Individual and Society | Človek a spoločnosť
ISSUE 1, YEAR 2023, VOLUME 26
doi.org/10.31577/cas.2023.01.615 RECIEVED 2 September 2022 | PUBLISHED 10 July 2023

Paying attention? An experiment of cognition and creative potential under the mere presence of a smartphone

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Kryštof Petr | krystof.petr01@gmail.com
Department of Psychology, Palacky University in Olomouc, Czech Republic
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Daniel Dostál | daniel.dostal@upol.cz
Department of Psychology, Palacky University in Olomouc, Czech Republic

Abstract | Background: While smartphones enhance communication and productivity, they may negatively affect mental health and cognitive performance. They can be distractive where the risk can have substantial consequences (e.g., in traffic, while working). Even when not in use, smartphones can be distracting and reduce cognitive capacity. This mere presence of smartphones has been described as having an adverse impact on social interaction and cognitive performance. Since creativity is also an increasingly important skill for finding new and useful ideas, the impact of mere presence on creative thinking should be investigated, as considerable evidence is missing. Objectives: The first goal of this study is to replicate the reduction effect of the mere presence of one's smartphone on cognitive capacity and test the effect of the dependency relationship on this hypothesized reduction. The second goal is to investigate this effect on divergent thinking. Methods: A between-subject experiment was carried out with two groups. One group was instructed to leave their phones with their other belongings at the front of the testing room (no phone group) while the second group could keep their phones with them and were instructed to place them on the desk with the screen down, volume and vibrations off. Both groups were tested with tests of attention, fluid intelligence, two divergent thinking tasks (verbal and figural), and the Smartphone Addiction Scale. The data from 47 participants were used to test the hypotheses. Results: The study did not find an effect of mere presence on attention. The groups differed in the expected direction, but the difference was not statistically significant, $p = .592$, Vargha and Delaney's A12 = .52. There was also not a significant effect for fluid intelligence with $p = .834$, A12 = .41. For divergent thinking, Principal Component Analysis was used to generate verbal and figural scores. We did not find a significant reduction in these two scores, verbal $p = .926$ with A12 = 0.32, figural $p = .069$, A12 = .55. There was no support for a moderation effect of smartphone dependency. Discussion and conclusion: Our data do not support the mere presence effect and its negative impact on cognition or divergent thinking. We have considered the differences in the location and ownership of the phone. It can be suggested that having one's own smartphone in the field of vision but knowing it is turned off is not as distracting as having an unknown smartphone where one cannot be sure if it is on or off. Another reason is the small sample size, which affects the possibility of detecting small effects. We propose the potential detectability of these effects in larger samples and advocate for continued research on technology's impact on cognition and creativity.

Keywords | attention, smartphone, divergent thinking, mere presence, smartphone dependency

Introduction

With the rapid spread of smart technologies and smartphones in particular, many researchers have become interested in their impact on human health, behavior, and the mind. Despite the undeniable benefits such as quick communication, social connectedness, work accessibility, safety, and entertainment, the use of smartphones also comes with significant challenges. These include the adverse effects on mental health (Sohn et al., 2019), poorer well-being (Horwood & Anglim, 2019), a negative association with academic performance (Amez & Baert, 2020), lower quality of social interaction (Dwyer et al., 2018), sleep quality (Lanaj et al., 2014) and cognitive performance (Wilmer et al., 2017 for a review).

Cognitive performance has been studied extensively in connection with phones and around 55% of US responders have reported that they find their smartphones distractive (Smith, 2015). Indeed, it can be difficult to focus on tasks if one hears or sees a phone notification. As we can get over 60 notifications a day (Liao & Sundar, 2022; Sahami Shirazi et al., 2014), this can lead to a loss of attention numerous times. Even without a real notification, one can get the urge to check their phone as if it had vibrated. This phenomenon is known as phantom vibration (Deb, 2015). Around 28% of car accidents are reported to be caused by driver distraction (NCSA, 2018) and therefore, attention related to smartphones is broadly studied behind a steering wheel. In driving simulations, young drivers have up to an 8.3% higher risk of an accident due to smartphone use, and this risk is even higher among the elderly at 134.5% (Ortiz et al., 2018). In addition to drivers, naturalistic observations have shown that pedestrians also put themselves into more dangerous situations if they use smartphones (31% versus 19% for non-users) (Horberry et al., 2019).

The long-term effects of smartphone use on attention are not well-known and no clear conclusion can be reached from previous studies (Liebherr et al., 2020). In one explorative study by Hadar et al. (2017), a group of non-users used a smartphone during a three-month intervention. The results suggest that smartphone use may be causally related to impaired numerical processing and negative social cognition effects.

The effect of smartphone distraction while driving is an example of research that is interested in the impact of technology on top-down attentional processes, i.e., processes where attention is consciously focused and executed. The complementary process is bottom-up, which is automatic and driven by the importance of stimuli (Connor et al., 2004; Katsuki & Constantinidis, 2014). Research has indicated that more personally relevant triggers can interfere with attention and concentration (Wingenfeld et al., 2006). Phones can be viewed as socially relevant stimuli as they help us fulfill our social (Kardos et al., 2018) and informational needs (Atchley & Warden, 2012).

For most users, their smartphone is close to them for most of the day and they spend around 3.7 minutes on average every hour interacting with them (Christensen et al., 2016). However, while doing other tasks and activities, this device might still have an impact on the mind and behavior, even without direct interaction. The distraction by the mere presence of one's phone has mainly been studied within cognitive functions (Thornton et al., 2014) and social interactions (Przybylski & Weinstein, 2013). In their first study with 57 students (Thornton et al., 2014), a group of participants in a laboratory setting had the experimenter's cell phone on the table in front of them while being given two concentration tasks (The Trail Making Test (Reitan, 1992) and Digit cancellation task (Teuber, 1972)). In contrast, the control group had a similarly sized spiral notebook on the desk in the parallel position. In both tasks, the groups only differed in the more difficult parts or in the accuracy of the performance. The experimental group was significantly more distracted by the mere presence of a cell phone. A second study (47 participants) replicated the effect in a class setting with similar results; the group performance differed in more difficult tasks as a result of the cell phone presence.

Similar results have been reported by Ward et al. (2017) in their study of 548 undergraduates. They tested three groups (smartphones in a different room, in a bag/pocket, or on the table) in the differences in measures of available cognitive capacity (working memory capacity test and fluid intelligence test). The results suggest a significant trend of decreasing available cognitive capacity with increasing smartphone salience. In a follow-up study with 296 undergraduates, the condition of power mode was introduced with all participants randomly assigned to the on or off mode of the phone. While the same trend was found, there was no significant relationship found with the power condition. Moreover, the mere presence effect was significant with the working memory capacity task but not with the Go/No-Go task, which is a measure of sustained attention (Bezdjian et al., 2009). A moderation effect of smartphone dependence was found for the working memory capacity measure with more dependent participants performing the worst in the phone-on-a-desk group. On the other hand, the best performance was measured for the highly (+1 SD) dependent group in the other-room condition, suggesting a strong smartphone dependence-salience relationship.

In a driving scenario, Strayer and Johnston (2001) found no significant difference in mistakes made between participants having a conversation via handheld or hands-free cell phones during simulated driving. However, both cell phone conditions made more mistakes than listening to a radio broadcast. Therefore, the effect of phone usage distraction was present, although not the effect of mere presence. In their conceptual replication and extension of Thornton et al. (2014), Ito and Kawahara (2017) suggest that a mobile phone in the visual field is distracting due to filtering costs (in comparison to a notepad). This has also been supported by the finding that participants with lower scores on Internet use/attachment had better performance in a cognitive task when a device was in sight than the higher scoring group. This further supports the role of smartphones as relevant stimuli and consequently, higher salience with higher importance of a device to its user. In the current study, the first goal is to replicate the concept of the mere presence effect on available cognitive domains and to test the moderation of smartphone dependence on this effect.

In addition to cognitive skills, being able to come up with more creative ideas has become a crucial skill in increasingly more jobs. UNESCO has selected creativity as one of the key competencies for the future (Marope et al., 2017). One part of being creative is to generate novel and useful ideas in an open-end problem solution. This ability is known as divergent thinking (Guilford, 1967). While cognitive performance has been extensively studied with smartphones, less research has been done in creative domains. Although people generally believe that smartphones have a generally negative effect on creativity, data has only offered limited evidence to support this belief. Indeed, only a marginally inconsistent correlation between screen time and divergent thinking has been found (Olson et al., 2022). Unfortunately, we have not found a study looking at the effect of the mere presence of one's smartphone on divergent thinking. Therefore, the second objective of the present study is to test the impact of the presence of smartphones on divergent thinking performance.

The current study aims to replicate the mere presence of a smartphone in cognitive capacity and divergent thinking, and also the dependency of the smartphone as a possible moderator of this relationship.

Methods

Participants

Fifty-three university students participated in the study with the possibility of winning cinema tickets as a reward. The required sample size was estimated based on previous studies (Thornton et al., 2014) with the maximum feasibility of available resources. The study was promoted as a research study of creativity and mental abilities. As smartphones were not mentioned in the promotion or enrollment criteria, data from six participants could not be used for the analysis as they reported not owning one. Two more participants were excluded from the divergent thinking analysis as they did not complete two tasks. Forty-seven participants were used in the analysis of which twenty-four were in the experimental condition. The research sample consisted of 77% females with an average age of 21.77 (SD = 3.18). Table 1 shows the descriptive statistics of the sample. The data were collected in February and March 2019. The study was approved by the Ethics Committee at the Department of Psychology.

Table 1 *Descriptive statistics of the research sample*

Characteristic	Modality	Mean; SD or %
Age		21.77; 3.18
Sex	Female	77.4%
	Male	22.6%
SP ownership	Yes	88.6%
	No	11.3%
Field of study	Humanities	47.1%
	Languages	9.4%
	Natural sciences	13.2%
	Art	9.3%
	Education	1.9%
	Combinations	11.29%
	Not reported	3.7%

Note. SP = Smartphone, SD = Standard Deviation

Design and procedure

The present study used a between-subject experimental design with a random condition assignment at a group level. There were several time slots reserved for the experiment and participants could choose one when registering for the study. The participants then arrived at the pre-selected time in the research room. Those in the control condition (no phone) were instructed to leave their belongings, including their mobile phones, at the front of the room in a hall which could be closed by a door from both sides. A research assistant was always present and was introduced as the person responsible for supervising the belongings. The experimental group was instructed to place their phones in front of them with the screen down to be used later. First, the participants completed the Alternative uses task, followed by the figural part of Torrance's divergent thinking test, the d2 attention test, the Vienna Matrix test and the Short Version of the Smartphone Addiction Scale with demographics. The real purpose of the procedure was revealed to the participants in the final part. The option to not include their records in the study was given to them although none of the participants opted for this.

Statistical analysis

First, a Welch t-test on the age between the experimental and control conditions was used to ensure that the groups were randomly created. This did not show a significant age difference, $t(50.82) = 1.39$, $p = .169$. Regarding sex, a Chi-square test showed that sex did not differ either, $X^2(1) < 0.01$, $p = .965$. Therefore, randomization at the group level was successful. Nonparametric Mann-Whitney U tests were used to test the differences between the groups while Vargha and Delaney's A_{12} (2000) was calculated as the effect size. The A_{12} describes the probability that a randomly selected participant from the group without a phone would have a greater score than a randomly selected participant from the group with a phone. Since multiple divergent thinking scores were used for measurement, a Principal Component Analysis (PCA) was used to explore the underlying structure and reduce the number of dimensions for hypothesis testing. The package psych (Revelle, 2020) was used for the calculations with varimax rotation. Regression models were performed to test the moderation effects.

Materials

Alternative Uses (AU)

There were two tasks used to assess verbal and figural divergent thinking potential. In the Alternative Uses task (Guilford, 1967), participants are asked to write down as many possible uses of an ordinary item as possible. The item selected for this study was a brick, one of the most used. There was no time limit given in the instructions, otherwise, the instruction was the same as in Gilhooly et al., (2013). Four attributes were measured to create the total scores – fluency (number of created responses), flexibility (number of unique response categories), originality (frequency of a response) and elaboration. The latter describes how much the response is elaborated from the simplest description of a core idea behind the response. As this method has not been standardized in the Czech environment, frequency tables were created to score flexibility and originality from all the responses in the sample. The time limit was set to 3 minutes.

Torrance's Test of Creative Thinking (TTCT)

For the second part of the creativity assessment, a single figural task called the circles was used from the Slovak version of Torrance's Test of Creative Thinking (Jurčová, 1984). The goal is to finish the preprinted circles. The same four scores were measured as in Alternative Uses: fluency, flexibility, originality and elaboration. Frequency tables to assess flexibility and originality were used from the manual. The reported mean reliability between raters is $r = .97$, with a mean reliability of the test rest $r = .67$.

d2 Test of Attention (d2)

The d2 is a cancellation test based on the presentation of visually similar stimuli (Balcar, 2000; Brickenkamp & Zillmer, 1998). It is used as a brief and reliable measure of attention and concentration processes. Participants have to cancel a specific target character and ignore distractors in 14 rows, with a time limit of 20 seconds per row. A concentration performance score was used which is the total number of correctly canceled items minus the total number of incorrectly canceled items. The Czech manual reports a reliability of $r > .90$ (Balcar, 2000).

Vienna Matrix Test (VMT)

The VMT (Formann, 2002) was selected as a measure of fluid cognitive ability to assess available cognitive resources. This intelligence test was developed as a successor to Raven's matrix tests. The test consists of 24 items in Raven's style where one object is missing in the 3*3 matrix, with eight response options. The manual reports Cronbach's α = .81.

Smartphone Addiction Scale – Short Version (SAS – SV)

In order to measure smartphone addiction as a possible moderator of the effect of mere presence, a self-report questionnaire by Kwon et al. (2013) with ten items and a six-point Likert scale (1: 'strongly disagree', 6: 'strongly agree') was used. The Czech version was translated by Švidrnochová (2018) and has Cronbach's α = .85 in the original translated version. In the current study α = .74.

Results

Main Analysis

As the mere presence effect was hypothesized, all the reported p-values were one-tailed. Most of the variables did not follow a normal distribution and therefore, nonparametric tests were used. All the analyses were performed in R 4.1.3 (R Core Team, 2022). Table 2 presents the descriptive statistics of the cognitive variables according to the groups.

Table 2 *Descriptive statistics for the task performance assessments*

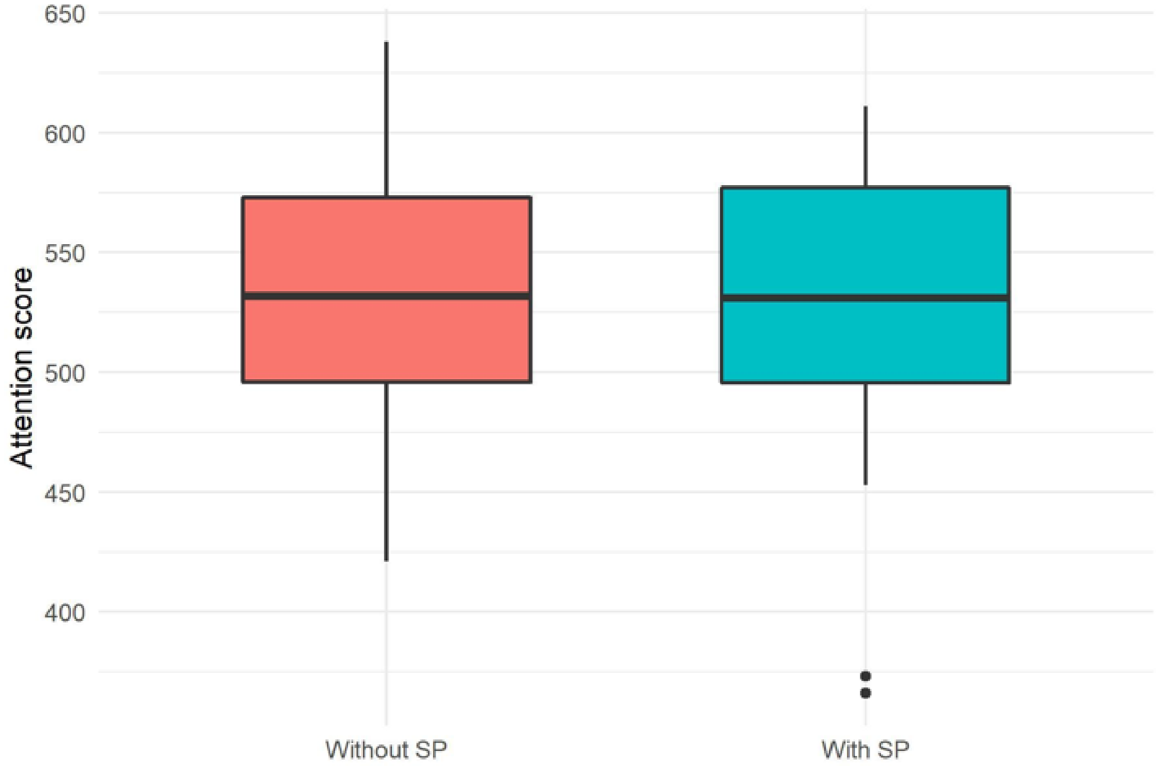
	Without SP			With SP		
Scores	Mean	Median	SD	Mean	Median	SD
Attention (d2)	531.43	532	58.76	523.66	531	64.90
Fluid intelligence (VMT)	17.47	18	4.9	18.45	19	2.95

Notes. SP = Smartphone, SD = Standard Deviation, d2 = d2 Test of Attention, VMT = Vienna Matrix Test

Effect of smartphone presence on cognitive resources

It was expected that the mere presence of one's smartphone would reduce available cognitive resources, i.e., attention and fluid intelligence. First, the difference in the attention performance scores was tested using a Mann-Whitney U test, U = 287.5, p = .592. However, it was not found to be statistically significant, A_{12} = .52, indicating a slightly higher probability of having a higher scoring participant from a randomly selected pair in the group without a phone.

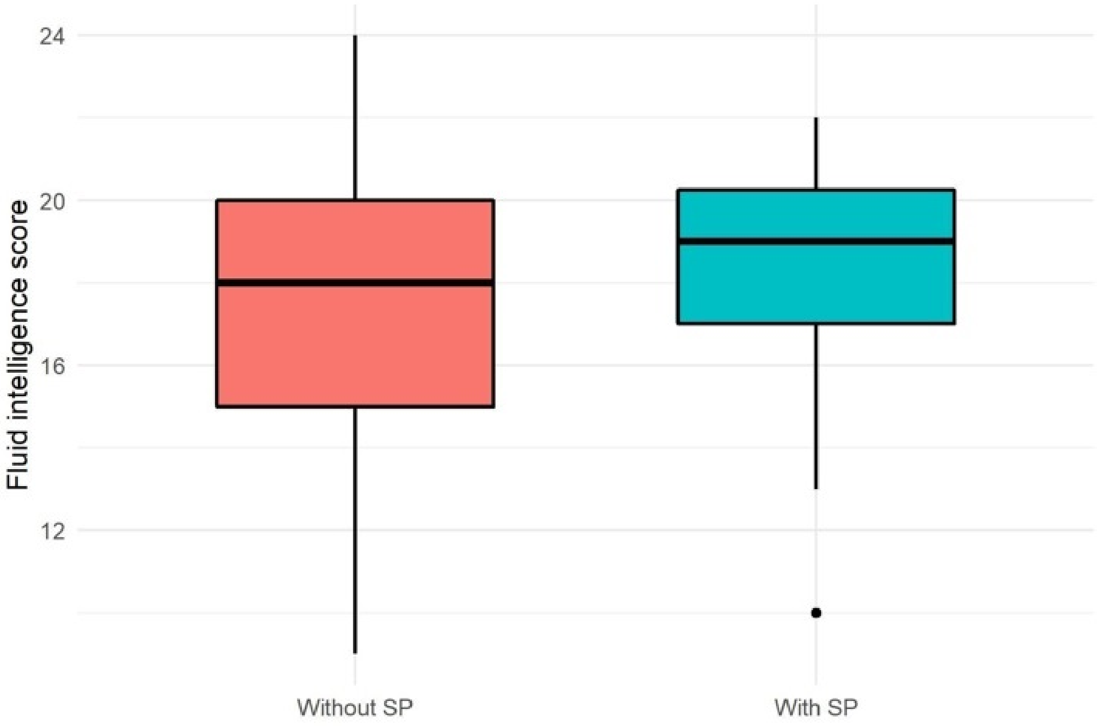
Figure 1 *Box plots of group differences in attention performance*



Notes. SP = Smartphone

A Mann-Whitney U test looked at the differences between the groups in fluid intelligence, U = 230, p = .834, A_{12} = .41. However, the experimental group was not found to be significantly different from the control group.

Figure 2 *Box plots of group differences in fluid intelligence performance*



Notes. SP = Smartphone

Effect of smartphone presence on divergent thinking

Two main components were extracted with the Principal Component Analysis. They both demonstrate the figural and verbal method differences almost perfectly. The factor loadings can be found in Table 3.

Table 3 *Divergent thinking loadings from the Principal Component Analysis*

Task	Score	Figural component loadings	Verbal component loadings
AU	Fluency	0.26	0.89
(verbal)	Flexibility	0.15	0.82
	Originality	0.32	0.90
	Elaboration	-0.02	-0.58
TTCT	Fluency	0.90	0.22
(figural)	Flexibility	0.91	0.19
	Originality	0.77	0.08
	Elaboration	-0.70	-0.14

Notes. AU = Alternative Uses, TTCT = Torrance's Test of Creative Thinking

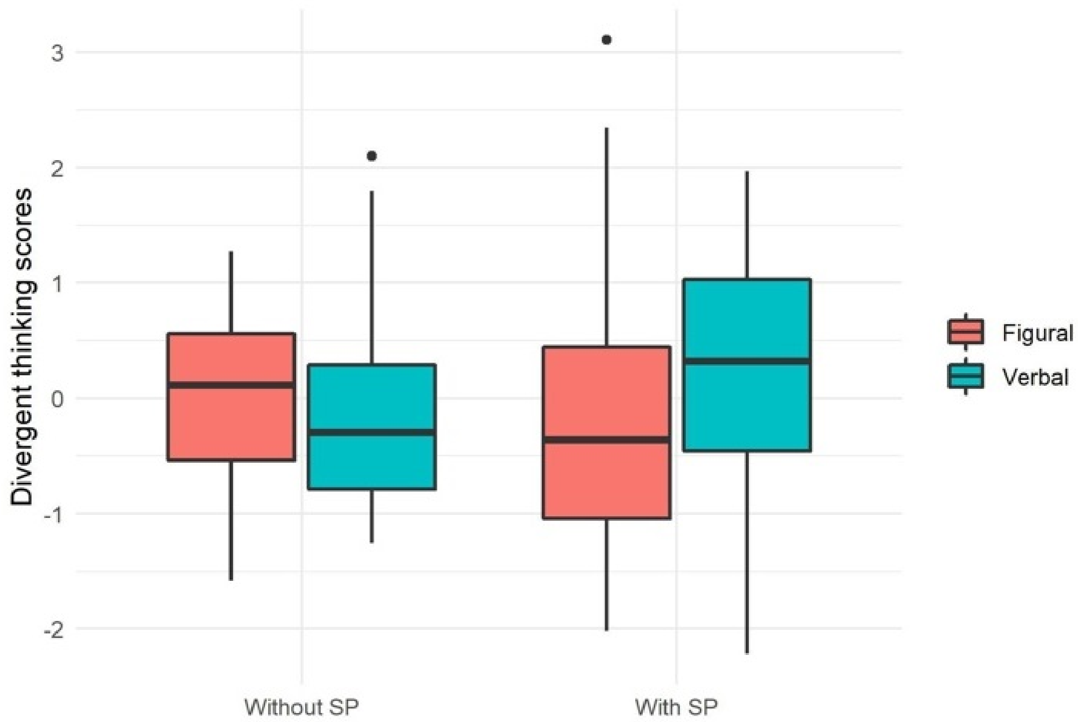
The component scores for both the figural and verbal creativity scores were used to test the differences between the groups. The score for figural divergent thinking was W = 305, p = .069, A_{12} = .55 and the score for verbal W = 179, p = .926, A_{12} = 0.32. The mere presence of a smartphone was not found to have an effect on creative potential either. The descriptive statistics are presented in Table 4.

Table 4 *Descriptive statistics for divergent thinking assessments*

		Without SP			With SP		
Scores		Mean	Median	SD	Mean	Median	SD
AU							
	Fluency	7.62	7	2.80	8.46	9	2.93
	Flexibility	6.90	6	2.64	7.33	7	2.68
	Originality	11.67	11	6.27	13.50	12.5	7.45
	Elaboration	1.95	1.67	1.79	1.37	1.11	1.68
TTCT							
	Fluency	13.74	13	4.69	12.35	11	7.92
	Flexibility	11.22	12	4.3	9.52	10	5.44
	Originality	17.13	17	7.21	14.39	12	9.60
	Elaboration	2.94	2	3.37	3.64	2.5	4.23
Creativity components							
	Verbal	-0.14	-0.30	0.91	0.23	0.32	1.12
	Figural	0.10	0.11	0.75	-0.23	-0.36	1.21

Notes. SP = Smartphone, SD = Standard Deviation, AU = Alternative Uses, TTCT = Torrance's Test of Creative Thinking

Figure 3 *Box plots of group differences in divergent thinking performance*



Notes. SP = Smartphone

Moderation effect of smartphone addiction

In order to test the hypothesis of moderation, regression models were created with attention and fluid intelligence as the dependent variables and group membership, SAS score and their interaction as the independent variables. Even though the dependent variables did not follow a normal distribution, the regression method was used due to marginal sampling skewness of the residuals (>-0.75) for all models. In both models, the interaction effect was not significant for attention score = 0.18, 95% CI [-0.44, 0.79], p = .559 or fluid intelligence = 0.41, 95% CI [-0.18, 1.00], p = .172. There were similar results found for the verbal and figural divergent thinking scores where the effect of the interaction on the former was = -0.05, 95% CI -0.67, 0.57] with p = .708, and for the latter = 0.21, 95% CI [-0.42, 0.85], p = .439. The mean of SAS in our data was 27.23 with SD = 6.44.

Exploratory analysis

In the last step of the analysis, Spearman correlations between cognitive and creative measures were tested. The results are presented in Table 5. There was no specific hypothesis prepared.

Table 5 *Spearman correlations of cognitive and divergent thinking variables*

		1	2	3	4	5	6	7	8	9	10	11
1	Fluid intelligence (VMT)											
2	Attention (d2)	-.13										
3	Figural DT	-.06	.19									
4	Verbal DT	.03	.14	-.02*								
5	TTCT F	-.01	.32*	.89*	.15*							
6	TTCT Fx	-.04	.31*	.90*	.14*	.95*						
7	TTCT O	-.09	.08	.79*	-.01	.56*	.56*					
8	TTCT E	.06	-.18	-.65*	-.23*	-.57*	-.57*	-.38*				
9	AU F	-.04	.20	.27*	.89*	.36*	.35*	.28*	-.39*			
10	AU Fx	-.03	.27	.27*	.87*	.33*	.33*	.26	-.42*	.94*		
11	AU O	.02	-.04	.10	.85*	.18	.19	.18	-.30*	.80*	.74*	
12	AU E	-.04	-.18	.04	-.57*	-.22	-.17	.19	.13	-.30*	-.31*	-.27

Notes. N = 50, VMT = Vienna Matrix Test, d2 = d2 Test of Attention, DT = Divergent thinking, AU = Alternative Uses, TTCT = Torrance’s Test of Creative Thinking, F = Fluency, Fx = Flexibility, O = Originality, E = Elaboration, *p < .05

Discussion

The current study had two research goals. The first was to experimentally replicate the mere presence effect of one's smartphone on available cognitive capacity in a sample taking into account the degree of importance of the device as measured by an individual's self-reported smartphone dependency. The second was to investigate the same effect on divergent thinking skills. Despite notable evidence from previous studies, the current study did not find a reduction in attention performance in the presence of a smartphone. This is in contrast to previous studies e.g., Thornton et al., 2014), which have described this effect. In their study, the mean effect size was found to be $_p^2$ = .11 (for Study 1) which is considered a medium or large effect. In a following study by Ward et al. (2017), the effect size for attention span was $_p^2$ = .014 which could be considered a small effect. This difference is not surprising as the latter study had a larger sample size (almost ten times more) and therefore enough power to discover even a smaller effect. While the current results showed a difference in attention performance between the groups in the expected direction, it was not found to be statistically significant. Hence, it can be suggested that the present study lacked the potential power to discover this small effect. In terms of the measurements, similar to Thornton et al. (2014), where The Trail Making Test (Reitan, 1992) and Digit cancellation task (Teuber, 1972) were used, in our study, assessment of attention was done by d2 Test of Attention. This test is used in applied settings, as a short and efficient assessment with good overall validity (Balcar, 2000). Therefore, it is possible to rely on these results regarding measurement quality.

Another factor that differed in comparison to Ward et al. (2017) is that they used a computer-based assessment of working memory capacity unlike the current study which used paper-and-pencil tests like Thornton et al. (2014). It is possible that working on a paper might put a smartphone more easily in the field of vision and thus make it more distracting. This is supported by Ito and Kawahara (2017) who used a computer-based task but with an attached smartphone with a flexible-arm clip to keep the researcher's device in a specific place. Their effect size for the mere presence effect was $_p^2$ = .11, which is again a medium to large effect. The instructions given to participants in the current study did not specify the exact spot where they should place their phones; only that it should be on their desk with the screen down and both the volume and vibrations off. While the phone was their own as in Ward et al. (2017), Ito and Kawahara (2017) and Thornton et al. (2014) used the researcher's device. It would be expected that using one's smartphone would be more disturbing as it is a personally relevant stimulus (Wingenfeld et al., 2006). As phones with notifications are distracting (Smith, 2015), participants with devices in front of them that are not theirs may expect them to start ringing, as they may not be sure that they are properly turned off. Therefore, participants with their own phones, which have been turned off by themselves, might be more focused on a task as they know the phone will not ring.

Participants who were in the 'no phone' condition might have felt uncomfortable as their phone was not with them. Despite the research assistant being there to look after the phones, this may still have been an unpleasant situation where it was hard to concentrate. This specific anxiety connected to phones is known as nomophobia (King et al., 2013). For users with a high fear of not being connected, reduced learning can occur (Mendoza et al., 2018). This could support the fact that the group with phones on their desks did not have to leave any belongings in a different room and did not therefore have any anxiety-causing situations.

The second cognitive measure used was a test of fluid intelligence known as the Vienna Matrix Test. Similarly, in this task, we did not find a significant difference between groups, hence, no mere presence effect. In contrast to the attention measure, the current data do not support a similar direction of the difference. With a similar test (10-item subset of Raven's Standard Progressive Matrices), Ward et al. (2017) found a significant small effect of $_p^2$ = .015. Although the current test has a wider range (24 items) and was used with the original instructions and time, the possible effect size would be smaller than can be reliably found with the current sample size. Since the test is used in applied settings to measure IQ (Formann, 2002), it might not tap the currently available cognitive resources but the stable general mental ability of participants.

Although creativity is an important skill, the question of technological influence on the ability to come up with novel ideas has not been studied extensively. The present study used two different measures of divergent thinking to capture the potential diversity better. In order to extract the common variance, principal component analysis was carried out and yielded two creativity components: verbal and figural. Neither of them demonstrated a significant difference between the phone location groups although the figural score was different between the groups and showed a 'trend', as $p < .1$. The group without a phone also scored better than the group with the phone which could be an indication of the mere exposure effect. On the contrary, the difference was in the opposite direction for verbal divergent thinking i.e., the group without phones performed worse. Since this is unambiguous support of the effect on divergent thinking, it can be concluded that the data did not demonstrate a significant and stable effect resulting in poorer performance under the mere presence of one's smartphone.

Given the originally expected effect was not observed, the dependency-salience relationship was not supported by the data either. The mean score of the Short Version of Smartphone Addiction Scale ($M = 27.23$) was just slightly higher than in the original study ($M = 25.26$) by Kwon et al. (2013), and 30% had a score equal to or higher than the cut-off suggested by the original authors. An analysis on this subsample was not carried out however as the number of participants would have been too small to rely on such a result.

In the exploratory analysis, the focus was on the relationship between the cognitive divergent thinking measures. There was no relationship found between these two groups except for a positive correlation between attention and figural flexibility and fluency. This is contrary to previous findings by Necka (1999) who found a negative relationship. Since both divergent scores are based on the number of ideas and their categories, but not elaboration or originality, simply being able to focus on a task and bring more ideas might have been a stronger factor. However, no stable relationship between either verbal and figural divergent thinking abilities and cognitive factors was found.

As already discussed, the current study lacked the necessary power to confidently find an effect of reducing cognitive resources by the mere presence of a smartphone. Based on previous studies, this effect seems rather small in effect size and therefore a larger sample size is needed. The study was based on a single-point assessment and therefore a momentary condition of participants might have played a role, e.g., time of the day, having a coffee before, and so on. The participants were not instructed before the experimental session and there was no measurement of nomophobia used. Therefore, it is not possible to conclude whether participants in the 'no phone' condition were more anxious because their phones were in the other room. Finally, only university students participated in this study and thus selection bias might be present. As a result, the generalizability of the results is limited.

Due to the null results, this research did not support the idea that the effect of mere presence is present, especially in small samples. In the future, more research on the impact of technologies on human creative processes, from momentary divergent thinking to long-term creative processes, and how it is affected by possible distractions from smartphones would be of interest.

Acknowledgments

Data collected for this study were originally used for the first author's bachelor thesis. The research was conducted in compliance with the ethical standards and was approved by the Ethics Committee at the Department of Psychology, Palacky University in Olomouc.

The funding for the present publication was provided by the Czech Ministry of Education, Youth and Sports for specific research (IGA_FF_2023_025).

We confirm that we reported all measures, conditions, data exclusions, and how the sample size was determined for all experiments. Anonymized data, R script, and materials have been made publicly available at the osf.io and can be accessed at https://osf.io/6vbct/.

The authors did not preregister their analysis plan.

The authors have no conflicts of interest to declare.

CRediT statement

Author 1: Conceptualization, Methodology, Conceptualization, Formal analysis, Investigation, Data curation, Visualization, Writing - Original Draft, Writing - Review & Editing.

Author 2: Conceptualization, Methodology, Supervision, Writing - Reviewing and Editing

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