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Are Social Media Notifications Distracting?

The Effects of Social Media Logos and Notification Badges on Visual Working Memory Performance

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Abstract: Visual working memory (VWM), due to its temporary nature, is highly volatile. VWM encoding may be easily disrupted by cues from our visually rich media environment, such as social media logos and notification badges. Yet, to what extent these social media-related cues adversely affect our cognitive processing is not well understood. In three experiments, participants performed a change-detection task with a memory array that contained colored stimuli. Next to the memory array, social media logos with or without notification badges might appear in conjunction with the memory array in critical blocks (Experiment 1) or in critical trials (Experiment 2 and 3). The presence of social media logos with notification badges adversely affected change detection performance in Experiment 1, but not in Experiment 2 or 3. Overall, the findings seem to indicate that the presence of social media logos does not interfere with visual working memory performance.

Keywords: notifications, smartphone, social media, distraction, working memory

Recent developments of mobile digital technologies such as laptops and smartphones have brought us to a fast-paced, rapidly changing, visually rich media environment. Within this dynamic environment that stimulates fast responses, focused attention and contemplation are discouraged. Instead, digital media seem to promote skimming and scanning large amounts of information (Lin, 2009; Loh & Kanai, 2016) and rapid switching from one form of media to another (Wiradhany et al., 2021). Consequently, our ability to retain and process a large amount of visual information has never been more valuable.

Our ability to retain visual information is dictated by our visual working memory (VWM) capacity – a limited temporary store of visual information (Baddeley, 2003; Cowan, 2000). Visual working memory is typically assessed using a change detection task (Luck & Vogel, 1997). Here, participants are presented with an array of visual objects twice and are subsequently asked to indicate whether one of the objects has changed in the second presentation. The number of visual objects may vary across trials such that correct detections of changes in a large array of objects indicate a large VWM capacity (Feuerstahler et al., 2019; Rouder et al., 2011). VWM capacity, in turn, has been found to be associated with the degree of control in accessing information in our working memory. Specifically, individuals with large VWM are also more able to ignore irrelevant objects or distractors compared to those with low VWM (Vogel et al., 2005). Additionally, VWM is positively correlated with fluid intelligence (Engle et al., 1999). Both attentional control and fluid intelligence, in turn, have been consistently found to be significant predictors of a large array of higher-order cognitive tasks, which include multitasking (Minear et al., 2013; Redick et al., 2016).

VWM, due to its temporary nature, is highly volatile. Successful VWM encoding depends on whether one is able to (1) perceive visual information in its entirety, (2) encode as much information as possible, and (3) maintain the encoded information as it is being consolidated in our long-term storage (Feuerstahler et al., 2019). In the current fast-paced digital environment, each of these steps may be easily disrupted by other stimuli or events that are related to digital devices, a phenomenon that has been dubbed *digital distraction* (Hanin, 2021). Hanin (2021) further argues that since modern day digital devices such as smartphones serve multipurpose roles for work and leisure, our interaction with them is inevitable, that is, we have very few options but to pay attention to them. This

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inevitability may have dire consequences. For instance, smartphones may engage our attention even in situations where undivided attention is necessary such as driving (Liebherr et al., 2020; Strayer & Johnston, 2001) or studying (for a review see, Chen & Yan, 2016). Subsequent studies have even shown that the physical presence of smartphones, even in absence of a direct interaction with these devices (i.e., their mere presence) may decrease performance on a cognitive task (Ito & Kawahara, 2017; Thornton et al., 2014; Ward et al., 2016) even though more recent studies have failed to show this effect (Hartmann et al., 2020; Koessmeier & Büttner, 2022).

Smartphones have become a ubiquitous communication device (Anderson, 2015; Deloitte Southeast Asia, 2017). Used wisely, smartphones can augment various mental and social functions (Hunter et al., 2018; Wilmer et al., 2017), yet, a growing body of research has shown that smartphones can have detrimental effects on cognitive performance (e.g., Ward et al., 2016). It is therefore crucial to understand how far VWM is affected by digital distractions. Previous research has indicated that specific visual cues from social media attract attention. For example, social media icons have been shown to be rewarding (Johannes, Dora, & Rusz, 2019; Matthews et al., 2020) and elicit spontaneous approach reactions (Du et al., 2020). Yet, the extent to which these social media features affect our cognitive processing and are distracting is relatively unknown. The aim of the present studies therefore was to examine the extent to which the presence of social media logos and notification badges (i.e., a small red dot that appears at the top right of an app icon that indicates incoming messages) affect VWM. Specifically, in three experiments, we asked participants to perform a modified change detection task where, in addition to the memory test array, additional distractors that include social media attributes may be presented.

The Effects of Social Media Logos and Notification Badges

Specific features of digital devices might have the potential to disrupt memory encoding as they provide visual, auditory, and tactile cues. For example, social media logos and their notification badges are ubiquitous and potentially distracting features of smartphones that have been argued to pull users toward their phone and thereby distract them from other tasks at hand (Bartoli & Benedetto, 2022; Fitz et al., 2019; Meier, 2022). There is some evidence on the distracting potential of social media. For instance, users checked phone apps more often if they displayed a notification badge (Bartoli & Benedetto, 2022), and they did report to be less attentive during the day if the number of times they had to check these notifications was not limited (Fitz et al., 2019). With regard to the effects of notifications on cognitive performance, Stothart et al. (2015) found that participants who received notifications on their smartphones performed worse in a demanding sustained attention task, even though they did not directly interact with their smartphones during the experiment. Others have argued that social media notifications could be perceived to be more rewarding than notifications from other types of apps (e.g., weather or clock). Johannes, Dora, and Rusz (2019) assessed the potentially distracting effect of social media logos and notifications in a visual search task. They indeed found that social media logos with notification badges were rated to be highly rewarding by participants. Critically, however, presenting social media apps and notifications as cues in a visual search task did not affect performance in comparison to the presence of other smartphone app logos (e.g., weather apps).

Finally, a few studies have shown that social media notifications on smartphones only adversely affected performance in a cognitive task for a subset of participants. Wegmann et al. (2020) found that excessive social media users, especially those with high levels of attentional impulsivity, performed worse in an inhibition control task where they had to withhold responses from social media-related auditory tones. Gao et al. (2019) found that excessive social media users did not perform worse in an inhibition control task. But analysis of the ERP signals of these participants indicated that they allocated more attentional control to social media notifications (i.e., showed higher ERP amplitudes), which indicates that they did pay more attention to those notifications. However, it is important to note that the findings from these studies only pertained to a subset of the population that scored high in social media use and dependency.

Together, findings from existing studies are rather mixed but seem to indicate that social media logos as well as social media notification badges might be distracting and negatively affect cognitive processing. The present study, thus, aims at further disentangling the potential distracting effects of social media logos and notification badges by dissecting their effects on VWM.

The extant literature suggests two competing hypotheses on the effect of social media notifications on visual working memory. On the one hand, and in line with the *brain drain* reasoning (Ward et al., 2016), social media notifications may *disrupt* working memory encoding since participants may orient their attention to and allocate some working memory capacity for the social media notifications. If this is the case, we expect participants to perform less accurately on a visual working memory task when social media logos are present. We call this the disruption hypothesis.

On the other hand, social media notification badges might increase vigilance (Koessmeier & Büttner, 2022) and might be perceived to be more rewarding (Johannes, Dora, & Rusz, 2019), but they might not necessarily disrupt performance. If this is the case, we expect participants to perform equally accurately or even more accurately when the memory array is presented in conjunction with social media logos and/or notifications. Currently, there is more supporting, albeit limited evidence for the brain drain hypothesis, as indicated in a recent meta-analysis (Parry, 2023). Thus, the brain-drain hypothesis guides our expectations in the current study.

Individual Differences: The Role of Online Vigilance

Whether social media information is distracting during task performance might not only depend on the specific cues presented but also on individual differences. Specifically, online vigilance might play a role here. Online vigilance is defined as the cognitive preoccupation with online activities (Reinecke et al., 2018). Individuals high in online vigilance think more frequently about what is happening online, monitor online activities more frequently, and have a stronger impulse to check online messages (Reinecke et al., 2018). As individuals high in online vigilance are more preoccupied with social media activities, they may be more easily distracted by social media logos. Social media cues might trigger automatic thoughts in individuals high in online vigilance more than in individuals low in online vigilance. Thus, we expected that individuals with high levels of online vigilance are more distracted by social media logos during task performance than individuals low in online vigilance.

The Current Studies

In the present studies, we used a modified change detection task (Luck & Vogel, 1997; Vogel et al., 2006). In this task, participants have to retain a feature of target objects that are presented with or without distractors. Specifically, participants had to retain the colors of one or four objects of varying colors and geometric shapes. The target object is highlighted in the second presentation (see Figure 1). We assumed that participants may only be able to correctly detect object changes if they manage to memorize the whole array and ignore potential distractors (Feuerstahler et al., 2019). Critically, to emulate digital distractions, we presented social media logos with or without their notification badges on every trial in critical blocks (Experiment 1) or randomly in critical trials (Experiments 2 and 3) in participants' peripheral vision (see Figure 1).

Based on the brain-drain hypothesis, we expect that the presence of social media logos distracts participants from memorizing the memory arrays and therefore that they perform less well. More specifically, given the intricate relationship between working memory and attentional control, participants may find the combination of the social media notifications presence and a larger set size to be especially difficult since they have to encode and retain the colors of four objects (e.g., see Vogel et al., 2005). Hence, we further expected a Presence × Set Size interaction, in which social media notifications would negatively affect performance as the set size increases. Lastly, we examined whether the distracting effects of social media logos are more prominent among individuals high in social media vigilance (Experiments 2 and 3).

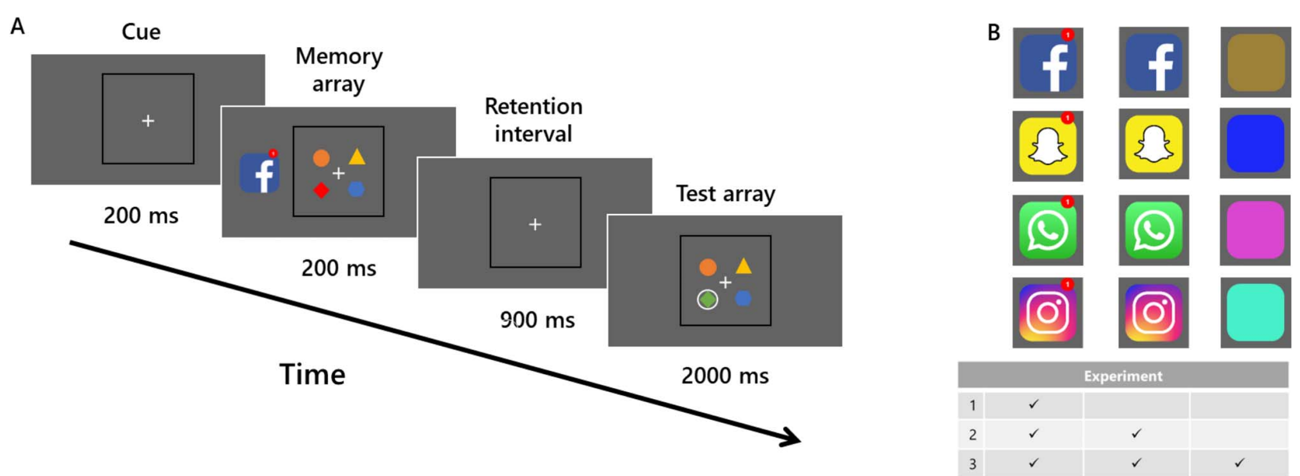

Figure 1. A. Trial sequence for the change detection task with the social media with notifications distractor. B. Types of distractors that are presented during the critical trials in conjunction with the memory array: social media logos with notifications (Experiments 1, 2, and 3, leftmost column), social media logos without notifications (Experiments 2 and 3, middle column), colored squares (Experiment 3, rightmost column).

Experiment 1

Experiment 1 aims to investigate the effects of social media notifications and set size on task performance in a change detection task.

Methods

Participants

Ninety first-year psychology students from the University of Groningen participated in this experiment in exchange for course credits through a participant pool system. They participated in person, in isolated computer cubicles. From the 90 registered participants, 88 completed the experiment. Participants' ages ranged between 17 and 28 years (M = 19.77, SD = 1.89). There were 17 male and 71 female participants. All participants had self-reported intact color vision. The experiment was approved by the Ethical Committee of Psychology of the University of Groningen.

Materials and Design

All tasks were programmed and implemented in OpenSesame (Mathôt et al., 2012), and all surveys were implemented in the Qualtrics survey system.

Modified Change Detection Task

Participants were briefly presented with an array of one or four objects with varying colors and shapes and were asked to retain the color of the object(s). After a delay, the array was presented for a second time, and participants had to decide whether the color of the circled object had changed (see Figure 1), which occurred in 50% of the trials. In the notifications-present condition, in addition to the array, social media apps logos with notification badges (see Figure 1) were presented equally often to the left or to the right of the presentation array, creating a 2 (array set size, one vs. four) × 2 (social media notifications present vs. absent) within-subjects design. The array set size manipulation was organized in blocks, which were counterbalanced across participants, and the notification presence manipulation was intermixed across different trials within a block.

Each trial began with a fixation cross for 200 ms, followed by the initial presentation of the memory array for another 200 ms, followed by a 900 ms delay. The test array was then shown for 2,000 ms, in which a white circle surrounded one of the object(s). Participants were instructed to press the "F" key on the keyboard if they thought that the color of the object in the circle had changed or the "J" key to indicate no change. During practice trials, a small smiley face is shown following a correct response. In nonpractice trials no feedback was provided to participants. Participants completed four blocks of 10 practice trials, after which they completed four blocks of 100 trials.

Additional Measures

Participants completed a Go/NoGo task and two questionnaires on impulsivity and attentional capacity. These additional measures were part of hypothesis testing of a graduate student project and were unrelated to the scope of the current article. Findings that are related to these additional measures can be checked on OSF (https://osf.io/5rfzn/).

Analysis

For the change detection task, practice trials (10%) and trials with very fast response times (<200 ms), which were considered as accidental button presses, and omission errors (2.6%) were not considered in the analysis. All analysis were conducted in R 4.2.1 (R Core Team, 2015). Linear mixed models were constructed using the lme4 package (Bates et al., 2015). For these models, p-values were estimated using the Kenward–Roger method (Luke, 2017), which has been shown to provide more conservative approximations, implemented in the lmerTest package (Kuznetsova et al., 2017). Pairwise comparisons, together with main effects and interactions from the mixed models, were estimated using the emmeans package (Lenth, 2024). Main effects and interactions were computed using the joint_tests() function, which corresponds to type III ANOVA test where equal-weighted averaging is used. Effect sizes from the linear mixed models were reported in odd ratios, while effect sizes from ANOVAs were reported as partial eta squared. Graphs were rendered using the ggplot2 package (Wickham, 2010). Analysis script, anonymized data, and experiment script are available on OSF (https://osf.io/5rfzn/).

Results

We constructed a linear mixed model with accuracy as the outcome measure, array set size and social media notification presence as fixed effects, and participants by set size as a random slope.

The analysis revealed a significant main effect of set size, F = 473.49, p < .001, with the probability to respond correctly to a trial decreased from .92 to .74 (i.e., an odds ratio of 4.15) in the condition with a larger set size, z = −20.16, p < .001. Importantly, there was a main effect of social media notifications, F = 16.22, p < .001; the probability to respond correctly to a trial decreased from .86 to .84 (i.e., an odds ratio of 1.14) in the condition where social media notifications were present, z = −3.46, p < .001. No Significant Set Size × Social Media Notifications Presence

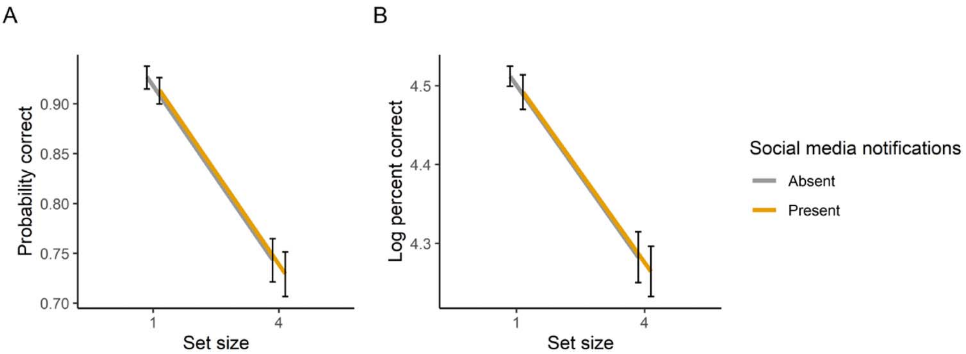

Figure 2. Probability to respond correctly (A) and Log percent correct (B) as a function of set size and social media notifications. *Note*. Error bar denotes 95% confidence interval of the means.

interaction was detected, $F = 3.00$, $p = .083$ (see Figure 2). To ensure the robustness of this effect, we constructed a repeated-measures ANOVA with log percent correct as the outcome variable (see Schweickert, 1985) and array set size and social media notification presence as the independent variables. This analysis also showed a main effect of array set size, $F = 560.72$, $p < .001$, $\eta_p^2 = .68$, and a small main effect of social media notification, $F = 3.93$, $p = .048$, $\eta_p^2 = .01$, but no significant array set size × social media notifications presence interaction, $F = .010$, $p = .920$, $\eta_p^2 < .001$.

Discussion

Experiment 1 showed that participants' working memory performance was worse in the conditions where social media notifications were present, although this effect was very small. This provides partial support for the distraction hypothesis as the performance decrement appeared to be unaffected by the increase of set sizes. Importantly, however, Experiment 1 suffered from several drawbacks. First, in the social media notifications-present blocks, participants were always presented with a social media logo with a notification badge. Thus, it is still unclear whether performance decrement that we observed was due to the social media or the appearance of the notification badges. Second, in Experiment 1, social media notifications presence was manipulated across blocks, such that in the notifications-present blocks participants would realize that a social media notification would always be shown. If we assume that attention control allocation would vary as a function of reward expectancy (i.e., as indicated by the notification badge; see also Fröber & Dreisbach, 2016; Frömer et al., 2021), we could not infer from this design that in the notification-present blocks participants performed worse *because* they perceived social media-related information to be rewarding since in our design, reward expectancy was constant in the notification-present blocks.

Experiment 2

The aim of Study 2 was to address these two limitations. Experiment 2 was similar to Experiment 1 with several important modifications. To test the effect of reward expectancy, such that notification badges from social media may be perceived to be more rewarding and facilitate orientation of attention (e.g., Johannes, Dora, & Rusz, 2019), in Experiment 2 the trials in which the social media logos with notifications were present or absent were intermixed instead of presented in blocks. Hence, in each block, notifications were presented randomly to participants who could thus not form any expectations. Furthermore, the findings of Study 1 show the distracting nature of social media logos including notification badges. We thus do not know whether these effects are due to the rewarding nature of social media logos in itself or whether they are driven by the even more rewarding notification badges (see also Johannes, Dora, & Rusz, 2019). Therefore, in Study 2 we dissect the contribution of the notification badges by presenting social media logos with or without notification symbol (see Figure 3B). Analysis script, anonymized data, and experiment script are available on OSF (https://osf.io/5rfzn/). We also preregistered the following hypotheses.

We hypothesize that social media apps with notification badges interfere with VWM; specifically, in line with our previous experiment, it may harm VWM encoding and hinder participants' ability to detect changes, resulting in less retained information (H_1). Additionally, in the second block of the experiment, we further test whether this interference effect is due to the notification badge symbol. Here, we hypothesize that the interference would be larger in the condition with a notification badge compared with

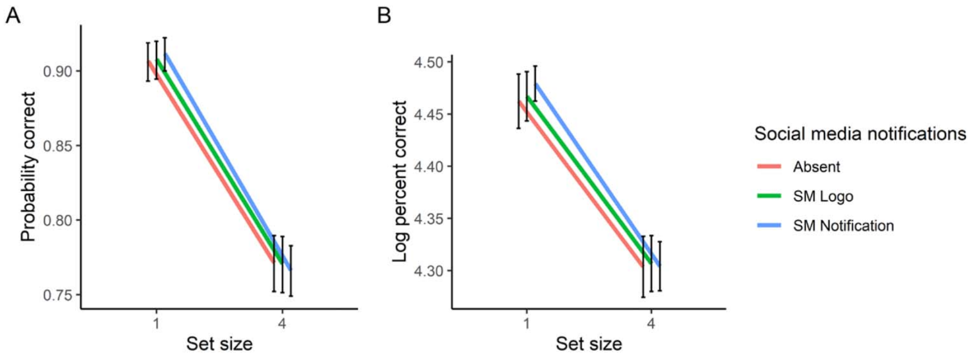

Figure 3. Probability to respond correctly (A) and Log percent correct (B) for blocks in which no additional distraction (red lines), social media logo (green lines), and social media logo + notification presence (blue lines) were compared. *Note*. Error bar denotes 95% confidence interval of the means.

the condition without the notification badge (H_2). The preregistration can be found here (https://osf.io/nv6y9/?view_only=68890dd6a01444f09db84b755dbfe568).

Methods

Participants

Two-hundred-twenty-two undergraduate students from the University of Amsterdam participated in the experiment online through a browser, in exchange for course credits. The study was approved by the Ethics Review Board of the University of Amsterdam. In line with our preregistration, trials with very fast response times and omission errors (9.94% of the trials) and participants who performed below the chance level (N = 11) were excluded from the analysis. We excluded an additional of 5 participants who had fewer than half of the total trials after the exclusion of trials with very fast response times (<200 ms) and omission errors. The final sample consisted of N = 206 participants.

Materials and Design

Our task was programmed and implemented in OpenSesame (Mathôt et al., 2012) with the OsWeb extension for online testing and data collection. Data collection was done through JATOS (Lange et al., 2015), which was hosted in the MindProbe server (https://mindprobe.eu/). All surveys were implemented in the Qualtrics survey system.

Modified Change Detection Task

The task was similar to what we used in Experiment 1 with two major exceptions. First, social media presence was manipulated across trials, as opposed to across blocks as in Experiment 1. Second, we added a block in which only the notifications presence was manipulated (Figure 1B). In the social media comparison block, in addition to the array, social media apps logos with notifications were presented equally often to the left or to the right of the presentation array in 50% of the trials. However, in the social media *notifications* comparison block, social media logo was always be presented in conjunction with the memory array; in 50% of the trials, these logos contain a notification badge symbol while in the other 50% they did not (see Figure 1B). The comparison blocks will be analyzed separately, which creates a 2 (array set size, one or four) × 2 (social media (notifications) present versus absent) within-subjects design. During practice trials, a small smiley is shown following a correct response. In nonpractice trials, no feedback was provided to participants. Participants completed 10 practice trials, after which they completed two blocks of 200 trials per block, of which 50% contained social media logos and notifications. The block order was counterbalanced across participants.

Modified Online Vigilance Scale

To measure to what extent participants orient their attention in general to social media, participants filled in the 12-item online vigilance scale (Reinecke et al., 2018). Item wordings for salience (e.g., "My thoughts often drift to *social media* content"), reactibility (e.g., "When I receive a *social media* message, I immediately give it my full attention"), and monitoring (e.g., "I constantly monitor what is happening on *social media* presently") were modified with an emphasis to social media as opposed to online activities. Responses were provided in a five-point Likert scale that ranges from 1 (does not apply at all) to 5 (fully applies). This social media vigilance scores would be used as a moderator in our models to evaluate whether WM performance across our conditions varies as a function of social media vigilance. Total scores were summed across dimensions and participants were binned into low and high groups using a median split.

Procedures

Participants took part in the experiment online through their internet browser. To ensure control for stimulus size, they were instructed to perform a credit card task (Li et al., 2020), in which they had to resize their browser screen so that a shown rectangle would have the same size with that of an actual credit card. This would help to ensure that our stimuli would be presented in the same size regardless of participants' monitor screen size and resolution. Upon finishing the experiment, a redirect link would lead participants to a Qualtrics survey in which they can provide their demographics and fill in the additional questionnaires. The experiment took about 20 min to finish.

Deviation From Preregistration

In the preregistration, we indicated that we would use *K* working memory capacity (Cowan, 2000; Rouder et al., 2011) as the primary outcome measure. However, since we are interested in working memory accuracy as opposed to working memory capacity, we revised the outcome measure as the probability to respond correctly to a trial instead.

Results

We constructed a linear mixed model with accuracy as the outcome measure, array set size and social media notification presence as fixed effects, and participants by set size as a random slope.

Our analysis revealed a significant main effect of set size, $F = 448.51$, $p < .001$, with the probability to respond correctly to a trial decreased from .91 to .77 (i.e., an odds ratio of 2.99) in the condition with a larger set size, $z = -14.66$, $p < .001$. However, there was no main effect of social media presence, $F = .107$, $p = .898$, and there was no set size × social media logo and notification badge presence interaction $F = .89$, $p = .408$ (see Figure 3A). Further pairwise comparisons revealed no significant difference between conditions with and without social media logo (absent – social media logo), OR = .995, $p = .997$, so H_1 was not supported, and no significant difference between conditions with social media with and without a notification badge, OR = .990, $p = .957$, so H_2 was not supported.

In line with the results above, our additional analysis using Log percent correct as the outcome measure (see Figure 3B) also showed a main effect of array set size, $F = 454.63$, $p < .001$, $\eta_p^2 = .31$, but no significant main effect of social media notification, $F = .426$, $p = .653$, $\eta_p^2 = .0008$, and No Significant Array Set Size × Social Media Notifications Presence interaction, $F = .445$, $p = .641$, $\eta_p^2 = .0008$.

In an exploratory analysis, we also added social media vigilance as a moderator. Our results revealed a main effect of array set size, $F = 430.52$, $p < .001$, a main effect of social media vigilance, $F = 4.62$, $p = .032$. Pairwise comparisons showed that overall, participants with social media vigilance scores above the median value ($n = 93$) were less likely to respond correctly to a trial compared to their counterpart ($n = 106$; (a decrease from .87 to .84; an odds ratio of 1.24). We also found a three-way array Set Size × Social Media Presence × Social Media Vigilance interaction, $F = 6.48$, $p = .002$, but the remaining main effects and interactions were not statistically significant, all F's < 1.03, all p's < .357, see Figure 3. The three-way interaction appeared to be driven by a steeper slope over set size for participants with high social media vigilance scores (blue vs. red and green lines at social media vigilance = high; $z = 14.79$, OR = 3.58, $p < .0001$ for SM notification vs. $z = 10.37$, OR = 2.98, $p < .0001$ and $z = 12.06$, OR = 3.28, $p < .0001$ for absent and SM logo, respectively). Additionally, participants with high social media vigilance scores performed poorer in conditions with social media notification present compared to that with logo only, $z = 3.11$, OR = 1.22, $p < .023$.

Discussion

Experiment 2 showed that VWM performance was not affected by the presence of social media and/or notification badges. These results indicate that overall, when additional information regarding social media and its notification was intermixed within the trials, participants did not orient their attention to this information, and thus, task performance was unaffected. Yet, this effect might be moderated by an individual differences factor, namely social media vigilance. Specifically, individuals with high social media vigilance appeared to be especially distracted by the presence of social media notifications in a condition with a larger set size.

Experiment 3

Experiment 3 aims to further replicate and disentangle the found effects. First, we wanted to replicate the findings from Experiment 1, namely that participants showed worse working memory performance in the conditions where social media notifications were present. In addition, to further disentangle whether the found effects were unique to the social media logos and not generalizable to any visual distraction, we expanded our types of visual distractors into (1) social media logo with notification badge, (2) social media logo without notification badge, and (3) colored squares with unrelated colors in the same shape and size (see Figure 1B). We hypothesized that WM performance would be worse in conditions where social media (i.e., logos and notifications) distraction occurs compared to the conditions with other types (i.e., colored squares) or no distraction. Finally, the aim of Experiment 3 was to replicate the findings related to online vigilance in Experiment 2, namely the advantage of individuals with low social media vigilance scores.

Methods

Participants

One-hundred-ninety-two undergraduate students from the University of Amsterdam participated in the experiment online through a browser, in exchange for course credits. The study was approved by the Ethics Review Board of the University of Amsterdam. Due to data collection occurring during summer holidays and at the time when many participants had completed their course credits, many participants opened, but did not finish the experiment. Seventy participants finished the experiment. Trials with very fast response times and omission errors (8.68% of the trials) were removed from the final analysis. Two participants were excluded due to excessively large number of error/very fast trials. The final sample consisted of 68 participants.

Materials, Design, and Procedure

Our task was programmed and implemented in OpenSesame (Mathôt et al., 2012) with the OsWeb extension for online testing and data collection. Data collection was done through JATOS (Lange et al., 2015), which was hosted in the MindProbe server (mindprobe.eu). All surveys were implemented in the Qualtrics survey system. Analysis script, anonymized data, and experiment script are available on OSF (https://osf.io/5rfzn/).

The modified change detection task was similar to what we used in Experiment 2 with one exception, namely that one additional type of distractors was added: a square that resembles an app icon in an unrelated color (see Figure 1). The colored squares were added to help us discern particular effect of social media characteristics (e.g., its logo or associated color) with other types of visual distraction. Thus, to contrast this type of distraction as much as possible from social media characteristics, we picked the square colors from the inverse of the main color of a social media logo that we use in the other conditions on its corresponding column (e.g., the brown color on the top left is the inverse of the blue color of Facebook). These additional distractors thus create a 2 (array set size, one or four) × 4 (distractor types) within-subjects design. Participants completed 10 practice trials, after which they completed one block of 192 trials with a set size of 1 with intermixed types of social media distractions followed by one block of 192 trials with a set size of 4. The block order was counterbalanced across participants. Upon finishing the experiment, participants completed the modified online vigilance scale that we also used in Experiment 2. The procedure was similar to that in Experiment 2. The experiment took about 20 min to finish (Figure 4).

Results

We constructed a linear mixed model with accuracy as the outcome measure, array set size and distractor type as fixed effects, and participants by set size as a random slope. The analysis revealed a significant main effect of set size, $F = 221.84$, $p < .001$, with the probability to respond correctly to a trial decreasing from .92 to .72 (i.e., an odds ratio of 4.35) in the condition with a larger set size, $z = -11.957$, $p < .001$. There was also a distractor type effect, $F = 3.97$, $p = .008$; further pairwise comparisons, however, revealed that this effect was driven by worse

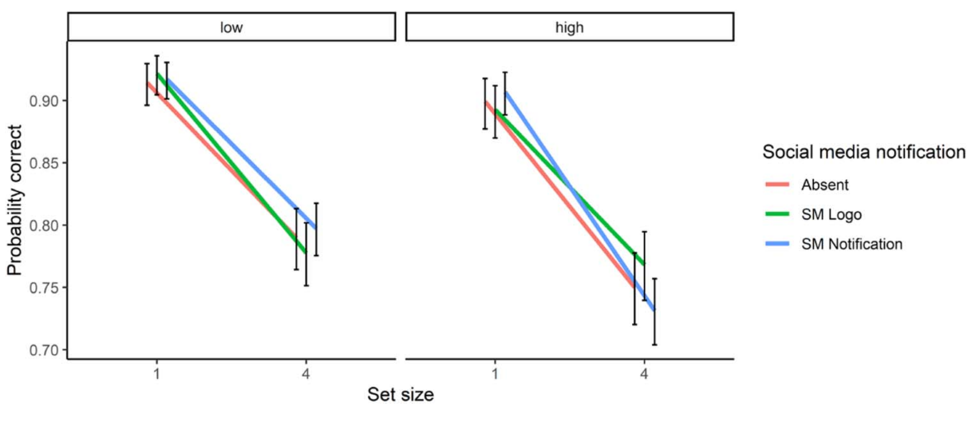

Figure 4. Probability to respond correctly with social media vigilance as a moderator in the social media notifications comparison block. *Note*. Error bar denotes 95% confidence interval of the means.

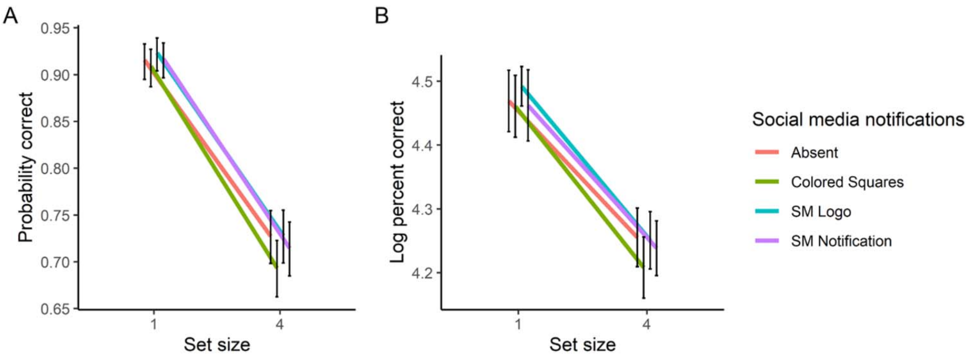

Figure 5. Probability to respond correctly (A) and log percent correct (B) as a function of set size and distractor type. *Note*. Error bar denotes 95% confidence interval of the means.

performance under the colored squares distraction type compared to the condition with social media logo (Color—Logo; $z = -3.34$, $p = .004$, OR = .837). The other comparisons revealed no further significant differences, all $|z|$'s < 2.38, all p's > .081 (Figure 5). There was no set size × distractor type interaction, $F = 0.36$, $p = .779$.

However, our additional analysis using Log percent correct as the outcome measure (see Figure 3B) showed only a main effect of array set size, $F = 324.08$, $p < .001$, $\eta_p^2 = .41$, no significant main effect of social media notification, $F = 1.59$, $p = .190$, $\eta_p^2 = .01$, and no significant array set size × social media notifications presence interaction, $F = .46$, $p = .708$, $\eta_p^2 = .003$.

Like in Experiment 2, we further added social media vigilance as a moderator. This model showed a main effect of array set size, $F = 209.35$, $p < .001$, and social media presence, $F = 4.75$, $p = .003$, but there was no main effect of social media vigilance, $F = 1.09$, $p = .294$, no significant interactions of social media vigilance with set size, $F = 1.35$, $p = .245$, and social media distraction, $F = 1.59$, $p = .189$, and no three-way interaction, $F = 2.23$, $p = .083$. No further pairwise comparisons were tested.

Discussion

Experiment 3 showed a main effect of distracting stimuli. Yet, in contrast to what we found in Experiment 1, this effect stemmed from a distracting effect of colored squares compared to social media logos instead of a distracting effect of social media logos or their notifications. Even though participants with higher social media vigilance scores performed numerically worse in the task, we also did not replicate the moderating effect of social media vigilance from Experiment 2. It should be noted, however, that the lower statistical power in Experiment 3 ($n = 70$) compared to Experiment 2 ($N = 206$) may have prevented us from detecting any effects of social media vigilance.

General Discussion

In the current visually rich, rapidly changing media environment, our ability to retain and process large amounts of visual information has never been more valuable. This ability to process visual information is dictated by our visual working memory capacity, that is, typically estimated using a change-detection task. In this study, we investigated to what extent the presentation of social media logos and their notification badges – two very ubiquitous visual stimuli in the digital media environment – disrupt visual working memory retention performance in a modified change detection task. Participants had to retain information about one or four geometric objects with varying colors (i.e., a memory array) and determine in the second presentation of the memory array whether one of the objects had changed its color. Importantly, in some of the blocks (Experiment 1) or trials (Experiments 2 and 3), social media attributes (Experiments 1 and 2) or a totally unrelated distractor (colored squares, Experiment 3) was shown in conjunction with the target array. We hypothesized that the presence of social media distractors may increase the salience of the whole presentation set and (1) it may trigger additional cognitive mechanisms to process the distractors, therefore disrupting performance or (2) it may increase vigilance and potentially improve performance.

The studies have three main findings. First, over all three experiments, the findings support neither the brain-drain nor the vigilance hypothesis. Although in Experiment 1, a small decrease in VWM was found, this effect could not be replicated neither in Experiment 2 nor in Experiment 3. This indicates that during a short visual memory task, participants are able to focus attention even if potentially distracting social media logos are present. This finding is in line with previous studies that also did not find performance decrements for a visual search task when social media logos were present (Johannes, Dora, & Rusz, 2019). Similarly, Gao et al. (2019) did not find any effects of social media logos on a Go/NoGo task, neither for excessive nor nonexcessive social media users. In sum, these findings seem to indicate that at least within a short cognitive task, participants are very well able to focus their attention even if distractors are present.

Interestingly, studies conducted in more ecological valid set-ups found that social media use is related to being distracted. For example, Siebers et al. (2022) found in an experience sampling study that during times that adolescents had used more social media they also were more distracted. Similarly, Meier (2022) found that habitual social media checking was related to task delays. This discrepancy in findings between experimental lab tasks and studies conducted in the everyday lives of individuals implies that although in everyday life social media are distracting and lead to task delays and impairments, individuals are able to ignore distractors for shorter periods when conducting a lab task. This reasoning is in line with findings by Koessmeier and Büttner (2022) who showed with an eye-tracking study that participants can regulate their attention to smartphone distractors during task performance quite well and are more likely to glance at their phones during task breaks. Thus, it seems that individuals are able to block distractors when motivated to perform well and for shorter time periods but might still have difficulties to do so in their everyday lives.

A second interesting finding of the present study is that participants seemed to be slightly more distracted by color blocks that were not related to the social media logos. Study 3 showed that participants performed less well during larger set sizes when color blocks were visible. This might indicate that social media logos and notifications have become so ubiquitous and are so familiar to individuals, that they have no additional informational value. In contrast, distractors in unrelated colors might have been surprising for individuals and have occupied cognitive resources. However, this effect needs to be interpreted with caution as the effect was small. Future studies need to replicate this effect before it can be generalized.

Finally, in Experiment 2, we found that whether social media notifications interfere with task performance depends on individual differences. The findings showed a disadvantage of participants with high social media vigilance scores; the presence of social media notification appeared to disrupt performance in this group, especially in a condition with a larger set size. However, this effect did not replicate in Experiment 3. Here, in line with our finding in Experiment 2, participants with high social media vigilance scores performed numerically worse than those low in social media vigilance, yet this difference did not reach statistical significance. One possible interpretation would be that participants with high social media vigilance scores pay particular attention to social media-related cues, and therefore when these visual cues were present, they become especially distracted and performed worse. Alternatively, participants with low social media vigilance scores did not find social media attributes, which includes social media logos with or without their notification badge, to be as ubiquitous. Thus, their presence attracts attention. In this case, the presence of social media notifications increases the salience of the target and subsequently boosts performance, which suggests that for those who are not yet habituated to social media, the presence of notification badges might provide benefits on attention alertness.

Even though our moderation effect of social media vigilance scores was small and could not be replicated, it may warrant additional exploration in future studies. Indeed, previous studies have shown that the presence of social media-related cues increased vigilance as reported in self-reports (Johannes, Veling, et al., 2019) and the number of gazes (Koessmeier & Büttner, 2022). However, even though social media-related cues seemed to invoke online vigilance, they did not negatively affect performance. This might indicate that despite higher levels of online vigilance, participants are able to regulate their attention during task performance. These findings, including ours, however, were demonstrated in nonclinical population. Social media and smartphone vigilance has behavioral characteristics, such as salience and reactivity, that largely overlap with that of addiction (e.g., online gaming addiction; American Psychiatric Association, 2013). Thus, one potential venue for future research would be to compare both self-reports and cognitive performance of people at the more extreme end of social media or online vigilance with those in the non-clinical population.

Overall, it appears that even though previous studies have shown that social media attributes were perceived as a distraction, through our series of three experiments where social media distractors were systematically manipulated, we found no evidence that the distraction that might be induced by social media attributes may negatively affect performance. Especially, in a change detection task, social media attributes did not appear to be encoded in visual working memory, of which additional processing may decrease one's ability to identify a target's change. Given that in Experiment 3, where a totally unrelated distraction did negatively affect performance, it seems that social media attributes are so ubiquitous that their visual presence seems to not attract attention.

Limitations and Future Directions

The three experiments indicated that social media logos do not interfere with individuals' visual memory performance. However, it is important to point out the artificial character of the experimental set-up. Importantly, although social media logos were presented, this experience might not accurately reflect the daily experience of social media users. Importantly, there was no possibility for participants to interact with the notifications (e.g., to open them). Thus, the rewarding nature related to typical social media interactions was not given, and thus, participants might have been better able to ignore these distractors. To further understand this, a study is needed in which participants are presented with social media information and are allowed to interact with them while they perform a primary task (Salvucci & Bogunovich, 2010; Stothart et al., 2015). Ideally, future studies might consider more ecologically valid study set-ups such as observational studies during real-life task performance.

In addition, the logos presented in the current studies were limited to visual information. In real life, notifications might oftentimes be accompanied by sounds or tactile information (i.e., vibrations). Adding sounds to the experimental set-up would provide useful information about the distracting nature of real-life notifications.

Finally, future studies might want to further examine individual differences. Although the findings from the present studies are mixed regarding social media vigilance, it could be that some individuals are more distracted by social media than others. For example, participants in our studies were university students who grew up with social media and are highly accustomed to social media notifications. For older age groups, or new social media users, these social media attributes might be more distracting. Studying various populations might thus be a fruitful endeavor for future studies.

Conclusion

In three experiments, we showed that social media-related information does not disrupt visual working memory performance. In our experiments, however, participants did not actually interact with social media. Therefore, to what extent social media information does distract task performance in daily life needs further research using a more ecologically valid setup where participants actually interact with their own social media.

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To the best of my ability and knowledge, I have provided all original materials and clear references to all other materials via a stable online repository.

Data and Materials for Experiments 1–3 are available at https://osf.io/5rfzn/ (Wiradhany et al., 2023).

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