as "the design and development of devices and procedures that collect, store, analyze, manipulate, and display numerically encoded information, usually via processes encoded in the binary number system." Cell phones, computers, and the Internet are the leading digital technology products in almost all our lives, such as communication, education, health, and entertainment. Especially in recent decades, most of the people consider this period as the 'rise of digital technology.' So why? How did people broadly embrace and use digital versions of information processing and storing methods? Lundberg (2013) answers this question by saying that using digital technology provides opportunities for people to reach and experience everything that exists and is happening in the world that we do not physically have access to. Easy and fast access to requested information may motivate people to embrace and universally use digital technology products. The Internet has become the primary and widely used source of information for people these days because of its effortless accessibility and the tremendous amount of information that is stored. This widespread reliance on digital information sources is particularly relevant from a psychological perspective, as information storage and processing are the human brain's key cognitive functions. It may be claimed that people are getting used to trusting digital technology products rather than internal memory to accomplish these processes. Hamilton and Benjamin (2019) state that people offload various cognitive tasks (such as storing contacts, finding directions, and searching for information) to the internet service and technology-enabled devices to use their memory capacity more efficiently, particularly in interpersonal communication. However, external storage of information is not a new concept for humans. Wegner et al. (1985) claimed the Transactive Memory Theory, a shared memory system theory that defines the development of common knowledge between people via interactions and explains a process of information recalling by using the experiences of others. The theory argues that social interactions and networks help people to remember, store, and analyze information. However, digital technology products replace the role of social interactions and person-person relationships as external memory sources these days.

Sparrow et al. (2011) define the Internet as a widely accessible external memory source that individuals can rely on at any time. Individuals increasingly depend on digital technology products as the tendency to store and retrieve information via digital devices becomes more habitual. In this context, the "Google Effect," first introduced by Sparrow et al. (2011), provides a significant conceptual framework for understanding the potential cognitive impacts of digital technology use. Sparrow et al. (2011) explain the Google effect as the potential and detrimental impact of relying on computers for cognitive abilities such as learning, recalling, memorizing, and interpreting information. Sparrow et al. (2011) found that when people encounter difficult questions, they first and effortlessly think that computers have the answer, and certainty about the permanency of the information decreases the recall rates of the information itself, increases the knowledge about where information can be found such as website or storage file. People started to intend to consult the internet or digital technology products rather than themselves when they needed information. Cognitive tasks such as recalling necessary information might be negatively affected while people save information in digital technology products. At this point, researchers may ask questions about the seriousness of the potential cognitive problems may be asked. If such cognitive issues occur, how significant are these problems, and how common are they? Most people use their phones and computers as external memory sources to remember essential information such as the date of marriage, notes for final exams, or phone numbers of their relatives. Also, people have used the Internet as a first source of information rather than encyclopedias, textbooks, or conventional libraries for about 10 years. In this context, Rowlands et al. (2008) mentioned the term "Google Generation," which describes people born after 1993, who grew up in a world led by digital technology, and who prefer the internet and search engines as the first way to access information. Digital resources have become the primary source the Google generation uses at many points in their learning process. Reaching textbooks on the Internet, taking photos of lecture slides, and voice recording in the classroom are examples of activities that students do often, thanks to digital technology opportunities. They have much easier ways to access information than many generations. However, it is debatable how good they are at cognitive processes, which require

utilizing information such as recalling or understanding information and critical thinking. Using digital technology products facilitates accessing and storing information for them. However, this situation might interfere with the cognitive processes needed to truly learn information.

The term "Digital Dementia" occurred around this topic in 2012 by Manfred Spitzer (Preiss 2014). Preiss (2014) analyzed Spitzer's book and referred to Spitzer's ideas that using digital technology has serious dementia-like effects, such as weakening of memory, learning, and attention, especially for young people in the long term. This term focuses on the link between potential adverse cognitive effects and using digital devices and the Internet. Also, this term refers to the possible adverse effects of digital devices on social behaviors. Preiss (2014) summarized the ideas of Spitzer about internet usage and its effects on social behaviors: "Intensive use of online social networks reduces the number of real friendships, limits social competence and atrophies the areas of the brain that are responsible for this behavior." Therefore, it may be more likely to see the adverse effects of digital technology in younger generations who use the Internet and digital devices every second of their lives.

Kaspersky Labs (2015) introduced the "Digital Amnesia" concept to describe the growing tendency to rely less on internal memory due to the increasing storage of information on digital devices. Mobile phones are one of the most essential devices digital technologies has brought into our lives. People check their phones every second as if they were breathing. People store the necessary information on their phones and rely on their phones to access the information with little cognitive effort at any time. In such a situation, encoding and storing information within internal memory and cognitive processes becomes more challenging. Thus, easy access to information complicates the encoding process of information in long-term memory. Also, using digital devices as external memory sources may decrease the need for people to interact to recall memories and significant information (Kaspersky Labs 2015).

All three terms (Google Effects, Digital Dementia, Digital Amnesia) emphasize the effects of digital technology on human memory and cognitive functions. They all argue that dependence on technology might affect cognitive abilities for processing and remembering information. The importance of these effects might be higher for the young generation because of the risk of permanent cognitive impairment and behavioral issues. From a behavioral perspective, Ali et al. (2024) summarize that cognitive impairments such as memory and information processing difficulties may negatively affect university students' emotional and behavioral situations. Furthermore, students might meet a decline in academic performance because of decreased productivity and an increased tendency to make mistakes. Constant use of digital technology products might cause significant adverse cognitive effects for the young generation, and these cognitive impairments might create potential behavioral issues.

The literature discusses the cognitive effects of digital technology use among young adults under various concepts and terms. However, there is still no consensus on the scope and nature of these effects. Moreover, existing studies on the cognitive impacts of digital technology use are limited in number. This gap in literature raises several important questions and highlights the need to investigate other factors that may contribute to these cognitive effects. This scoping review aims to examine existing research on the cognitive effects of digital technology use in young adults and to draw attention to the current gaps in literature.

Method

Researchers conducted this scoping review following PRISMA-ScR guidelines (Tricco et al. 2018). In the study, DergiPark, Science Direct, Wiley Online Library, Medline Plus, DOAJ (Directory of Open Access Journals), PubMed, EBSCO (Academic Search Ultimate), Scopus, Web of Science, IEEExplore and ACM Digital Library (Advancing Computing as a Science & Profession) databases were searched by researchers. All the time published studies were searched, and there were no time limits due to the currency of the topic. The keywords "Google Effect," "Digital Dementia," and "Digital Amnesia" terms were used as English and Turkish versions with 'OR' Boolean connector for database search without any filter because the keywords were not defined yet in Medical Subject Headings by National Library of Medicine due to currency of the topic. Thus, the number of publications reached was limited. If the title, abstract, method,

introduction, or results parts of the studies have one of these phrases, these studies were identified. As a result, 552 studies were screened. Researchers examined the relevance of the title, abstract, method, and result parts of the 552 studies according to the topic and inclusion criteria. Duplicated studies and ineligible studies according to inclusion criteria were eliminated. The researchers found and eliminated 167 duplicated studies. The researchers excluded 373 studies due to irrelevant topics and inconsistency of inclusion criteria.

Studies included in this scoping review were assessed using the inclusion criteria: Studies written in English and Turkish, quantitative studies (cohort, case-control, cross-sectional, case reports, case series, case studies, randomized comtolled study (RCT), non-randomized controlled trials), studies with full text accessible, studies working with young adults, studies containing the terms 'Google Effect', 'Digital Dementia' or 'Digital Amnesia' in the title, abstract, method, introduction or results sections, studies about the effects of digital devices and internet usage in cognitive abilities. Also, methodological, review, and meta-analysis studies were excluded from the study because of the nature of this study. Figure 1 shows the inclusion criteria and study selection process. As a result, researchers included twelve studies in the review process.

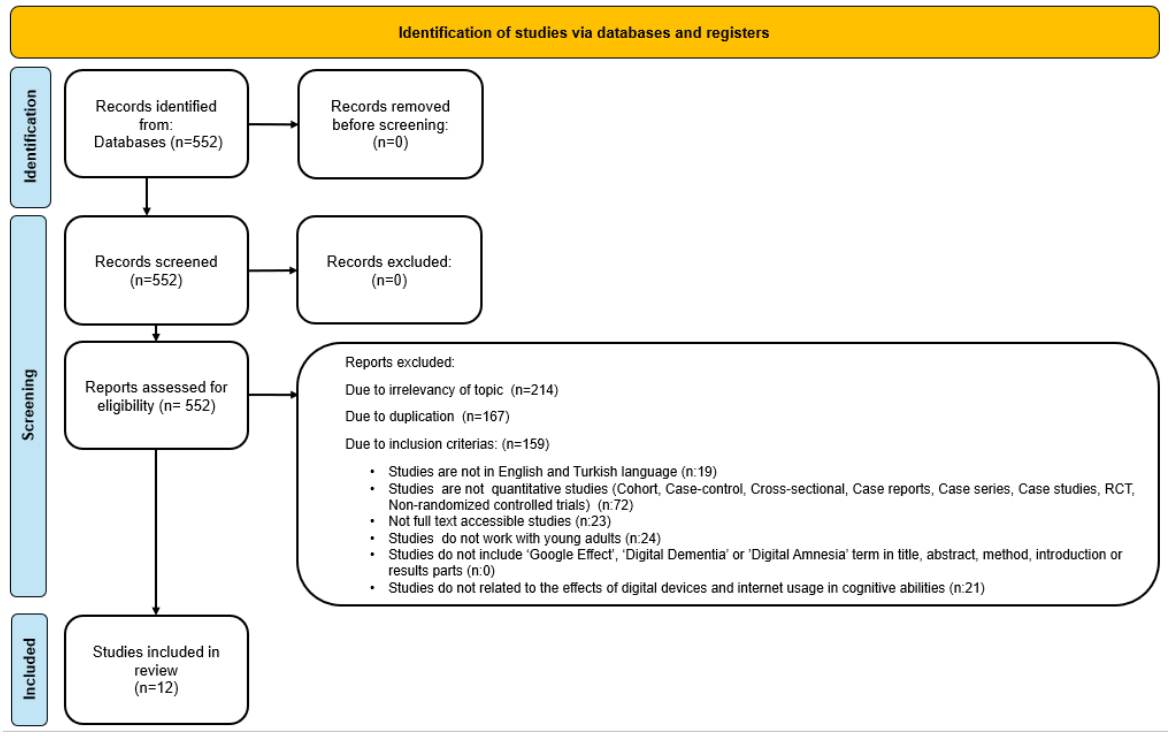

Figure 1. PRISMA-ScR flow diagram of the study selection process (Tricco, 2018)

Features of included studies were evaluated by the researchers objectively according to the quality assessment tool, which scores studies as strong (1), moderate (2), and weak (3) (Thomas et al. 2004). Table 1 shows the quality assessment of the included studies. According to quality evaluation, included studies received "strong (1)" and "moderate (2)" for overall scores in the review. Researchers evaluated the studies to analyze the cognitive effects of digital technology use on young adults in terms of participants, study type, measurements, and results. Researchers used PRISMA-ScR to summarize and evaluate study findings to improve the validity and reliability of this review (Tricco, 2018).

Results

Table 2 gives characteristics of the included studies published within the last 10 years. Researchers examined the included studies on study type, participants, measurements, and results.

Table 1. Quality assessment of the included studies

Study	Selection bias	Study design	Confounders	Blinding	Data Collection Method	Withdrawals and Dropouts	Overall Rating*
Dong and Potenza (2015)	1	1	1	2	2	1	1
Dong and Potenza (2017)	1	1	1	2	2	1	1
Kahn and Martinez (2020)	1	1	3	2	2	1	2
Babadağ Savaş and Balcı Alparslan (2021)	1	3	2	2	2	1	2
Lee (2021)	1	1	2	2	2	1	1
Schooler and Storm (2021)	2	1	1	1	2	1	1
Prathap and Singh (2021)	2	2	3	2	2	1	2
Savarimuthu and Subramanian (2022)	2	2	3	2	1	1	2
Siler and ark. (2022)	1	1	2	1	2	1	1
Sugimoto and ark. (2022)	2	1	3	2	2	1	2
Robert and Kadhiravan (2022)	2	2	3	2	1	1	2
Fellers and Storm (2024)	1	1	2	1	2	1	1

*1: Strong, 2: Moderate

Participants of the studies

The participants of the studies were young adults from different parts of the world, such as India (Prathap and Singh 2021, Robert and Kadhiravan 2022, Savarimuthu and Subramanian 2022), Japan (Lee 2021, Sugimoto et al. 2022), China (Dong and Potenza 2015, Dong and Potenza 2017), Türkiye (Babadağ Savaş and Balcı Alparslan 2021) and the United States (Kahn and Martinez 2020, Schooler and Storm 2021, Siler et al. 2022, Fellers and Storm 2024). The total number of participants in the studies was 2556.

Type of the studies

Researchers found that the included studies were conducted using experimental (Dong and Potenza 2015, Dong and Potenza 2017, Kahn and Martinez 2020, Lee 2021, Schooler and Storm 2021, Siler et al. 2022, Sugimoto et al. 2022, Fellers and Storm 2024), cross-sectional (Prathap and Singh 2021, Robert and

Kadhiravan 2022, Savarimuthu and Subramanian 2022), and descriptive (Babadağ Savaş and Balcı Alparslan 2021) designs.

Table 2. Characteristics of the included studies

Study	Country	Study Type	Sample	Measurements	Results
Dong and Potenza (2015)	China	Experimental study	50 university students	Search (Internet-based or encyclopedia-based) 60 items and remember (without any saving or taking notes) 60 items during fMRI imaging (used during the recall and recognition process)	Digital technology use created decreased brain activation, recall, and self-confidence problems during answering. The Internet group showed lower accuracy rates in recalling than the Encyclopedia group. Additionally, participants who learned information through the Internet were less confident about recalling/deciding a source of novel stimulus than the Encyclopedia group due to less brain activation in the 'what' related information processing area.
Dong and Potenza (2017)	China	Experimental study	44 university students	Remember 60 pieces of information (information acquired from the Internet vs. a book) and recall them in the scanner, using fMRI visualization during the process.	Digital technology usage created less brain activation and mistakes in decision-making and recall. The Internet group had more 'Remember-Incorrect' trials (mistakenly think they remember) than the book-based group. Also, the Internet group showed less brain activation in memory-related areas during the recalling and decision-making stages.
Kahn and Martinez (2020)	USA	Experimental study	199 university students	Watching the 5-min video that has 30 animals and associated trivia facts (Snapchat or text messages) and recalling facts, Cognitive Self-esteem Scale	Digital technology use did not create memory problems when accessing information via online messaging. No memory problems were found across communication channels (Snapchat, text messaging, and control condition). Cognitive self-esteem was positively associated with memory performance.
Babadağ Savaş and Balcı Alparslan (2021)	Türkiye	Descriptive study	386 nursing students	"Digital Dementia and Descriptive Characteristics Data Form" and "Phubbing Scale"	Participants' forgetfulness due to the use of digital technology was rare. There was no phubbing addiction in participants.
Lee (2021)	Japan	Experimental study	138 university students	Transcribing an English 105-word passage via handwriting or smartphone entry and having a quiz about information in the passage without any lookbacks.	Digital technology use created comprehension and transcribing issues. The handwriting group transcribed the text significantly faster than the smartphone group, and it scored significantly higher on the comprehension quiz.
Schooler and Storm (2021)	USA	Experimental study	Experiment 1: 80 undergraduate students.	30 trivia facts Experiment 1: Successful and failed	Digital technology use did not create recalling problems when the saving process failed in the practice phase.

Table 2. Characteristics of the included studies

Study	Country	Study Type	Sample	Measurements	Results
			Experiment 2: 82 undergraduate students	saving processes in the practice phase for two groups. Then, the main phase includes failed saving for all groups. Then, free recall Experiment 2: Successful saving in the practice phase for both groups and the same procedure, respectively, as Experiment 1.	The "Google Effect" did not occur when a failed saving idea occurred. The "Google Effect" was not observed when the belief of the saving process was unreliable.
Prathap and Singh (2021)	India	Cross-sectional study	101 college students	Digital Addiction Scale, Extended Mind Questionnaire (XMQ), Prospective Memory Tasks	Digital technology use creates memory problems when use reaches an addiction level. Digital addiction appeared as an essential factor that may lead to increased cognitive offloading and decreased prospective memory performance in young participants.
Robert and Kadhiravan (2022)	India	Cross-sectional study	326 youth	Digital Amnesia Scale, Sleep Disorders Symptom Checklist-17, Somatic Symptom Disorder-B Criteria Scale (SSD-12)	A significant positive association was found between digital amnesia, somatic symptoms, and sleep disturbances among youth. Digital amnesia had a significant impact on somatic symptoms through the mediation effect of insomnia and circadian rhythm dimensions of sleep disorders.
Savarimuthu and Subramanian (2022)	India	Cross-sectional study	326 youth	Digital Amnesia Scale, Sleep Disorders Symptom Checklist-17, Somatic Symptom Disorder-B Criteria Scale (SSD-12)	Digital technology usage leads to decreased sleep quality, and this causes cognitive issues, which leads to somatization. Digital amnesia has the potential to increase somatic symptoms and sleep disorders. Also, digital amnesia was more common in youth from joint families and men.
Siler et al. (2022)	USA	Experimental study	Experiment 1: 304 university students. Experiment 2: 138 university students	Experiment 1: Answer 60 general-information questions using an internet search or your memory in the first week, then answer the same questions without any internet help after 1 week and decide the answer source. Experiment 2: The same situation as Experiment	Digital technology usage for answering created better recalling than internal memory-based answering. However, when the time to answer questions was fixed, there was no difference in recalling performance. For Experiment 1, the recall accuracy of Internet-searched answers was better than internal memory-based answers, but the timing of answers was faster for internal memory-based ones than Internet-searched ones.

Table 2. Characteristics of the included studies

Study	Country	Study Type	Sample	Measurements	Results
				1. Additionally, a condition was added, like imagining a pre-Google search before answering for one's own memory condition.	For Experiment 2, No difference in recall accuracy for two situations (Internet search vs. internal memory search) was proven. For both experiments, participants tended to confuse the source of acquired information.
Sugimoto et al. (2022)	Japan	Experimental study	20 young adults	Travel and learn the routes using a smartphone or paper map, then retrace it without help and evaluate themselves.	Digital technology usage has caused decreased road remembering and misperception of information sources. Sense of direction affected the retraced accuracy whether the participant used navigation on the phone or a paper map. Participants who used a smartphone map showed worse retracing performance than participants who used a paper map, and smartphone map users were not aware of the memory impairment.
Fellers and Storm (2024)	USA	Experimental study	Experiment 1: 131 undergraduate students. Experiment 2: 231 undergraduate students	24 general information facts which are saved by hand or computer. Experiment 1: Recall test as the fill-in-the-blank test with sorting control. Experiment 2: Free recall test without the controlled order of output.	When information was saved digitally or paper-based, memory issues occurred due to less cognitive effort on saved information. The study confirmed that saving enhanced memory effect observed. Regardless of the saving or recall method, non-saved items were recalled more in the partial saving condition (half of the facts were saved) than in the baseline condition (not any facts saved).

Measurement Tools of the Studies

Included studies used different measurement tools to assess and describe the cognitive effects of digital technology use. Four studies used structured data forms or scales (Babadağ Savaş and Balcı Alparslan 2021; Prathap and Singh 2021; Robert and Kadhiravan 2022; Savarimuthu and Subramanian 2022). Babadağ Savaş and Balcı Alparslan (2021) used the Digital Dementia and Descriptive Characteristics Data Form and Phubbing Scale to detect digital dementia status from the addiction perspective of university students. Prathap and Singh (2021) used the Extended Mind Questionnaire (XMQ) and Digital Addiction Scale to analyze the addictive aspect of digital technology using the degree to which digital technology devolves cognitive and social functions. Two studies used the Digital Amnesia Scale, the Sleep Disorders Symptom Checklist-17, and the Somatic Symptom Disorder-B Criterion Scale to determine associations between digital amnesia, sleep disturbances, and somatic symptoms (Robert and Kadhiravan 2022, Savarimuthu and Subramanian 2022). Kahn and Martinez (2020) used memory tasks, which were both scales and recall tasks, and the Cognitive Self-Esteem Scale, which measured self-perceptions of thinking ability, memory, and working memory. The remaining seven studies (Dong and Potenza 2015, Dong and Potenza 2017, Kahn and Martinez 2020, Lee 2021, Schooler and Storm 2021, Siler et al. 2022, Sugimoto et al. 2022, Fellers and Storm 2024) used experimental procedures with memory tasks, which measured individuals' cognitive abilities and consisted of recall, retrieval, and response tasks.

Results of the Studies

Included studies aimed to analyze the cognitive effects of digital technology use from different perspectives. The negative cognitive effects of digital technology use were studied in the literature, and "Google Effect," "Digital Dementia," and "Digital Amnesia" became the main terms that define these effects. Schooler and Storm (2021) and Kahn and Martinez (2020) aimed to extend and improve the term "Google Effect" by examining related factors. Similarly, some studies have examined the effects of Internet searching on memory processes, brain and behavioral responses from the context of cognitive processing mechanisms related to information acquisition (Dong and Potenza 2015, Dong and Potenza 2017). Learning was examined as the leading indicator of cognitive processes that proceed differently when the source and acquisition of information are digital. Lee (2021) and Sugimoto et al. (2022) evaluated whether cognitive abilities, such as learning information from a text or learning directions from a map, change when the information source is digital or written. The significant difference between the sources of information and acquisition methods appears at this point. Cognitive offloading and effort were one of the topics. Siler et al. (2022) aimed to study the results of cognitive offloading when people choose digital devices to execute demanding internal cognitive tasks such as searching, saving, and remembering information. On the other hand, saving promotes cognitive abilities, especially enhancing memory to remember all information via distributing cognitive energy to unsaved information. Thus, Fellers and Storm (2024) aimed to examine the effect of partial saving on saving enhanced memory effect regardless of the saving method. However, saving on digital devices is easier than saving with writing. This situation created new factors which were examined in the literature. Digital addiction was examined as a related factor that promotes the adverse effects of digital technology use on cognitive abilities (Prathap and Singh 2021, Babadağ Savaş and Balcı Alparslan 2021). From another perspective, potential outcomes and prevalence of negative cognitive effects were examined in the context of somatic symptoms and sleep disorders (Robert and Kadhiravan 2022, Savarimuthu and Subramanian 2022). Included studies show the cognitive effects of digital technology from the perspective of cognitive processes such as learning, memory, and interpretation. Also, included studies examine common related factors such as addiction, saving methods, and interpersonal relationships with various techniques to analyze these effects and factors. As a result, the use of digital technology can negatively affect cognitive processes such as memory, comprehension, and interpretation; these effects may vary depending on the features of the individual and environment, such as usage habits. The advantages of easy access to information and reduced cognitive load may increase the risk of over-dependence on digital technology and cognitive decline in the long term.

Discussion

Many studies have tried to explain the cognitive effects of digital technology use from memory, learning, and information processing aspects. Also, some studies focus on the potential somatic symptoms of digital technology use. The aims and results of the studies varied according to the study focus. In this section of the review, researchers evaluated the results of the studies within the framework of the concepts of "Google Effect," "Digital Dementia" and "Digital Amnesia." Babadağ Savaş and Balcı Alparslan (2021) aimed to define phubbing addiction and the digital dementia state of university students, and the study found that students did not have phubbing addiction and rarely had digital dementia characteristics such as difficulties remembering new phone numbers, passwords, or name of the people. When digital technology use behavior becomes an addiction, the negative cognitive effects might be more detectable. Similarly, Prathap and Singh (2021) found that digital addiction creates an increased tendency to offload information cognitively, and cognitive offloading leads to a decrease in the prospective memory performance of people. Relying on digital devices to execute internal cognitive processes can negatively affect people's cognitive abilities, such as decreased memory performance about future events or not remembering necessary information in related contexts. However, addiction or relying heavily on digital devices might not be the essential factor in observing the negative cognitive effects of digital technology use. The use of digital technology products to execute internal cognitive processes can create dementia-like effects on people even in a short time. For instance, behaviors like finding a way or navigating require managing many cognitive processes, including learning, memorizing information, and decision-making.

Sugimoto et al. (2022) found that people learned a traveled route less accurately and showed worse route retracing performance when they used a smartphone map rather than a paper map in the learning phase without noticing their mediocre performance. Smartphone maps effortlessly complete many cognitive tasks that people do internally in paper-based maps, such as route planning and decision-making. Thus, people learn and memorize the related information less due to decreased internal cognitive processing of that information. Similarly, Dong and Potenza (2015) found that when search engines facilitate the information acquisition process, people execute the search-remember process faster than classical methods such as reading encyclopedias. However, people who use search engines show less ability to recall needed information. Additionally, the study's results were proven by functional magnetic resonance imaging (fMRI) results as less brain activation in the ventral stream, which works to execute the identification, recognition, and interpretation process of information in the brain (Dong and Potenza 2015). Similarly, Dong and Potenza (2017) found that Internet-based information access creates an incorrect sense of successful recall, which is related to decreased memory-related neural processes in recalling.

At this point, misinterpretation of recall performance might reveal a significant cognitive effect of digital device use within the perspective of the "Google Effect." People who know the information exists on external devices such as online maps, websites, or phones might be overconfident or unconfident about themselves. Briefly, they misinterpret the information access and use processes as they think they conduct the cognitive process to find the information and make decisions. Thus, problems about recalling information itself might expand as recalling and interpretation problems of that specific information-related cognitive tasks due to decreased and superficial active internal cognitive processing about that information during the acquisition and interpreting phases. Siler et al. (2022) found that people misinterpret the source of information more when they reach it via cell phones rather than internal memory. As people save information on external sources like the Internet and use digital methods to obtain the information, they tend to misjudge how they got the information. Thus, relying on the permanency of information in external devices causes less intention to execute internal cognitive effort for identification, recognition, and process of information. Also, relying on external devices for processing information interpretation might lead to a worse or misinterpreted recalling process due to weakness in internalizing information. As a result, the process of obtaining and analyzing information from digital sources may be helpful in terms of speed, but it is ineffective for truly learning that information and may cause us to confuse the source of the information.

Schooler and Storm (2021) stated that the idea of reliability in the recording process of information is essential to observe the "Google effect" and reliable saving conditions are precursors for the "Google Effect". Additionally, Fellers and Storm (2024) found that people recalled more non-saved items than saved items regardless of the saving method (paper-based or computer-based saving) and recall method. These studies might be beneficial in understanding the "Google effect" mechanism. Saving might help distribute cognitive resources to remember unsaved information, and it is beneficial for people to maximize their memory skills when they know they can access the saved information. Thus, people have been using saving methods such as writing, which requires internal cognitive processing and promotes learning of information to some extent. However, successfully and digitally saved items become more superficial in cognitive processes, which is the main point explaining the cognitive effects of digital technology use. When the recorded information is constantly passed through less cognitive processes, when the person relies more on technological devices for memorizing and analyzing, this situation can undermine the processes of learning and analyzing information. Adverse cognitive effects of digital technology use become more clear and intense when people put less internal cognitive effort into finding, learning, and understanding digitally saved knowledge. However, Fellers and Storm (2024) reported that the method of saving the information made no difference. Saved information in writing goes through a more complex cognitive process, such as writing, summarizing, and reducing it to keywords, than the information recorded digitally. Thus, saving by writing might increase the person's probability of remembering, learning, and analyzing saved and non-saved information by distributing cognitive sources more effectively.

Lee (2021) studied with Japanese students to transcribe foreign language text via hand or smartphone and found that the way of writing differs in the comprehension speed and level of saved text via transcribing. The study showed that the handwriting group transcribed the text significantly faster and got higher scores on the quiz than the smartphone group (Lee 2021). The saving method via handwriting might promote the learning of saved information even if the saved information is not in the native language. However, digitally saved items become more prone to forgetting. Thus, both saved and non-saved information can be comprehended better by using non-technological saving methods via distributing cognitive sources effectively for both saved and non-saved information processing. Recording information on external sources and knowing the recording process's reliability allows people to use their cognitive energy consciously. People can remember and comprehend both saved and non-saved information better. However, when the recording method is digital and digital devices replace external sources such as people or books, people tend to forget the recorded information.

On the other hand, literature has controversial ideas about using digital technology to save and reach information and its effects on cognitive abilities. Kahn and Martinez (2020) found that when people received information through text messaging and Snapchat, there was no Google effect on memory, and cognitive self-esteem is positively related to memory performance. Using different digital methods for reaching information might not create Google effects when the information acquisition process includes a sense of communication with other people, even if it is digital. Thus, people can combine digital technologies with interactive processes to eliminate negative cognitive effects. Also, when people do not ensure the saving process of digital information, they may not be faced with recalling issues. People may not interpret text messages as a reliable saving method. Regarding cognitive self-esteem, people who have high cognitive self-esteem can have better memory performance due to their high cognitive abilities, as expected. Siler et al. (2022) found that recall accuracy of the information was not significantly different between the different ways of access (Internet vs. internal memory) when the reaching process takes some time as cognitive processing (writing a search query or imagining searching for information on the Internet). The idea of the permanency of information digitally might not be sufficient to create negative cognitive effects. The decreased internal cognitive processing of existing information is a complementary point in observing the negative cognitive effects of digital technology use. When people rely on digital devices to execute more complex cognitive tasks, such as interpreting, acquiring, memorizing, and evaluating information, negative cognitive effects of digital technology use might occur robustly.

From another point of view, using digital technology might cause somatic symptoms in people. Savarimuthu and Subramanian (2022) found that digital amnesia positively correlated with somatic symptoms in university students, such as insomnia, narcolepsy, and restless legs syndrome. Also, the study found that digital amnesia was more common in youth from joint families and male gender (Savarimuthu and Subramanian 2022). Additionally, Robert and Kadhiravan (2022) defined the prevalence of somatic symptoms in the same study group, concluding that somatic symptoms due to digital amnesia were more prevalent for the male gender and students who live in joint families and urban areas. The negative impact of digital amnesia on perception and cognitive processes might increase the somatic symptoms. Thus, digital amnesia may indirectly lead to somatic symptoms. Also, living in joint families might decrease the opportunity to share valuable information for young people due to the generation gap and crowd. Thus, this situation may increase people's digital amnesia.

An important limitation of this review is the insufficient number of studies on the subject. Studies designed to measure the cognitive effects caused by digital technology use are diverse in terms of methodology and measurement tools. This situation made it difficult to objectively reveal the cognitive effects of digital technology use and evaluate the results.

Conclusion

Digital technology use can create negative cognitive effects such as low recall accuracy, decreased brain activation about memory, comprehension and transcribing issues about information, self-confidence problems during answering recall tests, forgetfulness about future events, and misinterpretation of the

remembering process. Although, literature calls these negative effects in different terms. The negative cognitive impacts of digital technology need to be examined further in other dimensions. In some cases, using digital technology may not cause forgetfulness or memory problems. Addiction to using digital technology, trust in the information-saving process, cognitive effort given in accessing and using information, and different methods of saving information affect the emergence of the negative cognitive effects of digital technology use. On the other hand, cognitive issues due to digital technology use can create somatic problems for people. Family relations, gender, and living place can be the potential determinants of the negative cognitive effects of digital technology. As a result, easy access to information and the opportunity to decrease internal cognitive burden can encourage people to use digital technology products despite the possible negative effects. Then, overuse of digital technology can lead to a permanent preference or reliance on digital technology for people due to decreased cognitive skills. As a result, this review reveals that the cognitive effects of digital technology use will be an essential topic in literature.

In literature, many aspects such as self-evaluations, free recall tests, comprehensive quizzes, and structured scales attempt to define digital technology use and its' cognitive effects. However, there is no common point about the extent of these effects and valid measurement methods for them. Thus, different terms have been used to define the cognitive impacts of digital technology use, such as “Google Effect," “Digital Amnesia," and “Digital Dementia." Focusing on university students due to the high use of technology was not the crucial point of the studies. University students were chosen for ease of accessibility. However, this population requires special attention because they are part of the society that uses digital technology to save, reach, and interpret information massively. For future studies, there might be an increase in methodological research to objectively examine the cognitive effects of digital technology use. Ranking the effects according to their importance and severity and collecting these effects under standard headings accepted by experts might improve the relevant literature. Also, the scope of future studies might include physical, psychological, and social issues related to the negative cognitive effects of digital technology use.

References

Ali Z, Janarthanan J, Mohan P (2024) Understanding digital dementia and cognitive impact in the current era of the Internet: a review. Cureus, 16:e70029.

Babadağ Savaş B, Balcı Alparslan G (2021) Yeni bir kavram dijital demans: hemşirelik öğrencilerinin dijital demans durumu. Sürekli Tıp Eğitimi Dergisi, 30:415-420.

Dong G, Potenza MN (2015) Behavioral and brain responses related to Internet search and memory. Eur J Neurosci, 42:2546-54.

Dong G, Potenza MN (2017) Internet searching and memory processing during a recollection fMRI task: evidence from pseudo recollected trials. J Technol Behav Sci, 1:32-36.

Fellers C, Storm BC (2024) The saving enhanced memory effect can be observed when only a subset of items are saved. Mem Cognit, 52:1325-1337.

Hamilton KA, Benjamin AS (2019) The human-machine extended organism: new roles and responsibilities of human cognition in a digital ecology. J Appl Res Mem Cogn, 8:40-45.

Kahn AS, Martinez TM (2020) Text and you might miss it? Snap and you might remember? Exploring “Google effects on memory” and cognitive self-esteem in the context of Snapchat and text messaging. Comput Human Behav, 104:106166.

Kaspersky Labs (2015) The Rise and Impact of Digital Amnesia: Why We Need to Protect What We No Longer Remember. Moscow, Kaspersky Labs.

Lee BJ (2021) Comparing factual recall of tapped vs. handwritten text. Acta Psychol (Amst), 212:103221.

Lundberg N (2013) Smartphones and (smart) people: how smartphones affect personal interactions (Masters thesis). Umea, Umea University.

National Library of Medicine (2020) Medical subject headings. https://meshb.nlm.nih.gov/record/ui?ui=D000082222 (Accessed 28.02.2025).

Prathap V, Singh S (2021) Impact of digital addiction and cognitive offloading on prospective memory of young adults. Indian J Health Wellbeing, 12:439-445.

Preiss M (2014) Manfred Spitzer: digital dementia: what we and our children are doing to our minds. Brno: host, 2014. Cognitive Remediation Journal, 3:31-34.

Robert SJ, Kadhiravan S (2022) Prevalence of digital amnesia, somatic symptoms and sleep disorders among youth during COVID-19 pandemic. Heliyon, 8:e10026.

Rowlands I, Nicholas D, Williams P, Huntington P, Fieldhouse M, Gunter B et al (2008) The Google generation: the information behaviour of the researcher of the future. ASLIB J Inf Manag, 60:290-310.

Savarimuthu JR, Subramanian K (2022) Associations between digital amnesia, sleep disorders and somatic symptoms among youth. Cogn Brain Behav, 26:121-135.

Schooler JN, Storm BC (2021) Saved information is remembered less well than deleted information, if the saving process is perceived as reliable. Memory, 29:1101-1110.

Siler J, Hamilton KA, Benjamin AS (2022) Did you look that up? How retrieving from smartphones affects memory for source. Appl Cogn Psychol, 36:738-747.

Sparrow B, Liu J, Wegner DM (2011) Google effects on memory: cognitive consequences of having information at our fingertips. Science, 333:776-778.

Sugimoto M, Kusumi T, Nagata N, Ishikawa T (2022) Online mobile map effect: how smartphone map use impairs spatial memory. Spat Cogn Comput, 22:161-183.

Thomas BH, Ciliska D, Dobbins M, Micucci S (2004) A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. Worldviews Evid Based Nurs, 1:176-184.

Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D et al (2018). PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med, 169:467-473.

Wegner DM, Guiliano T, Hertel PT (1985). Cognitive interdependence in close relationships. In Compatible and Incompatible Relationships (Ed WJ Ickes): 253-276). New York, NY, Springer.

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