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When the phone's away, people use their computer to play: distance to the smartphone reduces device usage but not overall distraction and task fragmentation during work

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The smartphone helps workers balance the demands of their professional and personal lives but can also be a distraction, affecting productivity, wellbeing, and work-life balance. Drawing from insights on the impact of physical environments on object engagement, this study examines how the distance between the smartphone and the user influences interactions in work contexts. Participants (N = 22) engaged in two 5h knowledge work sessions on the computer, with the smartphone placed outside their immediate reach during one session. Results show that limited smartphone accessibility led to reduced smartphone use, but participants shifted non-work activities to the computer and the time they spent on work and leisure activities overall remained unchanged. These findings suggest that discussions on smartphone disruptiveness in work contexts should consider the specific activities performed, challenging narratives of 'smartphone addiction' and 'smartphone overuse' as the cause of increased disruptions and lowered work productivity.

KEYWORDS

workplace interruptions, work fragmentation, smartphone, productivity, distraction

1 Introduction

The smartphone helps users manage the challenges of their daily lives and enables them to perform the tasks that are required of them professionally and personally (Dearman and Pierce, 2008; Oulasvirta and Sumari, 2007). However, the smartphone is also known to be a source of distraction and many users report spending more time on their phones than they would like to (Heitmayer and Lahlou, 2021; Voit et al., 2018). In the workplace context, some employers have therefore adopted policies to restrict the use of personal smartphones during working hours, but research shows this can lead to employee dissatisfaction and stress, particularly through the experience of the fear of missing out (fomo) and of not being able to respond to demands quickly (Heitmayer and Lahlou, 2021; King et al., 2013; Wang and Suh, 2018). Further, research into multi-device use shows the complexity of interaction patterns and identifies many chances for the smartphone to increase distractions, but also suggests opportunities where the use of personal smartphones can be beneficial to fulfilling one's work tasks (Heitmayer, 2022; Roffarello and Russis, 2021). Drawing on findings from previous work on the impact of the presence of the smartphone on usage patterns and the impact of proximal physical micro-environments (Hollands et al., 2013, 2017) on choices and self-regulation, this paper presents an experimental study into the effect of the accessibility of the smartphone during knowledge work on a computer on device use, task-switching, and distractions.

2 Related work

2.1 Multi-tasking and multi-device use

Following pioneering work on the adoption of digital technologies at the workplace in the early 1990s (Rouncefield et al., 1994; Weiser, 1991), research on computer-supported work has broadly investigated the impacts of multi-device interactions (Czerwinski et al., 2004; Dearman and Pierce, 2008; Grudin, 2001; Lahlou, 1999; Oulasvirta and Sumari, 2007; Santosa and Wigdor, 2013; Tungare and Pérez-Quiñones, 2009). Particularly for knowledge work, discontinuity of tasks caused by frequent interruptions poses a major challenge (Dabbish et al., 2011; González and Mark, 2004; Mark et al., 2005). Research has thus investigated differences in modes of multi-tasking, with the main distinction typically drawn between dual-tasking and task-switching. Dual-tasking refers to two tasks being carried out at the same time (Schumacher et al., 2001). Task-switching refers to two or more tasks being carried out sequentially and intermittently (Monsell, 2003). Recent work in the field has further embraced combinations of the two approaches (Heitmayer, 2022; Jeong and Hwang, 2016; Salvucci and Taatgen, 2008; Yeykelis et al., 2014).

2.2 Multi-tasking and task performance

Multi-tasking while using technology has been linked to difficulties in concentrating on tasks (Cain and Mitroff, 2011; Ophir et al., 2009; Rosen et al., 2013; Shin et al., 2019) and to reduced cognitive performance (Jeong and Hwang, 2016; Lang and Chrzan, 2015; Uncapher et al., 2016). Engaging with multiple tasks that share the same sensory information processing structures are performed less efficiently compared to tasks that involve different processing structures, such as seeing and hearing (Wickens, 2002), and there is rich empirical support for this effect of sensory interference on various tasks (Bowman and Pace, 2014; Fante et al., 2013; Hwang and Jeong, 2018).

Cognitive performance has further been found to be lower for tasks perceived as low priority (Lin et al., 2009; Wang et al., 2015) and the negative impact of sensory interferences is exacerbated for tasks perceived as secondary (Hwang and Jeong, 2018). The level of control individuals have over the inputs they receive (Eveland and Dunwoody, 2001; McMillan and Hwang, 2002; Milheim and Martin, 1991) and their ability to selectively direct attention to specific elements (Eveland, 2003) are additional factors influencing multi-tasking performance, and some evidence suggests that user control has a larger effect on cognitive processing than sensory interference (Hwang and Jeong, 2019; Jeong and Hwang, 2016; Santarpia et al., 2021). Initial qualitative work also suggests that technology proficiency, which is still highly correlated with age, influences how well users cope with technology interruptions (Baham et al., 2022; Tams et al., 2022).

2.3 Multi-tasking and work interruptions

Smartphone users typically interact with their phones every 4–6 min, in both work and leisure contexts (Heitmayer, 2022; Heitmayer and Lahlou, 2021; Rosen et al., 2013; van Berkel et al., 2016; Yan et al., 2012). Engagement with the phone is driven by involuntary habits and notifications and, thus, often perceived as disruptive (Anderson et al., 2019; Heitmayer, 2021). This is problematic because frequent interruptions may exacerbate the challenges of multi-tasking. Research on working patterns finds an association between task-switching and a decrease in continuous focus, as well as a difficulty in returning to interrupted tasks (Czerwinski et al., 2004). Further studies show that users tend to make more errors when completing tasks after being interrupted (Borst et al., 2015; Leroy, 2009), experience increased time pressure, stress, and frustration (Mark et al., 2008, 2018), become more susceptible to further interruptions (Dabbish et al., 2011), and need additional time to return to interrupted tasks or may not return to them at all (Mark et al., 2005; O'Conaill and Frohlich, 1995).

2.4 Distraction and self-regulation in the digital workplace

Modern works environments are technologically augmented *hybrid spaces* (Heinrich et al., 2024; Silva, 2006) that place novel demands on the attention of workers and may impact self-regulation (Lord et al., 2010; Orhan et al., 2021; Palvalin et al., 2013). Technological distraction also contributes to the overall cognitive load workers experience, which may reduce their ability to resist distraction (Dalton et al., 2009; Lavie, 2010; Lavie and De Fockert, 2005), but has also been shown to shield against distraction in certain contexts (Kim et al., 2005; Lavie, 2005; Sörqvist et al., 2016). Moreover, as users engage with personal devices at the workplace, or with professional hardware at home, work and leisure time become conflated and stress and pressures can spill over across domains (often referred to as *telepressure* or *technostress*), which can lead to reduced wellbeing, workplace engagement (Derks et al., 2021; Laethem et al., 2018) and work-life conflict (Farivar et al., 2022; Hartner-Tiefenthaler et al., 2023). Inversely, users may experience *nomophobia*, the fear of missing out on information when they cannot access their devices, which can lead to reduced productivity, emotional stress, and fatigue (King et al., 2013; Wang and Suh, 2018).

2.5 The effect of proximity on engagement

Prior research has established an association between the physical proximity and visibility of objects in the space surrounding individuals and their engagement with them, particularly in relation to food, alcohol, and tobacco consumption (Hollands et al., 2019). Early experimental work observed an increase in consumption of snacks in an office setting as they were placed more visibly or in more accessible locations (Painter et al., 2002; Wansink et al., 2006). Other studies replicate these findings (Maas et al., 2012) adding that cognitive load of participants does not affect this relationship (Hunter et al., 2018). Further work shows that this effect can be leveraged to increase the intake of healthy foods (Privitera and Creary, 2013), reduce the intake of unhealthy ones (Cole et al., 2021), as well as to reduce the prevalence of cheating in exams (Zhao et al., 2022). Broadly related to the discussion on choice architecture (Szaszi et al., 2018) and information access cost (Morgan and Patrick, 2010), the altering of proximal physical micro-environments (in this case, distancing) has thus been proposed as a viable strategy to support self-regulation (Hollands et al., 2013, 2019).

These findings are in line with smartphone users reporting they are better able to manage their use when the device is out of reach and sight and observations of users intuitively increasing their distance to the device when they seek to reduce distractions (Everri, 2017; Heitmayer, 2022; Heitmayer and Lahlou, 2021). The findings also resonate with experimental work on the impact of the presence of the smartphone on cognitive functioning (Lyngs, 2017; Niu et al., 2022).

2.6 Gap in the literature

Building on previous work on multi-device use and interruptions in work contexts, as well as the impact of object proximity on engagement, the current study investigates the impact of smartphone accessibility on device use and interruptions in work contexts. Specifically, it looks in more detail at how workers interweave and distribute their time between work and leisure activities, and what role the devices they are using play in this. We therefore formulate the following research questions:

RQ1: What is the impact of device proximity on frequency and duration of smartphone use in desk-work settings?

RQ2: Does increased distance to the smartphone reduce task disruptions caused by the device?

RQ3: Does increased distance to the smartphone increase overall time spent working?

3 Methods

3.1 Experimental setting

Following prior research on food consumption, we have adopted a within-participant design manipulating the proximity of the smartphone during work activity. Participants over 18 who owned both a laptop and a smartphone and used a laptop as their main work device were recruited via mailing lists at the London School of Economics and Political Science. Participants were invited to attend the laboratory between 9 am and 5 pm on two working days. Participants were given a private, soundproof room and were asked to bring the devices they normally use to work, but at least a laptop and a smartphone. Participants were informed that the interest of the study was to understand how they used their laptops and their phones in work contexts. They were asked to try to engage in their work or studies as they would normally. No instructions regarding device or notification settings were given. Participants were further informed they are free to leave the room and take as many breaks as they wanted but were asked to spend 5 h in the room on each day of attendance. Rooms were video-recorded with high-resolution cameras throughout the duration of the experiment. To respect participant privacy, no audio was recorded.

3.2 Smartphone distance intervention

In the accessible condition, participants were instructed to keep their phones inside an area marked with red tape on their work desk within arm's reach. In the inaccessible condition, participants were asked to keep their phones inside an area marked with red tape on a separate table placed about 1.5 m away so they had to get up from their chair to reach the phone (see Figure 1). In both conditions, participants were told they could remove their phone from the marked area and use it as much as they wanted. However, they were instructed to return the phone to the red zone as soon as they were finished using it. Participants spent 1 day of participation in each condition, with conditions counterbalanced to control for order effects.

3.3 Procedure

Ethical approval was sought and obtained from the London School of Economics and Political Science research ethics committee. All participants completed screening questions and provided informed consent prior to commencement of data collection. Data collection took place in June and July 2022. On both days, participants

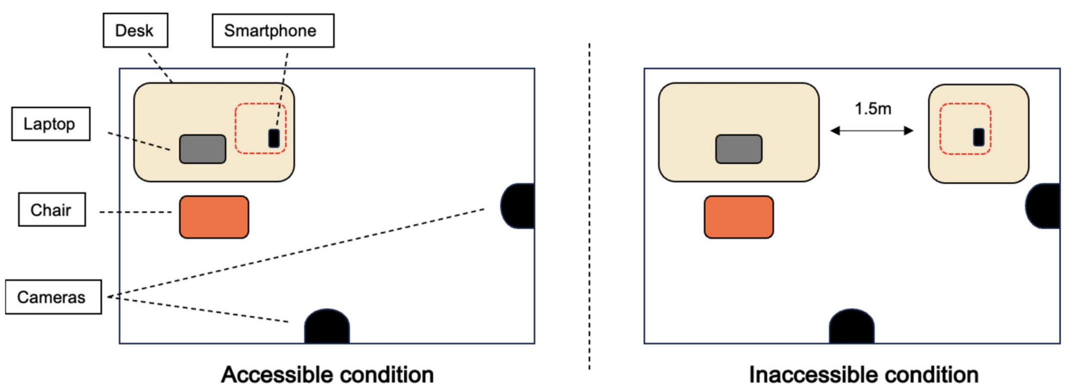

FIGURE 1
Room layout in the two experimental conditions.

were instructed to arrive 30 min prior to the start of the experiment and were greeted at the front desk. On the first day of participation, participants were given a short tour of the facilities including restrooms and a small kitchenette to store and heat food and prepare beverages. On both days, they were then guided to their room and recording of the session began. Researchers and lab staff were on site all day to help with queries about the study and any issues arising. At the end of both sessions, participants were asked to fill in an end-of-day survey reporting how often they thought they had used the device, and how often they had thought about using the device. On day 2, after completing the survey, participants were then debriefed and invited to participate in a replay-interview to watch and double-code their video footage together with the researcher.

3.4 Analysis

A total of 28 participants took part in the study. We excluded 6 participants from the final analysis as they either did not always keep their phones in the marked area, moved the furniture, or did not spend enough time in their room, resulting in a final sample of $N = 22$.

To prepare the analysis, we reviewed the video footage and developed the codebook in a two-step process. First, the entire footage was reviewed and coded by one researcher. We recorded (a) the amount of time participants spent on the individual activities they engaged in while using their computers, smartphones, and other devices (such as books or tablets)[1], (b) the overall number of activities participants engaged in, (c) whether participants' activities were related to their work or not, and calculated (d) mean duration of activities per device. We further coded (e) whether smartphone use was *alert-driven*, i.e., whether a notification had been delivered in the 15 s prior to an interaction beginning (Iqbal and Horvitz, 2007), as a measure for disruptive notifications.

Second, participants were invited to a replay-interview to review and double-code the footage with the researcher. We reviewed the entire footage with participants, fast-forwarding or slowing down and rewinding where relevant, seeking clarification particularly on whether activities were coded as work or non-work, following the general guidelines of replay interviewing (Lahlou et al., 2015; Le Bellu et al., 2016).

Based on the revised coding from these interviews, overall time spent working and time spent on leisure were calculated for participants' computers, smartphones, and other devices or activities, respectively. End-of-day survey data was downloaded from Qualtrics and prepared for analysis. All analyses were conducted using Stata 17. Following the Shapiro–Wilk test, the assumption of normality was violated for several variables in the dataset. We therefore decided to use more robust, non-parametric tests and investigated differences in device use patterns in the experimental data and in the data from the end-of-day-survey using the exact Wilcoxon's signed-rank test, or Kruskal-Wallis H-tests where specified. Given the non-parametric nature of the data and the modest sample size, we report Hedges' g for Wilcoxon's signed rank tests and η^2 for Kruskal-Wallis H-tests as estimates of effect size.

1 We observed very few instances of dual-tasking with computer and smartphone or computer and tablet in our sample, where activity could not be clearly attributed to one device (3.2% of all interactions). These interactions have been excluded from the analysis.

4 Findings

4.1 Descriptive statistics

Participants were 25.2 years old on average, ranging from 22 to 31. All participants lived and worked or studied in London at the time. 15 participants identified as female, 6 as male, and one as non-binary. Participants engaged in 60.64 activities per session and spent 4 h 54 min in the room on average, ranging between 3 h 59 min and 5 h 50 min (lunch breaks spent in the room were excluded from the total time). Of this time, participants spent 3 h 33 min working and 1 h 21 min on leisure activities. On average, participants received 1 disruptive smartphone notification in the inaccessible condition (ranging from 0 to 4) and 2.7 in the accessible condition (ranging from 0 to 17). In both conditions, 50% of sessions had no disruptive notifications. One third of participants did not receive any disruptive notifications in either condition.

Figure 2 takes an ethno-mining approach (Aipperspach et al., 2006; Anderson et al., 2009) to visualizing the study data and provides a visual overview over the individual trajectories and patterns of activity and device participants engaged in. Every row represents the timeline of activities running from left to right for one session for one participant. Duration of activities has been rounded to the full minute, with activities shorter than 1 min being rounded up to 1 min. The upper blocks of rows show the inaccessible condition, and the lower blocks show the accessible condition. The blocks on the left and right show the same data but use different color coding schemes. In panel A, work and leisure activities are depicted in darker and lighter shades of the same color per device. In panel B, work activities on different devices and leisure activities on different devices are depicted in similar colors, respectively. The figure highlights the complexity of the data set and makes the fragmentation of individual experiences salient.

4.2 Inferential statistics

4.2.1 Overall differences in device use

Our analysis shows no statistically significant difference in the overall duration participants spent in the room across conditions ($Z = 1.120$, $p = 0.276$), nor do we observe differences in mean duration of activities ($Z = 0.341$, $p = 0.750$) or total number of device interactions per day ($Z = -1.007$, $p = 0.325$) across the two conditions.

The overall duration of smartphone use was significantly lower in the inaccessible condition compared to the accessible condition (15 min vs. 29 min; $Z = -2.971$, $p = 0.002$, $g = 0.34$), and duration of computer use was significantly higher (4 h 27 min vs. 3 h 58 min; $Z = 2.289$, $p = 0.021$, $g = 0.33$). Mean duration of activities on the computer ($Z = 0.146$, $p = 0.899$) and on the smartphone ($Z = 0.406$, $p = 0.702$) also did not differ significantly from each other across conditions. The number of interactions with the device did not differ significantly across conditions for the computer ($Z = 0.520$, $p = 0.616$), but participants used their smartphones significantly less in the

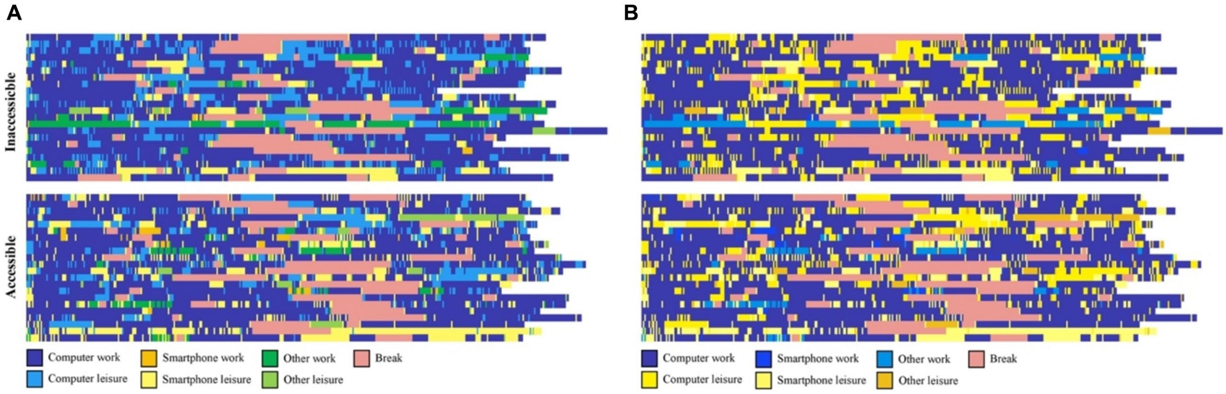

FIGURE 2
Two visual representations of the heterogeneity and segmentation of participants' device use. **(A)** Activities depicted in similar colors per device; **(B)** work activities and leisure activities depicted in similar colors.

inaccessible condition (6.5 interactions vs. 18.5; $Z = -3.898$, $p < 0.001$, $g = 1.31$).

4.2.2 Overall time spent on work and on leisure

Looking at work and leisure activities participants engaged in, we find that neither the overall time participants spent working ($Z = 0.601$, $p = 0.566$), nor the mean duration of work activities ($Z = 0.146$, $p = 0.899$) differed significantly across the accessible and inaccessible condition. The same pattern held for the overall time participants spent on leisure activities ($Z = 0.406$, $p = 0.702$) and their average duration ($Z = 0.893$, $p = 0.388$).

Further, the number of activities participants engaged in remained statistically invariant between the accessible and inaccessible condition for both work ($Z = -1.234$, $p = 0.225$) and leisure activities ($Z = -0.942$, $p = 0.357$).

4.2.3 Differences in work and leisure time per device

Turning toward differences in work and leisure use per device, we do not find any statistically significant differences across conditions for the computer in terms of overall work duration ($Z = 0.049$, $p = 0.975$), mean duration of work activity ($Z = 0.536$, $p = 0.610$) or number of work activities ($Z = -0.763$, $p = 0.458$). We further do not find statistically significant differences for the smartphone in overall work duration ($Z = -1.502$, $p = 0.137$), mean duration of work activity ($Z = -1.755$, $p = 0.083$), or number of work activities ($Z = -1.7$, $p = 0.105$).

We observe a significantly lower overall duration of computer use for leisure in the accessible condition compared to the inaccessible condition (27 min vs. 1 h 6 min; $Z = -2.614$, $p = 0.007$, $g = 0.71$), as well as a significantly lower number of leisure interactions with the computer in the accessible condition (20 vs. 12; $Z = 2.387$, $p = 0.015$, $g = 0.66$). We did not observe a difference in mean duration of leisure activities on the computer across conditions ($Z = 0.114$, $p = 0.924$).

For the smartphone, we observe a significantly higher overall duration of leisure use in the accessible condition compared to the inaccessible condition (23 min vs. 16 min; $Z = 2.646$, $p = 0.007$, $g = 0.27$), as well as a significantly higher number of leisure interactions in the accessible condition (17.5 vs. 6.5; $Z = 3.964$, $p < 0.001$, $g = 1.44$). We did not observe a difference in mean duration of leisure activities on the smartphone across conditions ($Z = 1.932$, $p = 0.054$).

4.2.4 Impact of disruptive notifications

We do not observe a statistically significant difference in the overall number of disruptive notifications participants received ($Z = -1.072$, $p = 0.294$), or the proportion of interactions that was initiated by disruptive notifications ($Z = 0.184$, $p = 0.870$) between the accessible or inaccessible condition. Using Kruskal-Wallis H tests, we do not observe significant differences in the overall duration of smartphone use between those who have and those who have not received disruptive notifications in both the inaccessible (H (1) = 3.752, $p = 0.053$) and in the accessible condition ($Z = 0.475$, $p = 0.491$), and for the mean duration of overall smartphone use in the accessible (H (1) = 0.087, $p = 0.77$) and in the inaccessible condition (H (1) = 0.182, $p = 0.67$). However, we observe that participants who received disruptive notifications in the inaccessible condition used their phone significantly more frequently than those who did not (11.6 vs. 5.1 interactions; H (1) = 6.391, $p = 0.012$, $\eta^2 = 0.17$), but this does not hold in the accessible condition (H (1) = 3.752, $p = 0.053$).

4.2.5 End of day survey

Participants' self-assessment of the number of times they had used their smartphone during the day was significantly higher in the accessible condition compared to the inaccessible condition (12.5 vs. 6.5; $Z = 2.088$, $p = 0.036$, $g = 0.19$). They also reported thinking about using the smartphone more frequently in the accessible condition compared to the inaccessible condition ($Z = 2.216$, $p = 0.028$, $g = 0.59$). Self-assessments did not differ statistically from actual number of interactions in the inaccessible condition ($Z = -0.065$, $p = 0.955$), but they were significantly lower than actual use in the accessible condition (12.5 vs. 18.5; $Z = 2.088$, $p = 0.012$, $g = 0.70$).

4.2.6 Order effects

Finally, we control the previous analyses for potential order effects resulting from the order of the conditions in which participants took part in the study (i.e., accessible–inaccessible, hereafter 'accessible-first' or inaccessible–accessible, hereafter 'inaccessible-first'). First, we have conducted Kruskal-Wallis H tests to investigate differences in device use across the two groups. In the accessible condition, participants in the accessible-first group used their smartphones significantly more frequently overall (27.2 vs. 14.6, H (1) = 6.958, p = 0.008, η^2 = 0.19), and for leisure activities in particular (24.1 vs. 13.8, H (1) = 5.463, p = 0.019, η^2 = 0.12), than those in the inaccessible-first group. For the inaccessible condition, we do not find any significant differences in device use between the accessible-first and the inaccessible-first group.

Secondly, we have replicated the analyses of within-participant effects independently for the two groups using Wilcoxon's signed-rank test. Like in the full sample, overall duration of smartphone use was significantly lower in the inaccessible condition compared to the accessible condition irrespective of the order in which participants had taken part in the conditions (Z = −2.073, p = 0.039, g = 1.02; Z = −1.992, p = 0.048, g = 0.18). In the inaccessible condition, participants further used their smartphones significantly less often overall (Z = −2.688, p = 0.004, g = 2.14; Z = −2.731, p = 0.004, g = 0.87), and less often specifically for leisure activities (Z = −2.668, p = 0.004, g = 1.93; Z = 2.872, p = 0.002, g = 0.94), regardless of their order of participation in the study.

Like in the full sample, overall duration of computer use was significantly lower in the inaccessible condition compared to the accessible condition among participants in the accessible-first group (Z = 2.429, p = 0.012, g = 0.97), but not for those in the inaccessible-first group (Z = 1.083, p = 0.305,). Similarly, we find a significantly lower number of leisure activities on the computer in the inaccessible condition for the accessible-first group (Z = 2.136, p = 0.035, g = 0.76), but not the inaccessible-first group (Z = 1.47, p = 0.154). Interestingly, we also only find a difference between participants' self- assessments of how frequently they had used the phone and their actual phone use in the accessible condition among participants in the accessible-first group (Z = −2.134, p = 0.031, g = 1.08), and not the inaccessible-first group (Z = −1.294, p = 0.210).

We do not observe the statistically significant main finding regarding the overall difference in the duration of leisure activities on the smartphone across conditions when looking at the accessible-first and inaccessible-first groups separately (Z = −1.836, p = 0.074; Z = −1.782, p = 0.080). We further do not replicate the significant main finding of the difference in the duration of leisure activities on the computer (Z = 1.836, p = 0.074; Z = −1.782, p = 0.154), as well as the differences in participants' self-assessments of how frequently they had used the phone (Z = −1.736, p = 0.094; Z = −1.263, p = 0.219) and of how frequently they had thought about the device (Z = 2.058, p = 0.063; Z = 1.252, p = 0.313) when looking at the accessible-first and inaccessible-first groups separately For the full analyses of the differences between the two groups, see Supplementary Table S1.

5 Discussion

The results of the experiment demonstrate the importance of the accessibility of the smartphone for the frequency of device interactions and add important nuance to the literature on multi-device interactions and work interruptions.

Firstly, participants spent almost twice as much time using their phones when they were within immediate reach, a median increase of 14 min more per session. More specifically, while the average duration of a smartphone interaction remained statistically invariant across conditions, participants engaged with their phones almost three times as often in the accessible condition. Consistently, participants spent more time overall on their computers when the smartphone was not accessible, but the number of activities performed on the computer remained unchanged. Participants further received only a small number of disruptive notifications overall (mean 1.86, median 0.50 per session), and disruptive notifications did not lead to differences in the overall duration of smartphone use. In the inaccessible condition, more disruptive notifications led to smartphone interactions, which can be feasibly attributed to participants not being able to glance at their screens easily.

These findings suggest keeping the phone within immediate reach leads to more frequent interruptions and to a flow of activity that is more fragmented between devices (see Figure 2A more yellow blocks representing smartphone use are apparent in the accessible than in the inaccessible condition). Looking in more depth at the laboratory recordings and interviews, it became evident that users frequently accessed messaging tools like WhatsApp or Facebook Messenger, which they usually accessed via their smartphone, from the computer in the inaccessible condition. At the same time, some leisure activities, like scrolling Instagram or TikTok which are not as user-friendly on the computer as they are on the smartphone occurred less in the inaccessible condition; instead, participants spent time reading news articles or shopping online.

Secondly, however, participants did not spend different amounts of time on work or leisure activities overall across conditions. This also applies to the mean duration and number of activities. Looking in more detail at work and leisure activities per device we observed that duration and number of work activities remained statistically invariant for both computer and phone across conditions. However, participants used their computer for twice as many leisure activities and for about twice the amount of time when their smartphone was not within reach, with mean duration of activities remaining unchanged. Inversely, the smartphone was used for a third less in terms of overall time, and a third in terms of the number of interactions when it was not accessible, with mean duration of activities, again, remaining unchanged.

Thirdly, participants' self-assessments at the end of the day show that they were aware of their increased usage and increased desire to use the phone when it is accessible. While they correctly estimated the number of times they used their smartphones in the inaccessible condition, they significantly underestimated their use when it was within immediate reach.

Taken together, these findings suggest that neither the overall time participants spent engaging in work and in leisure activities, nor the fragmentation of the workday in the sense of the frequency of switches between work and leisure activities, as well as their average duration, changed depending on whether the phone was accessible or not. The phone seems to be the preferred 'target object' for leisure and distraction, regulating the flow of activity by diverting attention away from a 'work device' to itself, a 'leisure device'. When it is not accessible, this leisure function is taken over by the main work device (see Figure 2B fragmentation of rows in terms of blue blocks (work activities) and yellow blocks (leisure activities) remains similar across the accessible and inaccessible conditions).

The findings are further qualified by the observed effect of the order in which participants took part in the two conditions. The main findings of this paper are replicated when controlling for order effects and can therefore be regarded as robust: there is a decreased frequency and duration of smartphone use in the inaccessible condition, and an absence of differences in the overall amount of time participants spent on work or leisure activities across conditions.

In contrast, some significant main effects such as the reduced overall duration of smartphone use in the inaccessible condition were found only among those participants who took part in the accessible condition first. Moreover, we find that usage patterns in the accessible-first and inaccessible-first group are generally the same apart from the frequency of smartphone use in the accessible condition. Participants in the inaccessible-first group used their phones only about half as frequently in the accessible condition compared to those who were in the accessible-first group. These observed order effects suggest that participating in the inaccessible condition first as well as filling in the end of day survey may have led participants to be more mindful of their smartphone use for the second day of the study, which has been linked to reduced levels of problematic smartphone use in previous work (Hallauer et al., 2022; Owen et al., 2018; Regan et al., 2020).

6 Implications

Overall, these findings have major implications for how we think about technology interruptions at the workplace and multi-device use in work contexts. Unsurprisingly, workers engage more with the smartphone when it is easily accessible. However, restricting access to the device may not be a viable solution as users simply find another source of distraction, and their overall work and leisure usage patterns appear invariant regardless of the devices that are available to them. Moreover, disruptive smartphone notifications seem to play only a minor role for work interruptions. The challenges for attention, self-regulation, and cognitive load more broadly that knowledge workers encounter thus seem to be due to the nature of their environment and the activities they engage in, rather than the concrete technological setup. This study therefore underlines once more that a habit-centered conceptualization of technological interruption, rather than a device-centered one seems to be the most promising route forward to help mitigate disruption and stress caused by everyday technologies (Anderson et al., 2019; Heitmayer and Lahlou, 2021; Oulasvirta et al., 2012).

In terms of workplace policies, it therefore appears questionable that forbidding the use of the phone for leisure activities is conducive to increasing productivity - workers will find other ways to distract themselves for a moment. Instead, helping workers to increase their capacity to self-regulate and to resist habitual patterns of engagement will be paramount to reduce technological distraction and increase both wellbeing and productivity. Future work should thus explore whether and how these findings extend to different approaches to limiting workplace disruption, such as software limitations or self-regulation apps that increase friction or information access costs for users when they seek to use their devices for distraction (Lyngs et al., 2019). Similarly, investigating the social norms and expectations around device use and reachability across contexts, both for professional and personal demands will help both researchers and employers make better sense of the challenges for workers associated with multi-device use (Heitmayer and Schimmelpfennig, 2023; Li et al., 2021).

Beyond validating the findings of the study outside of the laboratory context, further research should also look in more detail at the nature of the work, and particularly leisure activities users engage in with the respective devices. This agenda feeds into the broader discussion of the sequential and fragmented nature of tasks in contemporary multi-device computer-work environments, and which demands it places on workers (Roffarello and Russis, 2021). It will, finally, also be crucial to see whether the observed order effect resulting in reduced smartphone use in the accessible condition among those who participated in the inaccessible condition first is due to participant awareness of the study purpose, or whether this does indeed constitute a mindfulness effect that could be leveraged for further interventions to reduce unwanted or disruptive smartphone interactions.

7 Limitations

There are several limitations to this study. Firstly, as this study was done with a sample of young adult participants, and a slight skew toward females, further research with other populations will be needed to improve the generalisability of the findings. It will also be important to further investigate the important individual differences in user behavior we observed, as put to evidence by Figure 2. Moreover, while an effort has been made to create a setting for participants where they could work as they do normally in the laboratory, there were several challenges with this design. Both devices were individually owned by participants in our sample. In many professional contexts, this may not be the case and monitoring tools or restrictions on installing software, particularly on the computer, may be in place. This limits the ability of users to switch to the computer for leisure use when the phone is out of reach and may lead to more smartphone interruptions and more distress or discomfort when the phone is not within reach. We also did not observe the use of any native task-switching tools such as Apple's 'handoff', but effects of device pairing and seamless integration tools between smartphone and computer may be relevant in other contexts. Lastly, the lab environment offered almost no ambient distractions, potentially leading to lower cognitive load than workers usually encounter at work. Replicating the study in users' natural work contexts will therefore be crucial to understand these nuances and to affirm the ecological validity of the findings.

Secondly, the design of the study could be developed further by installing activity-logging software on smartphones and laptops of participants to capture more detail on their activities and any shared or multi-device notifications they received. It will be particularly insightful to also investigate those notifications that did not lead to interactions. The use of logging software would further enable a comparison of experimental findings to long-term usage patterns.

Thirdly, in its attempt to emulate a normal work experience for participants, this study has not included an objective measure of performance or productivity. It is possible, for example, that while leisure activities shift to the computer when the smartphone is inaccessible and the overall time spent on work and leisure remains invariant, users may still experience differences in overall productivity. While the current research reveals how work and device usage patterns have been rearranged, the impact of smartphone proximity on objective work output will be an interesting extension of this study. In this context, research should also investigate how much time workers spend at their workstation more broadly, as general reference figures for this are lacking.

8 Conclusion

This paper has presented an experimental investigation of the effect of smartphone accessibility on interruptions and work engagement in knowledge-work contexts. We have looked at multi-device use in work contexts, providing a differentiated insight into work and leisure activity per device based on complete and detailed, naturally occurring observations of user behavior. While users, unsurprisingly, engage more with the smartphone when it is easily accessible, the amount of time spent on work and non-work activities and the fragmentation of their workdays does not depend on the smartphone's accessibility. These findings suggest that discussions on the disruptiveness of smartphones in work contexts must look beyond the devices into the activities that are being performed, and challenge narratives of 'smartphone addiction' and 'smartphone overuse' that lead to increased disruptions and lowered work productivity.

Data availability statement

The quantitative data supporting the conclusions of this article can be made available by the author. Requests to access the data should be directed to the author.

Ethics statement

The studies involving humans were approved by London School of Economics and Political Science Ethics Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomp.2025.1422244/full#supplementary-material

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