Thesis

False memory among digital natives and digital immigrants in online and offline message contexts

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Abstract

Theory suggests that differences in information processing behaviour for digital natives and digital immigrants exist. Digital natives, born in 1993 or later, have grown up with digital Internet technologies, while digital immigrants had to adapt at a later age. Online information processing behaviour is associated with different reading strategies than offline information, which can result in differences in cognitive abilities. However, it is not clear if online information leads to a different number of false memories as well.

This study investigated if the message context influences the number of false memories that are created and the reading speed, and if this differs for generations. An online experiment was conducted in which digital natives and digital immigrants were presented with either messages that were presented in a social media message context (online) or in a neutral message context (offline), after which they were asked to do the Deese-Roediger-McDermott (DRM) task. For this short memory task, participants had to indicate which of the presented words, critical lures (words that were semantically related to the presented words and can result in false memories) and unrelated words that were displayed they recognized from the message. Results did not show significant effects of generation or message context on the number of false memories. However, digital natives did read faster than digital immigrants, but differences in message context on reading speed were not found.

A possible explanation for the lack to confirmed hypotheses on false memory and the influence of message context could be partly found in the limitations of this study. The present study did possibly not successfully replicate different message contexts. Besides, the operationalisation of digital natives and digital immigrants could be inaccurate. Further research is needed to empirically investigate the influence of digital Internet technologies on cognitive abilities, especially for false memory.

Keywords: language processing, false memory, digital natives, DRM paradigm, online reading behaviour

Introduction

The information people consume nowadays is often presented in online environments. Work e-mails, social media posts and websites: most of the information we read is presented on a digital device. Since the invention of digital Internet technologies, there is more information available than ever, and to more people than ever before (Giedd, 2012). The Internet has not only reshaped how we communicate with our social connections (Firth et al., 2019) but also how we search for information, how we learn and how we read (Leu et al., 2011). It raises the question of what implications digital Internet technologies and the enormous load of information that it holds have for the way humans cognitively process information.

Technological inventions have, in the past, transformed the way humans think and act. The invention of the Internet in 1993 emerged as the most recent technological innovation with the potential to completely transform human cognition (Loh & Kanai, 2016). While substantial technological inventions, such as toolmaking (Stout et al., 2008) and language (Aboitiz & García, 1997) have taken place in the history of humankind before, never was the adaptation of a tool, method, or skill so widespread in a short amount of time as the Internet (Leu et al., 2011; Loh & Kanai, 2016). Fortunately, homo sapiens are very successful in adapting to new environmental factors. The primary reason for this is human cognition. Loh and Kanai (2016) define human cognition as a specialized set of mental operations that are used to process information regarding the environment and to produce behaviour that aligns with the surroundings. These cognitive abilities are flexible for changes in behaviour and environment (Pascual-Leone et al., 2005) and are further expanded via technological inventions, such as the Internet. Acquiring a new tool or technological invention could affect and alter the cognitive systems in the brain performing similar functions (Dehaene & Cohen, 2007). The ability of the brain to adapt to environmental needs is a regular, continuous process and is called neuroplasticity. The plasticity of the brain evolved to help humans survive their surroundings. Specifically, the brain is by design created to adjust to not only environmental factors but also to physical changes and experiences (Pascual-Leone et al., 2005). The Internet is one of those environmental factors that has transformed human thoughts and behaviours (Loh & Kanai, 2016). While Wang (2022) suggests that digital Internet technologies have changed the way humans retrieve, retrain, and share information, it is not yet clear in what way they have transformed cognitive information processing.

Information processing, either for online or offline information, is a process that consists of three stages (Atkinson & Shiflrin, 1968). Before information is transferred to long-term memory and the associative network, it comes in through the senses and is stored in the working memory, after which it may be transferred to long-term memory (Simon & Siklóssy, 1972). A distinction between the two types of information processing is often made in research about information processing, namely deep and shallow processing, such as in the study by Loh and Kanai (2016). Shallow information processing requires limited cognitive effort, and is associated with reduced memory retention (Carr, 2011). Deep information processing, on the other hand, demands more available cognitive sources, and therefore a greater cognitive effort is required (Graham & Golan, 1991). Online information tends to lead people to a different information processing mode than offline information (Carr, 2011).

Online information can activate shallow processing. Since the Internet and online settings promote different behaviour than offline contexts, research suggests that differences in online versus offline information processing exist (e.g., Firth et al., 2019; Liu, 2005; Loh & Kanai, 2016). Digital Internet technologies are designed to catch and keep attention (Firth et al., 2019). Through notifications, hyperlinks, and endless information flow, the user is constantly activated to consume multiple inputs at the same time (Loh & Kanai, 2016; Ophir et al., 2009). It is therefore not surprising that wide use of the Internet has led to increasing (media) multitasking behaviours. Internet-related multitasking can lead to increased distractibility (Carrier et al., 2009). Furthermore, Ophir et al. (2009) found that heavy media multitaskers performed worse in task-switching tests than light media multitaskers. In their study, participants were first identified as light or heavy media multitaskers after filling in a questionnaire. These two groups were then compared across their performances in four different tasks on different cognitive control conditions, namely filtering environmental distractions, filtering irrelevant representations in memory, and task switching. While the researchers expected that heavy media-multitaskers would be used to task-switching and thus have a cognitive benefit performing this behaviour, the experiment revealed the opposite result. Heavy media multitaskers were worse at filtering out interferences and therefore more easily distracted by irrelevant stimuli in the environment. Typical online behaviour, such as multitasking, could have serious consequences for the quality of information processing, and therefore possibly the accuracy of memory.

The significance of human memory retention could be declining due to the proliferation of digital Internet technologies. The Internet can be seen as an external network that holds all information, with the consequence that the user itself has little obligation to remember the presented information (Ward, 2013). Consequently, the accessibility of the Internet could have negative consequences on how people remember information, as the Internet is always and at almost any place available. In line with this assumption, Sparrow et al. (2011) indeed found that people do not recall the information itself but instead recall where to access the information, such as in which folder on a computer. The Internet has become an external memory where information is stored, causing us to no longer store information in our cognitive memory (Carr, 2011). Moreover, Firth et al. (2019) indicate that people could in this way become reliant on digital Internet technologies for the retrieval of information. On top of that, it could be possible that the Internet will replace certain parts of the human memory system, such as semantic memory, that is used, among other things, for remembering facts (Vargha-Khadem et al., 1997). The Internet has thus, in a way, diminished the need to remember and effortfully process information. Consequently, one could argue that it has partly fulfilled a function of human memory (Carr, 2011).

The Internet has possibly changed or even partly replaced the function of human memory (Carr, 2011; Firth et al., 2019) and could, therefore, also have an influence on false memory. Human memory can in some cases consist of a powerful illusion. Notably, people can remember things that never happened or can remember things very differently from the way they happened (Roediger & McDermott, 1995). Underwood (1965) makes a distinction between reproductive and reconstructive memory. Reproductive memory is the accurate production of material from memory, often used when materials are simple (e.g., word lists). With reconstructive memory, the active process of filling in elements that are missing while remembering is emphasized. Materials that are richer in meaning, such as stories, provoke this type of memorisation. Errors in reconstructive memory do often occur. False memories are then created, which consist of information that was not presented in the message. With the Deese-Roediger-McDermott (DRM) paradigm, the production of false information is tested in a simple and short memory task. Firstly, participants are presented with a word list, either to read themselves or to be read out loud. Secondly, the participants are presented with a different word list and are asked which word they recognized from the first list. This word list consists of the presented words, unrelated words, and critical lures (Pardilla-Delgado & Payne, 2017). Critical lures are words that were not presented but are semantically associated with the presented words (Roediger & McDermott, 1995). A critical lure for the word *sleep* would, for example, be *rest* (Stadler et al., 1999). This concept originates from a study by Underwood (1965), who found that words that were semantically associated with previously presented words could lead to false recognition. Habitually, lure words are recognized as having been presented (Pardilla-Delgado & Payne, 2017). In this way, the DRM paradigm can reveal false memories. Individual factors, such as working memory, could affect false memory (Gallo, 2010; Lövdén, 2003). Possibly, how information is read could influence false memory as well.

Online reading requires different reading strategies and skills to reach comprehension than offline reading (Leu et al., 2004). As the nature of online messages is different, more cognitive flexibility is needed from readers (Spiro, 2001). Liu (2005) confirms these findings and states that online reading behaviour differs from offline reading behaviour. Readers spend more time on text-scanning, keyword spotting and non-linear reading when the message is presented online. Reading online information has many advantages over reading offline information, such as enhanced interactivity, efficiency, and flexibility (Hooper & Herath, 2014; McPherson, 2005). However, the different reading behaviour that is associated with online information could diminish the quality of information processing. The used reading strategies come at the cost of in-depth and concentrated reading, to which less time is allocated. These reading strategies are conceivably used to cope with the overload of information that is present online. One way of dealing with this enormous load of information is increasing the reading speed. In the exploratory study of Hooper and Herath (2014), which consisted of four focus groups and a complementary survey, readers reported that they read faster when information is presented in online environments than when information is presented in offline environments. A part of the respondents in this study claimed that this faster reading speed was indeed due to the large amount of online information. Another given reason was that the online reading strategies they used resulted in faster reading speed, such as browsing and *skim* reading, which is defined as a form of rapid reading with the goal of quickly finding out where the text is about (Nunan, 1999). Respondents of the study by Hooper and Herath (2014) also reported that they had less concentration, comprehension, and recall after reading online materials in comparison with reading offline materials. Information processing was experienced as lower in quality for online messages than for offline materials. The reading strategies that are used for online information could have serious consequences on the quality of information processing.

The extent to which digital Internet technologies affect information processing could also be dependent on other factors, like age. Loh and Kanai (2016) indicate that information processing can differ for different generations. Digital natives, as defined by Prensky (2001), are generations that have grown up with digital Internet technologies. They are “native speakers” of mobile phones, computers, the Internet, and social media. Consequently, these generations could process information differently than older generations. Older generations are identified as digital immigrants, who have matured in the pre-digital period and adapted to these digital Internet technologies at a later age. While digital immigrants learn to adapt themselves, Prensky (2001) argues that they will always retain their “accent”. They were socialized and educated in a different way than younger generations, which has implications for how they use these technologies. Hence, the difference in age of being faced with digital Internet technologies relates to different behaviour. According to Prensky (2001) and Carr (2011), digital natives could show different cognitive profiles than digital immigrants. Digital natives would tend to a shallower way of information processing than digital immigrants, which is characterized by fast attention shifting and typical Internet behaviour like multitasking, increased distractibility, and poor executive control (Carr, 2011; Carrier et al., 2009; Ophir et al., 2009). Synonyms of the term digital natives appear in online behavioural research. For example, Tapscott (1998) introduced the term *Net Generation.* People that are born between 1980 and the present are considered to belong to this generation, which grew up with computer-based technology (Carrier et al., 2009). Nicholas et al. (2011) speak about the *Google Generation* in their paper, which they define as people born after 1993 (the year of the introduction of the Internet) who have not or have barely known life before the Internet and specifically ubiquitous search via Google. While earlier generations gained knowledge through books, this generation gathers information via search engines. Although the three concepts differ in which year they consider someone to belong to the generation, they all indicate that there are differences between people that grew up with the Internet, and people without (Nicholas et al., 2011; Prensky, 2001; Tapscott, 1998). For this study, the definition by Nicholas et al. (2011) is considered, as the interactive Web 2.0 as the Internet is now only emerged around 2004. Web 2.0 is defined by its interactive applications that allow users to contribute, participate, organise, and create, such as social media applications like Facebook and Instagram (O’Reilly & Battelle, 2009). While the so-called first generation of digital natives and digital immigrants did not grow up with this function of the Internet, the second generation (born after 1990) did (Helsper & Eynon, 2010). Consequently, the conceptualization of Helsper and Eynon (2010) is followed for this study, namely that someone is considered a digital native when they are born after 1993.

Although the exact cause of differences in information processing between digital natives and digital immigrants remains unclear, a possible explanation can be the high plasticity of the adolescent brain (Giedd, 2012). While the human brain stays flexible for a very long period, plasticity is the most powerful in the early development phase and the most useful in adolescence, when the environment demands humans to survive independently. Perhaps, the plasticity of the brain could explain the suggested differences in information processing between digital natives and digital immigrants. As digital natives were earlier exposed to the environmental changes that digital Internet technologies have caused, they could have adapted themselves more. Potentially, this is causing different information processing behaviours than older generations, such as differences in used reading strategies. Older readers could lack the techniques to deal with the Internet as an information environment because they did not learn these from an early age. More specifically, older generations learnt to read in a linear manner and were forced to acquire reading skills that can be used in online environments as well (Helsper & Eynon, 2010), while younger generations developed reading skills that are specifically pointed at online messages, as they were able to adapt from an early age. The neuroplasticity of the brain during adolescence could explain differences in information processing behaviour between digital natives and digital immigrants, as suggested by Carr (2011).

While theory suggests information processing differences between digital natives and digital immigrants, previous research did not empirically investigate if these differences are present in false memory as well. Moreover, previous research implicates that online reading has negative consequences for comprehension, concentration, and memory (Leu & Zawilinski, 2007). Although memory has been researched in a social media context before (e.g., Mickes et al., 2013), it is unclear if the way information is presented also affects the number of false memories that are created. As there are suggestions of differences in information processing quality for online versus offline texts, it is important to research how this relates to the number of false memories. If more false memories are created when reading online than offline messages, this could implicate that we incorrectly remember what we read online and this could thus contribute to the spread of misinformation. The shift from deeper information processing towards a shallower way of information processing that is suggested for especially digital natives (e.g., Loh & Kanai, 2016) could have negative consequences. It could hinder the development of deep reading skills, such as critical evaluation and reflection (Wolf & Barzillai, 2009), which is especially crucial for evaluating information that is presented online, as this content is more diverse than for offline media (Fabos, 2008). It is therefore important to research what the influence of online versus offline messages is and if online information processing plays a role in causing false memories. Moreover, empirical research is needed to investigate if self-reported differences in reading speed (e.g., Hooper and Herath, 2014) for online versus offline information can be replicated. The present study will therefore research if the way in which a message is presented (*message context*) influences false memory and reading speed and will investigate if this differs for digital natives versus digital immigrants. This will be done via an online experiment in which digital natives and digital immigrants are presented with either a a social media message context or a neutral message context, after which they are asked to do a false recognition task according to the DRM paradigm (Roediger & McDermott, 1995). The research question is: Are digital natives more likely to falsely remember information than digital immigrants, and does the context in which the information is presented matter?

As Carr (2011), Loh and Kanai (2016) and Prensky (2001) suggest that digital natives have different information processing behaviour than digital immigrants, it could be possible that this causes differences in false memory, especially when presented with information in an online context. Online messages evoke different information processing behaviour (such as different reading strategies; Hooper and Herath, 2014) which digital natives may be more sensitive to, as they possibly have adapted to this type of message from a very early age (Prensky, 2001). It is therefore expected that this effect is greater for online message contexts. Moreover, it is predicted that in general, readers have more false memory after reading an online text, as online information processing is typically more based on for example text scanning than offline information processing. Consequently, this could negatively affect cognition, concentration, comprehension, and recall (Liu, 2005). Based on these findings, the following hypotheses are formulated:

H1: Digital natives have a different number of false memories after reading messages versus digital immigrants.

H2: Readers have more false memories after reading a message in an online message context versus an offline message context.

H3: Digital natives show bigger differences in false memories between online and offline contexts compared to digital immigrants.

It is plausible that online environments ask for faster reading, as there is an enormous load of information available (Hooper & Herath, 2014). As online reading techniques often consist of for example keyword spotting (Liu, 2005), which cost generally less time than traditional, linear, reading, it is expected that readers take less time reading online messages than offline messages, as was found in the earlier study by Hooper and Herath (2014). Moreover, since digital natives have grown up with online information (Prensky, 2001), it is expected that they adapted this type of reading behaviour more and are thus quicker readers overall, but especially in online message contexts versus in offline message contexts. Therefore, the following hypotheses are created for this study:

H4: Digital natives read faster than digital immigrants.

H5: Readers read faster in an online message context versus an offline message context.
H6: Digital natives show bigger differences in reading speed between online and offline contexts compared to digital immigrants.

Method

The present study was preregistered via *OSF* (https://osf.io/hjv8m/).

Material

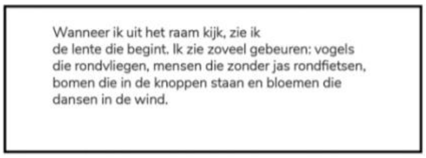
The material of this study consisted of seven different messages that were specifically created for this online experiment. The messages consisted of two to seven phrases of text (37 to 55 words). The content of the messages was mainly about specific objects and daily occurrences so that it was both fitting to the online and offline message context (See Appendix A for an overview of all messages). Each message was put in a social media format for the online condition and a plain text format for the offline condition. The content of the two message contexts was the same, only the format in which they were presented was different (See Figures 1 and 2 for an example). For the online message context, a format was made that closely resembled the appearance of posts on the social media platform Instagram. An Instagram format was specifically chosen for the online message context, as Instagram is very popular in the Netherlands, with 7.8 million users in 2023. It is the fastest growing among the five most popular social media platforms (WhatsApp, YouTube, Facebook, Instagram, and LinkedIn) in users, but also growing in the number of daily users (4.7 million in 2023). It is popular among younger age groups (ranging from 50% to 59% among people of 15 to 34 years old), but it is less commonly used among older age groups (varying from 38% to 26% among people of 35 to 64 years old) (Hoekstra et al., 2023). To closely replicate the format of Instagram posts, a username, profile picture and caption were presented. Usernames consisted of names of fictional persons that were created using the artificial intelligence tool *ChatGPT* (OpenAI, 2023). Profile pictures were downloaded via the stock photo website *Pexels* (2023). Other pictures were not included in either the plain message context or the social media context, as this could have influenced the information processing of participants and this study was specifically about language processing. In the social media format, the place where normally a picture appears was left blank. The formatting of the text, such as the font type, the font size, and the column width, was held constant in both message context conditions, as this could influence information processing and the reading speed of participants.

The messages were created based on ten lists of critical words and related lures that were reviewed by Stadler et al. (1999). For every individual message, a critical word was chosen, which was not only represented in the message but was also the subject of the content of the message. Lists of eleven words were created for every message (See Appendix B for the complete word lists). The lists consisted of one word that appeared in the message (the critical/presented word), five unrelated words that were not presented and not related to the appearing words, and five words that were critical lures: words that did not appear in the message but were semantically related to the presented word. The procedure of creating the word lists as described by Pardilla-Delgado and Payne (2017) was partly followed. For the feasibility of this study, only one word was included as presented word, instead of multiple, and the word lists were made shorter than was described. The word lists with the highest probability of false recognition by Stadler et al. (1999) were chosen. The first five critical lures of these lists were included in the word list. The unrelated words were picked from five other word lists that were also included in the paper by Stadler et al. (1999), of which one word of every list was included for all seven word lists.

The English word lists were translated to Dutch by the researcher and checked via a back-translator exercise, that was conducted by an independent translator. After the translation had been done, a small pretest was conducted, for which two participants were presented with the word lists and the critical, presented word. They had to select five words which they thought were related to the presented word. The pretest resulted in two minor changes in the word lists. Two unrelated words were replaced by other words from the word lists by Stadler et al. (1999), as these words were falsely recognized as related to the presented word (see Appendix B for details).

Figure 1. Message with the critical word ‘window’ (raam) for the online message context condition.

Figure 2. Message with the critical word ‘window’ (raam) for the offline message context condition.



Participants

Two types of participants were included in this study: digital natives and digital immigrants. Based on the definition of the Google Generation by Nicholas et al. (2011), digital natives were defined as people that are born between 1993 and the present. Participants born in or before 1992 but no later than 1958 were considered digital immigrants. Participants that are born before 1958 were not considered for participation in this study, as this age group use social media less than younger age groups (Hoekstra et al., 2023). A requirement for participants was that they were 18 years or older and that they were native speakers of the Dutch language.

The software program G*Power was used to conduct a power analysis. The goal was to obtain .95 power to detect a medium effect size of .25 at the standard .05 alpha error probability. According to this calculation, 210 participants were needed for this study, divided into four different groups. In total, 237 participants took part in the online experiment. 119 participants that did not fully complete the survey were removed from the data, as this not only caused missing data columns but was also seen as a withdrawal of their consent. Two participants did not answer the attention check correctly and were thus also removed from the data, as this could be seen as a sign of a lack of attention by participating in the online experiment. Two participants that had a reading time of 2.5 standard deviations above the average were removed as well, as this could indicate that breaks were taken in between reading the messages. After removing participants that did not fulfil the requirements, 114 participants were left, of which 84 (73.7%) fell in the digital natives' group and 30 (26.3%) in the digital immigrants' group (see Table 1 for an overview of the division of participants among conditions).

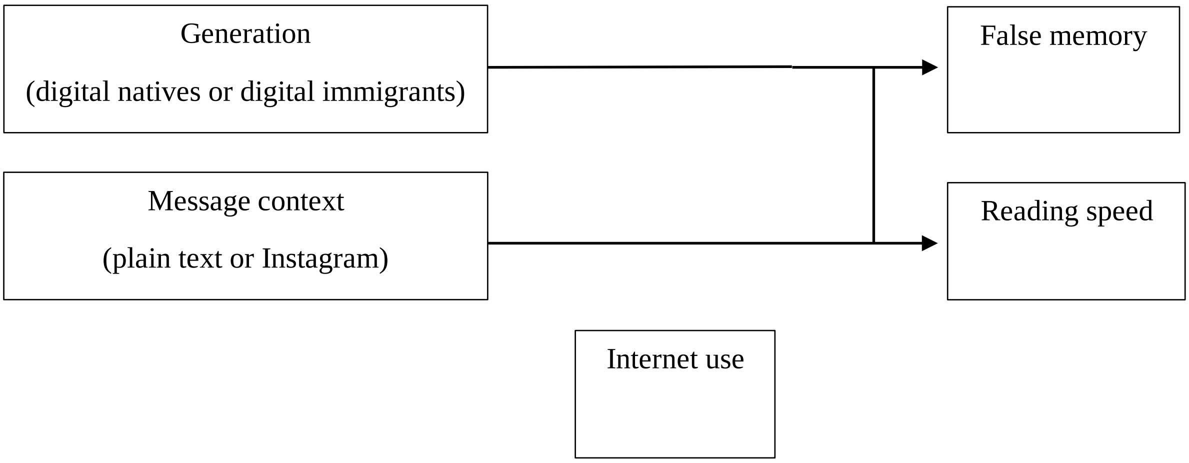
The digital natives' group did not consist of an equal distribution of gender. 15 identified as men (17.9%), 68 as women (81%) and 1 (1.2%) as non-binary. The age range was 18-32, with a mean age of 22.95 (*SD* = 1.87). The participants in the digital natives' group had as educational level secondary school – WO Master. WO Bachelor was the most occurring level (29.8%). The mean of the Internet use score, which varied between 23 and 76, was 47.02 (*SD* = 10.28). For the digital immigrants' group, 16 identified as women (53.3%) and 14 identified as men (46.7%). The age range was 31-64, with a mean age of 50.57 (*SD* = 9.99). The participants had as education level HBO – WO master. HBO was the most occurring educational level (36.7%). The mean of the Internet use score, which varied between 25 and 60, was 39.53 (*SD* = 8.14).

Table 1. Overview of division and group sizes of participants among conditions generation and message context.

		Message context		
		online	offline	total
		n	*n*	*n*
Generation	digital natives	44	40	84
	digital immigrants	17	13	30
	total	61	53	114

Design

This study consisted of a 2 (generation: digital natives, digital immigrants) x 2 (message context: plain, Instagram) between-subjects design. As covariate, Internet use was measured and will result in a ratio variable. This variable was included to see what the influence of Internet use on dependent variables false memory and reading speed was.



Independent variables *Covariate* *Dependent variables*

Instruments

The dependent variables in this study were false memory score and reading speed. False memory score was measured as the number of incorrectly recognized critical lures (minimum 0 -maximum 35). Correctly recognized presented words (minimum 0 – maximum 7) and incorrectly recognized unrelated words (minimum 0 – maximum 35) were also considered in this study, to check the overall ability of participants to do the task. All three variables were a sum of the recognized words. Reading speed was measured by taking the average reading speed of all seven messages. The covariate Internet use was measured via a shortened version of the Internet use survey by Helsper et al. (2016) (see Appendix C for an overview of the questions). The original survey consisted of 33 questions in four usage clusters, but for this study, a shortened and more relevant version of 18 questions in two usage clusters (social use and personal use) was used. Participants were asked to answer the questions on a scale of 1 (never) to 6 (several times a day). This resulted in a score between 0 and 108. The reliability of the covariate 'Internet use' compromising 18 items was good, α = .803.

Procedure

The online experiment was conducted online and was created partly via the online survey web programme *Qualtrics* and partly via the online experiment software *PsychoPy*, which was launched via the website *Pavlovia*. The online experiment survey was spread by a convenience sampling method via social media (WhatsApp, Instagram, Facebook, and

LinkedIn). The social connections of the researcher were asked to spread the online experiment among older family members, as a form of snowball sampling. Participants were first presented with part one of the survey that was conducted via *Qualtrics.* Firstly, information about the online experiment and the terms of agreement of the online experiment were presented. Participants had to give consent for their participation in the study. After participants had given their consent, they were led to the survey. The online experiment started with questions about their personal characteristics: their birth year, their age, their gender, and their educational background. After these questions, the participants were led to part two of the online experiment via an URL. The participants were randomly assigned to either the online or the offline message context condition, depending on the year they were born, to make sure that the two participant groups were evenly spread among message context conditions. Before they were presented with the first message, the participants were briefly instructed as to what they were going to see and be asked in the second part. Participants had to click on their phone or with their computer mouse to go to the next part of the online experiment and were not able to return to previous parts of the experiment. After participants were informed about this, the seven different messages were presented, together with three extra messages and comprehension questions, one by one in random order. The comprehension messages and questions were included to check if participants were consciously reading and processing the information. The extra messages were created by following the same procedure as the stimuli messages, namely centred around a critical word of a list by Stadler et al. (1999), with a similar text length and put in the same format as other messages, either in an online or offline message format. The reading speed of the participant was measured in milliseconds, for every individual message. Measurement started when the message was opened and stopped when the participant clicked and was presented with the next message. After reading all ten messages and answering the three comprehension questions, participants were presented with brief instructions about the DRM task. Participants were instructed that in every word set, there was one or there were several words that appeared in the message that they had just read. To avoid potential confusion among participants, the decision was made to not explicitly state that each message contained only one presented word. This approach was chosen as there was no option for participants to go back to previous content in the online experiment, and this could thus have led to confusion. Before every set of words was presented, participants read a small instruction of how the task worked. Participants were asked to click on a green checkmark icon if they recognised the word from the message that they read and to click on a red cross icon if they did not recognise the word from the message that they read. The word lists and the words within the list were presented in random order. In between the word lists, an attention check was placed (Shamon & Berning, 2019), for which participants were asked to click on the green checkmark icon. After the DRM task, participants were able to leave any questions or comments about the online experiment via a free text response. Lastly, participants were debriefed about the purpose of the study and thanked for their participation. This formed the end of the online experiment.

Statistical treatment

To test the eight hypotheses, statistical analyses were conducted using *IBM SPSS Statistics*, version 27. Multiple two-way univariate ANCOVAs were conducted for dependent variables incorrectly recognized critical lures (false memory), correctly recognized presented words, incorrectly recognized unrelated words and reading speed. Besides the two independent variables generation and message context, the covariate Internet use was tested as well to study if Internet use had an effect on the dependent variables false memory and reading speed and if interaction effects for Internet use, generation and message context were present.

Results

False memory

A two-way univariate ANCOVA for generation and message context for dependent variable incorrectly recognized critical lures with as covariate Internet use did not reveal a significant main effect of generation on incorrectly recognized critical lures (F (1, 109) <1). If a reader was a digital native or a digital immigrant did thus not influence the number of false memories. H1 (Digital natives have a different number of false memories after reading messages versus digital immigrants) could therefore not be confirmed.

A significant main effect of message context on incorrectly recognized critical lures was also not revealed (F (1, 109) <1). The context in which a message was presented did thus not influence the number of false memories. H2 (Readers have more false memories after reading a message in an online message context versus an offline message context) could therefore not be confirmed according to the data.

A significant interaction effect of generation and message context on incorrectly recognized critical lures was not found (F (1, 109) <1). The number of false memories was not affected by generation and message context. No significant differences between the four groups were revealed. H3 (Digital natives show bigger differences in false memories between online and offline contexts compared to digital immigrants) could therefore not be confirmed. Exploratory analyses with the covariate Internet use for incorrectly recognized critical lures can be found in Appendix D.

Correctly recognized presented words

A two-way univariate ANCOVA did not show a significant main effect of generation on correctly recognized presented words (F (1, 109) <1). If a reader was a digital native or a digital immigrant did thus not influence the number of correctly recognized presented words. A significant main effect of message context on correctly recognized words (F (1, 109) <1) was also not found. If the message was presented in an online or offline message context did thus not influence the number of correctly recognized presented words. A significant interaction effect of generation and message context on correctly recognized presented words was not revealed (F (1, 109) <1). Generation and message context did thus not cause significant differences in the number of presented words that were correctly recognized. Exploratory analyses with the covariate Internet use for correctly recognized presented words can be found in Appendix D.

Incorrectly recognized unrelated words

A two-way univariate ANCOVA did not reveal a significant main effect of generation on incorrectly recognized unrelated words (F (1, 109) <1). If a reader was a digital native or a digital immigrant did thus not influence the number of incorrectly recognized unrelated words. A significant main effect of message context on incorrectly recognized unrelated words was also not revealed (F (1, 109) = 1.49, p = .226). If the message was presented in an online or offline message context did thus not influence the number of incorrectly recognized unrelated words. A significant interaction effect for generation and message context on incorrectly recognized unrelated words was found (F (1, 109) = 5.56, p = .020, η^2 = .049). Post hoc tests were conducted to see if there were significant differences between groups**.** A univariate one-way ANOVA did not show significant effects for message context for digital natives (F (1, 82) = 1.50, p = .225) or digital immigrants (F (1, 28) = 2.92, p = .098) of incorrectly recognized unrelated words. While significant differences between groups were not revealed, the overall pattern was significant. Digital immigrants incorrectly recognized more unrelated words in an online message context (M = 7.53, SD = 8.65) than digital immigrants in an offline message context (M = 3.23, SD = 2.92), and digital natives incorrectly recognized more unrelated words than digital natives in an offline message context

(*M* = 5.62, *SD* = 5.15), and digital natives in an online message context (*M* = 4.30, *SD* = 4.81). Descriptive statistics of incorrectly recognized critical lures, correctly recognized presented words, and incorrectly recognized unrelated words can be found in Table 2. Exploratory analysis with the covariate Internet use for incorrectly recognized unrelated words can be found in Appendix D.

Table 2. Means, standard deviations (between brackets) and group sizes for correctly recognized presented words (maximum = 7), incorrectly recognized critical lures (maximum= 35) and incorrectly recognized unrelated words (maximum = 35) for digital natives and digital immigrants for online message context and offline message context (*N = 114).*

		DRM paradigm			
		Critical lures incorrect	Presented words correct	Unrelated words incorrect	
		M (SD)	*M (SD)*	*M (SD)*	*n*
Digital natives	online	10.07 (4.83)	4.93 (1.17)	4.30 (4.81)*	44
	offline	10.15 (5.34)	4.95 (1.49)	5.62 (5.15)*	39
	total	10.11 (5.05)	4.94 (1.32)	4.93 (4.99)	83
Digital immigrants	online	10.82 (7.55)	5.24 (1.89)	7.53 (8.65)*	17
	offline	9.85 (5.73)	5.46 (1.66)	3.23 (2.92)*	14
	total	10.40 (6.73)	5.33 (1.77)	5.67 (7.04)	31
Total	online	10.28 (5.66)	5.02 (1.40)	5.20 (6.22)	61
	offline	10.08 (5.39)	5.08 (1.53)	5.04 (4.79)	53
	total	10.18 (5.51)	5.04 (1.45)	5.12 (5.58)	114

*p = .020

Reading speed

A two-way univariate ANCOVA was conducted for generation and message context on reading speed with Internet use as covariate. This did show a significant main effect of generation on reading speed (F (1, 109) = 11.96, p <.001, η^2 = .10). Digital natives read faster (*M* = 10.96, *SD* = 3.75) than digital immigrants (*M* = 15.05, *SD* = 6.60). H4 (Digital natives read faster than digital immigrants) could therefore be confirmed.

A significant main effect of message context on reading speed was not revealed (F (1, 113) = 1.11, p = .294). There was no significant difference between the reading speed of readers in an online message context versus an offline message context. H5 (Readers read faster in an online message context vs an offline message context) could therefore not be confirmed according to the data.

A significant interaction effect of generation and message context on reading speed was not revealed (F (1, 109) <1). Digital natives did not show bigger differences in reading speed between the two message contexts than digital immigrants did. H6 (Digital natives show bigger differences in reading speed between online and offline contexts compared to digital immigrants) could therefore not be confirmed. Descriptive statistics can be found in Table 3. Exploratory analyses with the covariate Internet use for reading speed can be found in Appendix D.

Table 3. Means, standard deviations (between brackets) and group sizes of reading speed for digital natives and digital immigrants for online message context and offline message context (*N* = 114).

	Reading speed		
	online	offline	total
	M (SD)	*M (SD)*	*M (SD)*
Digital natives	10.90 (3.80)	11.02 (3.74)	10.96 (3.75)*
Digital immigrants	14.10 (7.30)	16.27 (5.58)	15.05 (6.60)*
Total	11.80 (5.17)	12.31 (4.79)	12.03 (4.98)

**p <.001*

Conclusion

The present study aimed to answer the following research question: Are digital natives more likely to falsely remember information than digital immigrants, and does the context in which the information is presented matter? Eight hypotheses were tested in an online experiment with two message context conditions among digital natives and digital immigrants.

Digital natives did not have a different number of false memories after reading messages versus digital immigrants (H1). Moreover, readers did not have more false memories after reading a message in an online message context versus an offline message context (H2). Besides, digital natives did not show bigger differences in false memories between online and offline contexts compared to digital immigrants (H3). All three hypotheses on false memory could thus not be confirmed according to the data. Generation and message context did not seem to influence the number of false memories a reader had.

However, exploratory analyses on the number of correctly recognized presented words did reveal a significant pattern for message context and generation on incorrectly recognized presented words. Digital immigrants incorrectly recognized more unrelated words in an online message context than in an offline message context. For digital natives, the opposite pattern was revealed: they incorrectly recognized more unrelated words in an offline message context than in an online message context.

Besides investigating the effect on false memories, this study also examined reading speed. Digital natives read faster dan digital immigrants (H4). Generation did thus influence reading speed. Overall, readers did not read faster in an online message context versus in an offline message context (H5). Message context did thus not affect reading speed. Moreover, digital natives did not show bigger differences in reading speed between online and offline contexts compared to digital immigrants (H6).

Results from this quantitative study did not reveal differences in the number of false memories that were caused by the message context in which the messages were presented or caused by generation. For reading speed, a difference was found for generation, but an effect for message context and an interaction effect of message context and generation were not found.

Discussion

The present research investigated if message context and generation influenced false memory and reading speed. Previous research suggests that information processing is different for online versus offline information (e.g., Liu, 2005; Loh & Kanai, 2016) and that this could have consequences for the cognitive abilities of readers, such as for memory (Carr, 2011; Firth et al., 2019). It was hypothesised that message context also caused differences in the number of false memories and that this differed for digital natives and digital immigrants because of differences in information processing behaviour (Carr, 2011; Loh and Kanai, 2016; Prensky, 2001). However, these differences were not revealed in the present study as it suggests a minimal effect of the Internet on false memory. Substantial differences in information processing behaviour that were caused by the context in which a message was presented were not found. However, differences in the reading speed of digital natives and digital immigrants were revealed. As digital natives have grown up with online information, it was expected that they had adapted to these environments more (Carr, 2011; Prensky, 2001) and thus used specific reading strategies that are associated with a faster reading speed (Hooper & Herath, 2014), in both online and offline environments. Although differences caused by message context were not found, it was revealed that digital natives read faster than digital immigrants.

In the present study, someone was considered a digital native when they were born in or after 1993. This is the year in which the Internet was invented (Loh & Kanai, 2016). People born in or after 1993 have grown up with the interactive form of the Internet, Web 2.0, which was introduced around 2004 (O'Reilly & Battelle, 2009). However, differences in the year in which a digital native is considered to be born vary among researchers. While Nicholas et al. (2011) and Helsper and Eynon (2010) argue that 1993 is indeed the year that forms the line of demarcation between the one generation and the later, Carrier et al. (2009) argue that digital natives are born earlier, namely between 1980 and the present. While the Internet was only invented in 1993, there is a whole generation that used digital Internet technologies in their childhood, but who in this study are considered as digital immigrants. It could therefore be said that the terms digital natives and digital immigrants and related terms such as the *Google Generation* and the *Net Generation* are not very robust and more importantly, few studies empirically tested the hypotheses of differences between the two groups. Moreover, in this and other studies, digital natives and digital immigrants are presented as binary categories, while it could be plausible that there are individuals who fall within grey areas between these two labels. Dingli and Seychell (2015) state that, although some individuals did not grow up with digital Internet technologies, they still managed to adapt to and integrate into the digital environment and are therefore not experiencing difficulties when using digital Internet technologies. It could be the case that other factors than age alone that could be influencing neuroplasticity and therefore digital nativeness, such as individual differences in flexibility and adaptability. The inability to confirm hypotheses in this study could therefore not only be a result of an absence of an effect but could also be caused by an incorrect operationalisation of the term digital natives and digital immigrants. More empirical research is needed to test and possibly improve the operationalisation of these concepts.

The lack of confirmed hypotheses in this study could not only be explained by an absence of effects or the poor operationalisation of digital natives and digital immigrants but could also be caused by limitations in the study design and in the execution of the experiment. A possible explanation could be found in the way the online message context was replicated. While the format of the social media posts was very similar to real Instagram posts, the way in which they are presented was different. Readers are, when reading messages on social media like Instagram, confronted with notifications, hyperlinks, and an endless information flow (Loh & Kanai, 2016; Ophir et al., 2009). This can lead to online reading behaviour that is different from offline reading behaviour, such as text-scanning, keyword spotting and non-linear reading (Liu, 2005). These reading strategies are typically used to cope with information overload online (Hooper and Herath, 2014). According to Loh & Kanai (2016) and Ophir et al. (2009), readers are activated to consume multiple inputs at the same time when messages are presented in online environments. Carr (2011) argues that especially hyperlinks cause differences in information processing, as fragmented presentation of information leads to higher processing demands and therefore reduces the amount of available cognitive resources. Hyperlinks increase cognitive loads by looking different than other text, and therefore increasing visual processing demands. Moreover, they force the reader to decide whether to click or not click on the hyperlink and, when clicked on, require extra effort to combine contents of different sources (DeStefano & Lefevre, 2007). This hinders deeper information processing, as not enough cognitive resources are available, and can lead to worse information learning (Zhu, 1999). The online messages were in this experiment presented in an isolated manner, all one by one, without hyperlinks or clickable icons. It could therefore be that the multitasking behaviour that is associated with (social) media use and online reading are causing differences in information processing for offline versus online messages (Carrier et al., 2009), was not activated during the online experiment. As Leu et al. (2011) argue, it is not a flat online text, like a single webpage, that requires different reading skills, but it is the presence of social interactions and the connections with other texts (e.g., hyperlinks) what differentiates online from offline information. The processing demands that the online messages required could have been limited, or at least not substantially more than for offline messages, which resulted in not causing differences in information processing behaviour. A possible reason for not finding differences in false memories for online versus offline message contexts could therefore be that the online message context did not manage to trigger the information processing behaviour that is normally activated in online contexts.

Another limitation of this study was the small sample size. The intended number of participants, which was calculated via a G*power analysis, was not achieved after the removal of incomplete and insufficient entries in the data file. This was the most problematic for the digital immigrants' group, which was substantially smaller than the digital natives' group. The most probable reason that the intended sample size was not reached, could be the dependence on the personal network of the researcher to recruit participants, as due to limited time and resources, no other ways were available. Participants were asked to participate voluntarily, which made it more difficult to find a sufficient number of participants that wanted to participate. Possibly, this could also have led to la lower quality of participant entries, as the voluntary character of this study could have caused participants' low motivation and therefore led to participants doing the study as fast as possible, instead as correct as possible. This could have led participants to a shallow information processing mode, regardless of the message context, as they were perhaps not motivated or involved enough with the task to process the presented information deeply. Moreover, some technical problems in *PsychoPy* made it unable for a small number of participants to successfully finish the task, as some got error messages that did not let them continue and others could not correctly view the messages as these were either presented as too small, too big, or too blurry. These participants were deleted from the data.

Ideally, all participants would conduct the online experiment on either a desktop computer or a laptop, as participation via mobile phones or tablets could lead to different results. For this study, participants could choose from which device they would take part in the online experiment. As this study is about online information processing behaviour, it could be possible that the way the experiment was conducted influenced the results. The device where the messages are read on could influence information processing behaviour. As desktop computers and mobile phones have different functions in daily life (e.g., used for work, entertainment or maintaining social relationships), this could go hand in hand with different habits and usage styles. In a way, all participants were in an online condition, where messages were presented on a digital device. To improve ecological validity, an offline experiment may be important to consider for future studies, as via this manner, it could be controlled what information processing behaviour is activated by reading a message on paper (offline context) or reading a message on social media via a smartphone (online context). In this way, the offline context is not just a plain text format but really placed in an offline context. The online message context could be made more similar to real social media posts, such as more interactive by including clickable icons and hyperlinks, to replicate real social media posts better. In this way, the online message context could be more successful in triggering the information processing behaviour that is expected to be activated when people read information online. The ecological validity of the experiment would benefit from improving the way of presenting offline and online message contexts. Further research that has more resources should thus consider conducting a similar experiment either in a controlled situation (e.g., a research lab) or specifically asking participants to participate on a specific device, e.g., smartphones.

Further research could also extend the message contexts which were included. For this study, an Instagram format was chosen, as this is the most popular social medium in the

Netherlands. Nevertheless, a disadvantage of including Instagram as the online message context was that it is less used by digital immigrants (Hoekstra et al., 2013) and that this group is therefore possibly less familiar with this format and its implications. This could influence the results. As this group of participants was maybe not or less used to this message context, perhaps it did not activate typical online behaviour for this group. In a larger study, it could be interesting to not only implement more social media formats (e.g., Facebook, Twitter, WhatsApp, or LinkedIn) but also other online formats, such as Google search results or blog texts. For these message contexts, longer texts could be included, which can possibly reveal bigger differences in reading speed and cognitive information processing. When there is more text to process, there is more information that should be remembered, which could make the DRM task more difficult. Moreover, differences in reading speed would perhaps be revealed more visibly when longer texts are included. The expansion of message contexts could give more insight into how different user patterns influence online cognitive information processing.

This research provided one of the first experiments that tests the DRM paradigm of Roediger & McDermott (1995) for messages instead of word lists. Overall, the accuracy of participants in the DRM paradigm task was high. On average, participants correctly recognized around 70% of the presented words, and they had almost twice as many false memories for the critical lure words than for unrelated words. However, as this study was one of the first to use the DRM paradigm not for word lists but for messages, the paradigm needs more piloting to find the best way to test false memory for messages. Further research could test the Signal Detection Theory in relation to the DRM task, as this is a frequently used measure to test the effects of unwanted response biases, encoding manipulations or differences between groups (Dobbins et al., 2000). The theory examines hit (a presented stimulus that is recognized as presented) false alarm (a non-presented stimulus that is recognized as presented), correct rejection (a non-presented stimulus that is not recognized as presented) and miss rates (a presented stimulus that is recognized as not presented) and can be used to compare the accuracy of the task across different experimental conditions (Abdi, 2007). As this study is the first that has tested the DRM paradigm for messages, it could be useful to include the Signal Detection Theory for more theoretical insight into false memory for messages.

This study did not find any effects of message context on false memory and reading speed. If these findings are replicated in further studies, this could have different implications for (online) information processing. Firstly, the lack of differences in the number of false memories in online and offline message contexts could mean that signals about changing cognition because of digital Internet technologies are not as severe as is stated, as online messages did not seem to be influencing false memory. On the other hand, the opposite could be taking place as well. As theory suggests that human cognition is very adaptable to changing environments (Pascual-Leone et al., 2005), it might be the case that human cognition has already transformed because of online information processing behaviours. Perhaps, digital Internet technologies did change reading strategies, information processing and with that human cognition, which causes readers to have poorer memory and more false memory overall, not only in online message contexts but also in offline contexts. The reading strategies that are used in online environments, such as scanning, browsing, and skimming (Liu, 2005), could be transferred to offline contexts as well, which causes poorer cognitive skills after reading in general. Human cognition has been profoundly reshaped before, for example when toolmaking (Stout et al., 2008) and language (Aboitiz & García, 1997) evolved. Potentially, the reshaping of human cognition that was caused by digital Internet technologies over the last thirty years ago (Loh and Kanai, 2016) happened more profoundly than research suggests. From only this study, especially with its small sample size, a clear answer cannot be given. Further research should answer the question if the Internet really does alter cognition, as Carr (2011) described, or whether these are unjustified concerns. More investigation is, therefore, necessary to discover if differences between online and offline information processing exist. Specifically, further research could contribute to existing research on the emergence of misinformation online by finding an answer to the question if we incorrectly remember what we read online more than for offline information. Besides, empirical studies that investigate the influence of message context on cognitive abilities, preferably by taking the limitations of this study in mind, could result in more clarity about the impact of digital Internet technologies on human cognition.

Although the present study made a start at investigating the influence of message context and generation in relation to false memory, it does not show evidence for earlier discussed theories on (online) information processing behaviour differences for digital natives and digital immigrants. This was one of the first studies that examined the DRM paradigm in a message context. In a society where digital Internet technologies are increasingly influencing daily lives, this topic will remain relevant to research, especially as this is fast-changing and earlier research on this topic is quickly becoming outdated. Further research could take this study as a starting point in investigating the relationships of generation and message context on (false) memory and online information behaviour in general.

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Appendix A. Online message context stimuli

Message 1. Message with the critical word ‘window’ (raam).

Wanneer ik uit het raam kijk, zie ik de lente die begint. Ik zie zoveel gebeuren: vogels die rondvliegen, mensen die zonder jas rondfietsen, bomen die in de knoppen staan en bloemen die dansen in de wind.

Message 2. Message with the critical word ‘smell’ (geur).

De geur van deze parfum past helemaal bij mij. Het is fris en bloemachtig, met noten van vanille en roos. Het geeft me een vrouwelijk en zelfverzekerd gevoel en ik krijg er veel complimenten over. Het opspuiten van mijn luchtje is een vast onderdeel van mijn ochtendroutine.

Message 3. Message with the critical word ‘cold’ (koud).

Het is zo koud buiten, verschrikkelijk dit weer! Zowel buiten als in mijn huis is het niet fijn. Ik heb nog liever regen dan deze temperatuur… Ik ga mijn muts, handschoenen en dikke jas wel weer uit de kast halen.

Message 4. Message with the critical word ‘chair’ (stoel).

Zo kan je mij uittekenen: ik in mijn favoriete stoel. Dit is mijn lievelingsplek in de huiskamer. Hier neem ik de dag door in de ochtend, lees ik een fijn boek, drink ik een koffie en plof ik neer na een lange dag. Als je me zoekt, weet je me te vinden.

Message 5. Message with the critical word ‘cup’ (beker).

Dit is mijn favoriete beker. Ik drink er het liefst in de ochtend, middag en avond uit. Melk of koffie, dat maakt niet uit. Als deze ooit kapot zou vallen, zou ook mijn hart breken. Het klinkt overdreven, maar het is echt een onderdeel van mijn dagelijkste ritueel om hieruit te drinken.

Message 6. Message with the critical word ‘soft’ (zacht).

Deze deken is zo zacht! Echt een aanrader, het materiaal is heerlijk om helemaal onder te verdwijnen en jezelf in te wikkelen. Lekker ontspannen na een lange dag werken! Een perfect cadeau voor een dierbare die wel wat extra comfort kan gebruiken.

Message 7. Message with the critical word ‘sleep’ (slaap).

Ik hou zoveel van slaap, het is echt mijn favoriete activiteit van de dag. Ik kijk in de ochtend al uit naar wanneer het er weer tijd voor is. Werkelijk niets dat me gelukkiger maakt dan dat.

Message 8. Message with the critical word ‘anger’ (woede), presented with comprehension question ‘Was the window of the car broken?’ (Was de ruit van de auto kapot?).

Ik voel zoveel woede vandaag. Waarom zijn er zulke mensen? Ik trof mijn auto net aan met een grote kras op de zijkant, zonder briefje of bericht. Zo asociaal! Je laat dan toch even je telefoonnummer achter? Nu kan ik zelf voor de kosten opdraaien. Ik voel er echt hevige emoties over, het is niet te beschrijven.

Message 9. Message with the critical word ‘sweet’ (zoet), presented with comprehension question: ‘Does the person like sweet food?’ (Houdt de persoon van zoet eten?).

Ik hou echt heel veel van eten wat zoet is. Als het voor me staat kan ik niet ophouden met ervan eten, ik snak ernaar. Zo ben ik dol op koekjes en kan ik die elke dag wel op. Dat is natuurlijk niet zo gezond, maar jezelf af en toe trakeren op iets lekkers mag.

Message 10. Message with the critical word ‘thrash’ (vuilnis), presented with the comprehension question: ‘Do the rats run over the garbage?’ (Lopen de ratten over het vuilnis?).

Er ligt hier zoveel vuilnis op straat. Volgens mij wordt er gestaakt. Het is echt geen gezicht: het ziet er zo vies uit! De ratten lopen er nog net niet overheen, maar de katten maken de zakken wel open. Laten we hopen dat het snel opgelost wordt, zodat we weer kunnen lopen over schone straten.

Appendix B. Word lists

Table 4. Word list for Message 1, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
window	raam	presented word
door	deur	critical lure
glass	glas	critical lure
pane	ruit	critical lure
shade	schaduw	critical lure
ledge	vensterbank	critical lure
fruit	fruit	unrelated word
smoke	rook	unrelated word
high	hoog	unrelated word
doctor	dokter	unrelated word
thief	dief	unrelated word

Table 5. Word list for Message 2, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
smell	geur	presented word
nose	neus	critical lure
breathe	ademen	critical lure
sniff	snuiven	critical lure
aroma	aroma	critical lure
hear	horen	critical lure
apple	appel	unrelated word

ashes	as	unrelated word
low	laag	unrelated word
nurse	verpleegster	unrelated word
steal	stelen	unrelated word

*The unrelated word ‘cigarette’ (sigaret) is replaced by ‘ashes’ (as) according to pre-test results.

Table 6. Word list for Message 3, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
cold	koud	presented word
hot	heet	critical lure
snow	sneeuw	critical lure
warm	warm	critical lure
winter	winter	critical lure
ice	ijs	critical lure
vegetable	groente	unrelated word
puff	trekje	unrelated word
clouds	wolken	unrelated word
sick	ziek	unrelated word
robber	overvaller	unrelated word

Table 7. Word list for Message 4, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
chair	stoel	presented word
table	tafel	critical lure

sit	zit	critical lure
legs	poten	critical lure
seat	zitplaats	critical lure
couch	bank	critical lure
orange	sinaasappel	unrelated word
blaze	brand	unrelated word
up	omhoog	unrelated word
lawyer	advocaat	unrelated word
crook	oplichter	unrelated word

Table 8. Word list for Message 5, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
cup	beker	presented word
mug	mok	critical lure
saucer	schotel	critical lure
tea	thee	critical lure
measuring	afmeten	critical lure
coaster	onderzetter	critical lure
kiwi	kiwi	unrelated word
billows	golven	unrelated word
tall	lang	unrelated word
medicine	medicijn	unrelated word
burglar	inbreker	unrelated word

Table 9. Word list for Message 6, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
soft	zacht	presented word
hard	hard	critical lure
light	licht	critical lure
furry	harig	critical lure
pillow	kussen	critical lure
plush	pluis	critical lure
citrus	citrus	unrelated word
pollution	vervuiling	unrelated word
tower	toren	unrelated word
health	gezondheid	unrelated word
money	geld	unrelated word

*The unrelated word ‘couch’ (bank) is replaced by ‘desk’ (bureau) according to pre-test results.

Table 10. Word list for Message 7, based on word lists of Stadler et al. (1999).

English word list	Dutch (translated) word list	Word category
sleep	slaap	presented word
bed	bed	critical lure
rest	rust	critical lure
awake	wakker	critical lure
tired	moe	critical lure
dream	droom	critical lure
ripe	rijp	unrelated word

ashes	as	unrelated word
jump	springen	unrelated word
hospital	ziekenhuis	unrelated word
cop	agent	unrelated word

Appendix C. Shortened version of the Internet use survey by Helsper et al. (2016)

Social Use - Personal networks (α =.81)

Comment on the updates friends or family put online

Talk to family or friends who live further away

Share pictures of you with your family or friends

Social Use – Formal networks (α =.76)

Look for information (online or offline) on clubs or societies

Interact with people who share your personal interests and hobbies

Comment about a political or societal issue

Social Use – Political networks (α =.83)

Look for information about national government services

Ask a representative of a public institution for advice on public services

Look for information about an MP, local councilor, political party or candidate

Personal Use – Health & Lifestyle (α =.83)

Talk to others about your lifestyle

Look up information on how to improve your fitness

Ask others about a training program

Personal Use – Self-actualization (α =.79)

Exchange information about events or concerts with others

Look up information to understand problems or issues that interest you

Consult others' opinions on problems or issues that interest you

Personal Use – Leisure (α =.68)

Play games

Listen to music

Watch videos/TV programs

Appendix D. Exploratory analyses for Internet use

Incorrectly recognized lures

A two-way univariate ANCOVA for generation and message context on incorrectly recognized critical lures with as covariate Internet use did not reveal a significant effect of Internet use (F (1, 106) <1). Significant interaction effects of Internet use and generation (F (1, 106) <1), Internet use and message context (F (1, 106) = 1.59, p = .211) and Internet use, generation, and message context (F (1, 106) = 2.82, p = .096) on the number of incorrectly recognized critical lures were not revealed. Internet use behaviour did thus not influence the number of false memories.

Correctly recognized presented words

A two-way univariate ANCOVA for generation and message context on correctly recognized presented words with as covariate Internet use did reveal a significant effect of Internet use on correctly recognized presented words (F (1, 106) = 4.47, p = .0.37, η^2 =.040). However, Internet use did not seem to be a significant predictor for correctly recognized presented words (B = -.03, p = .248). Moreover, the ANOCVA did not show a significant effect of Internet use without including the interactions in the analysis. This makes it unclear what role Internet use plays in influencing the number of presented words that were correctly recognized. Significant interaction effects of Internet use and generation (F (1, 106) = 2.01, p =.159), Internet use and message context (F (1, 106) = 3.64 p =.059), and Internet use, generation, and message context (F (1, 106) <1) on the number of correctly recognized presented words were not revealed.

Incorrectly recognized unrelated words

A two-way univariate ANCOVA for generation and message context on incorrectly recognized unrelated words with as covariate Internet use did not reveal a significant effect of Internet use on incorrectly recognized unrelated words (F (1, 106) 1.44, p = .233). Significant interaction effects of Internet use and generation (F (1, 106) <1), Internet use and message context (F (1, 106) <1) and Internet use, generation, and message context (F (1, 106) = 2.47, p = .119) on the number of incorrectly recognized unrelated words were not revealed. Internet use behaviour did thus not have an effect on the number of unrelated words that were recognized.

Reading speed

The two-way univariate ANCOVA for generation and message context on reading speed with as covariate Internet use did not reveal a significant effect of Internet use on reading speed (F (1,106) = 1.13, p = .290). Significant interaction effects of Internet use and generation (F (1, 106) <1), Internet use and message context (F (1, 106) = 3.50, p = .064) and Internet use, message context and generation (F (1, 106) = 3.64, p = .059) on reading speed were also not revealed. Internet use behaviour of participants did thus not influence their reading speed.

Appendix E. Ethical checklist

Checklist EACH (version 1.9, December 2022)

You fill in the questions by clicking on the square next to the chosen answer ☐

After clicking, a cross will appear in this square ☒

1. Will you be collecting data from social media platforms?

☐ Yes → consult and contact the EACH to see if assessment is necessary

☒ No → continue with questionnaire

2. Will you use an existing dataset?

☐ Yes → continue with questionnaire

☒ No → go to question 4

3. When using an existing dataset, do you comply with the EACH guidelines**?

☒ Yes → continue with questionnaire

☐ No or in doubt → contact the EACH to see if assessment is necessary

** Guidelines: - ethics approval is obtained for the original data collection, - subjects have consented to the

reuse of the research data, or the reuse fits within the original research purpose.

4. Will you be collecting data from subjects?

☒ Yes → continue with questionnaire

☐ No → end of checklist

5. Is a health care institution involved in the research?

Explanation: A health care institution is involved if one of the following (A/B/C) is the case:

A. One or more employees of a health care institution is/are involved in the research as principle or in the carrying out or execution of the research.
B. The research takes place within the walls of the health care institution and should, following the nature of the research, generally not be carried out outside the institution.
C. Patients / clients of the health care institution participate in the research (in the form of treatment).

☒ No → continue with questionnaire

☐ Yes → Did a Dutch Medical Institutional Review Board (MIRB) decide that the Wet Medisch Onderzoek (Medical Research Involving Human Subjects Act) is not applicable or does the research comply with one of the described by the EACH

☐ Yes → continue with questionnaire

☐ No → This application should be reviewed by a Medical Institutional Review Board, for example, the Dutch CMO Regio Arnhem Nijmegen. If review by an MIRB has already taken place → continue with questionnaire. If this review has not yet taken place → end of checklist

6. Does the research include medical-scientific research that might carry risks for the subject?

☐ Yes → This application should be reviewed by a Medical Institutional Review Board, for example, the Dutch CMO Regio Arnhem Nijmegen → end of checklist

☒ No → continue with questionnaire

Standard research method

7. Does this research fall under one of the stated standard research methods of the Faculty of Arts or the Faculty of Philosophy, Theology and Religious Studies?

☒ Yes → 12. Standard survey research **(fill in name and number of standard research method)** → continue with questionnaire

☐ No → assessment necessary, end of checklist

Subjects

8. Is the subject population a healthy one?

☒ Yes → continue with questionnaire

☐ No → assessment necessary**, end of checklist → go to assessment procedure

**Exception for studies with patients participating in one of the described standard studies in the field of language and speech pathology

9. Will the research be conducted amongst minors (<16 years of age) or amongst (legally) incapable persons?

☐ Yes → assessment necessary, end of checklist → go to assessment procedure

☒ No → continue with questionnaire

Method

10. Is a method used that makes it possible to produce a coincidental finding that the subject should be informed of?

☐ Yes → assessment necessary, end of checklist → go to assessment procedure

☒ No → continue with questionnaire

11. Will subjects undergo treatment or are they asked to perform certain behaviours that can lead to discomfort?

☐ Yes → assessment necessary, end of checklist → go to assessment procedure

☒ No → continue with questionnaire

12. Are the estimated risks connected to the research minimal?

☒ Yes → continue with questionnaire

☐ No → assessment necessary, end of checklist → go to assessment procedure

13. Are the subjects offered a different compensation than the usual one?

☐ Yes → assessment necessary, end of checklist → go to assessment procedure

☒ No → continue with questionnaire

14. Should deception take place, does the procedure meet the standard requirements?

☐ Yes → continue with questionnaire

☐ No → assessment necessary, end of checklist → go to assessment procedure

☒ deception is not applicable

15. Are the standard regulations regarding anonymity and privacy met?

☒ Yes → continue with questionnaire

☐ No → assessment necessary, end of checklist → go to assessment procedure

Conducting the research

16. Are subjects recruited via the Radboud Research Participation System (SONA) and/or is the research conducted in the CLS Lab?

☐ Yes → assessment necessary, end of checklist → go to assessment procedure

☒ No → continue with questionnaire

17. Will the research be carried out at an external location (such as a school)?

☐ Yes→ Do you have/will you receive written permission from this institution?

☐ No → assessment necessary, end of checklist → go to assessment procedure

☐ Yes → continue with questionnaire

☒ No → continue with questionnaire

18. Is there a contact person to whom subjects can turn to with questions regarding the research and are they informed of this?

☒ Yes → continue with questionnaire

☐ No → assessment necessary, end of checklist → go to assessment procedure

19. Is it clear for subjects where they can file complaints with regard to participating in the research and how these complaints will be dealt with?

☒ Yes → continue with questionnaire

☐ No→ assessment necessary, end of checklist → go to assessment procedure

20. Are the subjects free to participate in the research, and to stop at any given point, whenever and for whatever reason they should wish to do so?

☒ Yes → continue with questionnaire

☐ No→ assessment necessary, end of checklist → go to assessment procedure

21. Before participating, are subjects informed by means of an information document about the aim, nature and risks and objections of the study? (see explanation on informed consent and sample documents).

☒ Yes → continue with questionnaire

☐ No→ assessment necessary, end of checklist → go to assessment procedure

22. Do subjects and/or their representatives sign a consent form? (see explanation on informed consent and sample documents.

☒ Yes → checklist finished

☐ No→ assessment necessary, end of checklist → **go to assessment procedure**

If you want to record the results of this checklist, please save the completed file.

If you need approval from the EACH due to the requirement of a publisher or research grant provider, you will have to follow the formal assessment procedure of the EACH