The Mere Presence Effect of Smartphones on Decision-Making Performance

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Statement of Sources

I declare that this report is my own original work and that contributions of others have been duly acknowledged.

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Table of Contents

List of Tables

List of Figures

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Abstract

The present study investigated the 'mere presence effect' of smartphones on decision-making performance. We also explored whether the relationship between smartphone presence and decision-making could be partially explained by cravings when moderated by smartphone dependency. Fifty-one participants (29 female; aged 19-45 years, $M = 25.76$, $SD = 5.57$) were recruited and randomly allocated into one of two conditions: a smartphone condition where participants had their phones in the lab face down and on silent and a control condition where participants had their phones in a separate room. Both conditions completed a decision-making task via a computer. On completion of the task, all participants filled out a problematic phone use scale to determine smartphone dependency and a craving intensity scale to determine cravings to use the smartphone device throughout the study. Results demonstrated no moderated mediation of cravings and smartphone dependency. However, as expected we demonstrated that smartphone presence does indeed affect decision-making performance, with participants in the smartphone condition (smartphone present) employing significantly more heuristic-based decisions ($M = 7.59$) than participants in the control condition (smartphones absent) ($M = 6.33$). Our data demonstrates that merely having a smartphone present is cognitively demanding and can increase the use of heuristics (i.e., mental shortcuts) in decision-making.

Why should we be concerned about smartphones?

Smartphones have become increasingly popular in recent years (Wilmer, Sherman, & Chein, 2017). Smartphones are regarded as flexible and powerful tools (Strayer & Johnson, 2001). They allow us to connect with friends via social media apps, listen to music and other entertainment, as well as providing unlimited information – all at our fingertips (Wilmer et al., 2017). Just a decade ago, the ability to be in 'constant connectively' would have been unimaginable; however, nowadays it is seemingly indispensable (Ward, Duke, Gneezy, & Bos, 2017). It has been estimated that eighty-eight percent of Australians own a smartphone (Deloitte, 2017), on average smartphone users interact with their phones up to eighty-five times a day (Perlow, 2012) and ninety-one percent of users report never leaving home without their smartphone (Deutsche Telekom, 2012). A further forty-six percent of people say they could not live without their mobile phone (Pew Research Centre, 2015). Research also indicates that excessive smartphone use can lead to addiction-like symptoms such as cravings and feelings of dependence (Billieux, Van der Linden, Rochat, 2008). Given the high rate of smartphone use, and its overall popularity, it is important to ask how interacting with these devices affects cognitive processing.

There is increasing concern that habitual involvement with smartphones may interfere with cognitive processes including memory, emotion regulation and attention (Wilmer et al., 2017). Research shows that interacting with smartphones impairs academic performance in students (Froese et al., 2010). For example, in one study Froese et al. (2010) found that students who used their mobile devices while learning new information had a reduction in comprehension. Similarly, Strayer and Johnson (2001) found that interacting with mobile phones whilst driving caused performance deficits such as delayed reaction time. In addition, research shows that interacting with smartphone devices reduces both sleep quality (Adams, Daly & Williford, 2013) and productivity in the workplace (Spira & Feintuch, 2005). These findings are consistent with an attention-based explanation wherein performance is impaired due to the diversion of attention away from the task at hand, to active engagement with the mobile phone (Strayer & Johnson, 2001).

It is not surprising that actively engaging with one's smartphone (e.g., to call or text) causes distraction from performance on a wide range of tasks. However, there are often times when smartphones are present but not in use. For example, in class, students may leave their mobile phones on the desk in front of them without interacting with them. What is surprising about these types of situations is that recent research demonstrates the mere presence of a smartphone reduces performance on cognitive tasks, even when the phone is face-down, on silent, and not touched throughout the task (Ward et al., 2017). It seems that merely having one's mobile phone nearby is cognitively demanding. Thus, the present study is interested in situations where smartphones are present but not in use – 'the mere presence effect'.

Only two studies have looked at the mere presence effect of mobile phones on cognition. In one study, Thorton, Faires, Robbins and Rollins (2014) found the mere presence of a mobile phone impaired performance on tasks requiring sustained attention. In Thorton et al's. (2014) study participants were asked to complete a digit cancelation task and a trail-making task with both tasks involving two levels of difficulty. Thorton el al. (2014) found that participants who were asked to place their mobile phones on the desk in front of them performed significantly worse on the challenging sections of the task than those in the control condition (mobile phone absent). Thorton et al. (2014) concluded that the mere presence of mobile phones impairs cognitive functioning, but only during demanding tasks.

In a more recent study, Ward et al. (2017) demonstrated that the mere presence of one's smartphone reduces cognitive capacity. In their study, participants were randomly allocated to one of three conditions: a smartphone condition where participants placed their phones on the desk, face down, on silent; a smartphone condition where participants placed their phones in either their pocket or bag (on silent); and a control condition where participants placed their phones in another room. Results demonstrated that participants in the desk smartphone condition performed significantly worse on a working memory and fluid intelligence task than those in the control condition. While the pocket/bag smartphone condition did not perform significantly different to the desk smartphone group and the control group, planned comparisons demonstrated a significant linear trend (i.e., desk > pocket/bag > control) – suggesting as smartphone salience increases, cognitive performance decreases. In addition, Ward et al. (2017) demonstrated a moderating effect of smartphone dependency, such that the relationship between smartphone presence and cognitive performance was moderated by individual differences in smartphone dependency. Ward et al. (2017) concluded that the mere presence of smartphones left fewer attentional resources for other tasks, thus impairing cognitive performance.

The effects of smartphones on cognition is a new field of research and there is currently no published research investigating the effects of smartphones on decision-making. The aim of the present study is to investigate the mere presence effect of smartphones on decision-making – which refers to the cognitive process in which one selects a course of action, option or choice from several alternative possibilities (Kahneman & Fredrick, 2002). Specifically, we aimed to examine the effect of smartphone presence on the use of heuristics in decisions-making. According to dual process theories of decision-making under cognitive load, it is common for the mind's decision-making processes to favour the use of heuristics rather than deliberate analytical analysis (Evans, 2003). Given the presence of smartphones increases cognitive load (Ward et al., 2017), we would expect people to use heuristic-based decisions (because they require little cognitive capacity) more when their smartphones are present than when they are absent (Evans, 2003).

In summary, we wish to explore whether smartphone presence will increase heuristic use on a decision-making task. Furthermore, the existence of cravings (i.e., irritability if the phone cannot be used) in problematic mobile phone users has been shown in several studies (e.g., Hooper & Zhou, 2007), thus, we also wish to explore whether the relationship between smartphone presence and impaired decision-making performance can be partially explained by cravings and whether this relationship is moderated by smartphone dependency.

Dual process theories of decision-making

Judgments and decision-making form a fundamental part of human cognition (Ayal, Rusou, Zakay, & Hochman, 2015). Everything we do consciously or unconsciously is the result of some underlying decision (Acker, 2008). It is therefore important to understand whether regularly encountered stimuli (e.g., smartphones) affect human decision-making processes. Decisions come in all different forms (e.g., risk management, consumer choices) and there are a variety of different theoretical frameworks for understanding decision-making. Here, we are focussed on one influential framework – dual process theories of cognition (e.g., Evans 3003; Petty & Cacioppo, 1986; Sloman, 1996; Stanovich & West, 2000).

Dual process theories of cognition propose that there are two separate systems used in the decision-making process: system 1 (intuitive) and system 2 (analytical) (Evans, 2003; Petty & Cacioppo, 1986; Sloman, 1996; Stanovich & West, 2000). When decision-making occurs, system 1 and system 2 can independently or jointly contribute to the decision-making process (Kahneman & Fredrick, 2002). The purpose of dual process theories of cognition is to identify attributes that underlie the two systems (i.e., intuitive and analytical processing), respectively (Stanovich & West, 2000).

Dual process theories: system 1

System 1 is assumed to be a form of universal cognition found in both humans and animals (Kahneman & Fredrick, 2002). It consists of a set of sub-systems that reflect the domain-specific nature of learning and are shaped by associative learning processes (Evans, 2003). Thus, system 1 is associated with prior knowledge and belief. System 1 primarily relies upon heuristics and is therefore generated without much cognitive effort, providing a rapid, automatic, intuitive response (Kahneman, 2003). Heuristics refer to conscious and unconscious cognitive processes that involve concentrating on one aspect of a problem while ignoring other information that might be relevant (Sloman, 2002). Heuristics help to make decisions and judgements quickly without spending time analysing all information available and are often used when people need a quick solution to a problem (Kahneman & Fredrick, 2002). In many situations heuristics can be useful by helping people to make accurate decisions effectively (Gigerenzer, 2008). According to Gigerenzer and Gaissmaier (2011), the mind resembles an 'adaptive toolbox'. This toolbox is made up of a number of heuristics that are 'fast and fugal', meaning that they can make accurate decisions rapidly using only small amounts of information from the environment (Gigerenzer & Gaissmaier, 2011). However, while heuristic-based decisions help to make quick, rapid, automatic responses, they often lead to errors and biased judgements (Evans, 2003).

While there are a number of different heuristics people use to make judgments, in particular relevance to the present study, there are three broad heuristics that participants may employ when undertaking the decision-making task – including the representativeness heuristic, the availability heuristic and the anchoring and adjustment heuristic (Tversky & Kahneman, 1974). The representativeness heuristic is a mental shortcut used for making judgements about the probability that a stimulus (e.g., a person) belongs to a certain category

(Tversky & Kahneman, 1983). The Linda problem is one illustration of where people might use this heuristic.

> Linda is 31 years old, single, outspoken, and very bright, with a major in philosophy; has concerns about discrimination and social justice; and was involved in anti-nuclear demonstrations while a university student. Is Linda more likely to be a bank teller, or a bank teller who is active in the feminist movement? (Tversky & Kahneman, 1983).

The heuristic-based answer to this question is Linda is a bank teller and is active in the feminist movement (Tversky & Kahneman, 1983). However, this answer violates the conjunction rule. For example, two events co-occurring at once (i.e., Linda being both an active feminist and a bank teller) cannot be more likely than one of the events occurring independently (i.e., Linda just being a bank teller) (Tversky & Kahneman, 1974). According to the representativeness heuristic, in this scenario Linda is more similar to, and representative of, the events occurring in conjunction (i.e., Linda being both an active feminist and a bank teller) than in conjunct (i.e., Linda just being a bank teller) (Tversky & Kahneman, 1974). Thus, for this problem, the representative heuristic promotes an incorrect response.

The availability heuristic is a mental shortcut used to assess the likelihood of an event occurring by the ease in which the occurrence comes to mind – which is based on how vivid, imaginable and salient it is (Tversky & Kahneman, 1974). The following Volvo problem is an illustration of where people might use the availability heuristic. For example, the problem asks you to imagine that you need to buy a new car and you would like to purchase either a Volvo or a Saab (Fong, Krantz, & Nisbett, 1986). You do lots of research and determine that the Volvo is the better make (Fong et al., 1986). You go to purchase the Volvo and suddenly remember that you have two friends who own a Saab and one who owns a Volvo (Fong et al., 1986). You called for their advice, both friends who own a Saab reported no real mechanical problems, however, the friend who owns the Volvo reports lots of mechanical issues (Fong et al., 1986). You then have to decide which car you should buy (i.e., the Volvo or the Saab; Fong et al., 1986). The heuristic-based answer to this question is to purchase the Saab. According to the availability heuristic, a preference for the Saab demonstrates an individual's tendency to rely on personal testimony over the opinion of experts (Fong et al., 1986). Tversky and Kahneman (1974) suggest that for people who choose the Saab, the salience of the event (i.e., the recent occurrence of the friend experiencing trouble with their car) makes the probability of that event occurring more plausible.

The anchoring and adjustment heuristic is a mental shortcut used to estimate quantities by beginning with a reference point (i.e., the anchor) and then adjusting it until a suitable value is reached (Tversky & Kahneman, 1974). However, the adjusting process tends to be insufficient which leads to final judgments being biased toward the reference point (i.e., the anchor) (Tversky & Kahneman, 1974). The following illustration is one example of where the anchoring and adjustment heuristic may be used. For example, the problem asks participants whether the population of Chicago is more or less than 200,000 people (Epley & Gilovich, 1983). After this question (which is used to make a comparative assessment), participants are asked to provide an absolute estimate of the actual population of Chicago (Epley & Gilovich, 1983). According to the anchoring and adjustment heuristic, peoples absolute estimate is influenced by the value considered in the first comparative assessment (Tversky & Kahneman, 1974). For example, people who begin with an initial estimate that the population of Chicago is less than 200,000 people, their absolute estimate will typically be underestimated and for people who start with an initial estimate of more than 200,000 people, their absolute estimate will be overestimated (Epley & Gilovich, 1983).

Dual process theories: system 2

By contrast, (to system 1) system 2 is believed to be unique to humans and relies more heavily on the use of working memory – which refers to the cognitive system that actively selects, maintains and processes information relevant to current tasks (Evans, 2003). System 2 is much slower, deliberate, analytical and requires significantly more cognitive effort than system 1 (Kahneman, 2003). It is typically assumed that because system 2 processes information more carefully and consciously it is more likely to lead to less biases and errors in decision-making than system 1 (Evans, 2003, Kahneman, 2003). In line with this claim, a number of studies have demonstrated that analytical deliberation of numerical tasks improves the accuracy of performance in comparison to reliance on intuition (e.g., Beilock & Decaro, 2007; Rusou et al., 2013). In addition, studies have also demonstrated that participants higher in analytical thinking are less susceptible to decision-making biases (e.g., Kahneman, 2001).

Whereas system 1 provides a quick intuitive response to judgment problems, system 2 monitors the quality of those responses and may override or correct the initial response (Kahneman & Fredrick, 2002). Accordingly, intuitive responses are those that are retained from the initial response that have not been modified by system 2 (Ayal et al., 2015). By contrast, analytical responses are those that have been made via analytical analysis (system 2) which have overridden or corrected an initial intuitive response (system 1) (Kahneman, 2003). While the two systems of thought are often described as separate, it is important to acknowledge that decisions are often arranged along a continuum (i.e., decisions can be either intuitive or analytical, or somewhere in between; Hammond, McClelland, & Mumpower, 1980).

Cognitive load

According to dual process theories of decision-making, the role of the two systems in determining decisions has been shown to depend on many factors. These include, the task being performed (Stanovich & West, 2000), whether the individual has been exposed to statistical thinking (Agnoli, 1991), and the respondent's mood (Bless et al., 1996). Of particular importance for the present study, cognitive load (i.e., the amount of mental activity enforced on working memory at one time) also impacts an individual's capacity to make decisions (Hoffman, von Helversen, & Rieskamp, 2013). For example, a study by Hoffman, et al. (2013) found that when participants were under cognitive load, participants were more likely to use less demanding cognitive strategies (i.e., heuristic-based decisions) than participants under no cognitive load. In line with these findings, other research has shown that decision-making strategies requiring high amounts of working memory capacity are less effective whilst under cognitive load (e.g., Beilock & DeCaro, 2007; Rieskamp & Hoffrage, 2008).

These findings suggest that when individuals are under higher working memory load, fewer cognitive resources are available for concurrent tasks (Beilock & DeCaro, 2007). As a result, because heuristic-based decisions (system 1) are performed automatically and involve little working memory capacity, individuals are more likely to use them (Rieskamp & Hoffrage, 2008). By contrast, when individuals are not under cognitive load there is more working memory capacity available to dedicate to analytical based decisions (system 2) (Hoffman, et al. 2013). Based on this rationale, we propose that smartphone presence increases cognitive load. Given that cognitive load drains cognitive resources (e.g., Hoffman, et al., 2013), we would expect participants in the present study to use heuristic-based decisions more when their smartphones are present than when they are absent.

How might the mere presence of smartphones affect cognitive resources?

At any given time, our cognitive system operates in a world surrounded by an enormous amount of potentially meaningful information (Truong & Todd, 2017). However, in order for information to reach conscious awareness and guide behaviour (i.e., carrying out a task) we must be able to select relevant stimuli from the environment while simultaneously filtering out irrelevant information – a process known as selective attention (Chelazzi, Perlato, Santandrea, & Della Libera, 2013). In addition to selective attention, the capacity to carry out a cognitive task is also dependent on the ability to manage and process information relevant to the task (i.e., working memory) and the availability of attentional resources that assist in regulating cognitive processes (i.e., working memory capacity) (Fougnie, 2008). However, working memory has a limited capacity that can only deal with around seven (plus or minus two) bits of information at once (Turner & Engle, 1986). As a result of this limited capacity, when using attentional resources for one cognitive process or task, there are fewer available for concurrent tasks (Ward et al., 2017).

Although selective attention and working memory allow us to process relevant information, this process is not flawless (Carretie, 2014). There are certain distractors that may capture attention and lead to impaired performance (Truong & Todd, 2017). The probability that a stimulus will capture attention has been shown to depend on both its visual salience (e.g., location), and relevance to current goals (i.e., how important is the stimulus to the current goal; Carretie, 2014). When engaging in a task, goals relevant to the task become active in working memory, and stimuli that are applicable to that goal are more likely to capture attention (Ward et al., 2017). However, stimuli that are associated with self-relevant goals have been shown to automatically capture attention (Ward et al., 2017). This attention (to self-relevant goals) occurs even when the goals corresponding to these stimuli are not currently active in working memory (Ward et al., 2017).

In particular, self-relevant stimuli (i.e., stimuli that is relevant to the self through its rewarding and punishing effects) has been shown to automatically capture and prioritise attention (Truong & Todd, 2017). For example, people automatically attend to their own name in unattended channels (e.g., cocktail party effect; Bronkhorst, 2015), and one's own face captures attention over other faces (e.g., Bredart, Delchambre, & Laureys, 2006). Ownership has also been demonstrated as a category of self-relevant stimuli, with multiple studies showing that stimuli that has become self-relevant through ownership is better remembered and attended to than neutral stimuli (e.g., Cunning, Turk, Macdonald & Macrae 2008). In line with these findings, several studies have demonstrated that evoking self-relevant stimuli (e.g., own name) is associated with enhanced P300 – a component attributed to attentional allocation processes (e.g., Gray, Ambady, Lowenthal, & Dedlin, 2004; Tacikowski & Nowicka, 2010). Truong and Todd (2017) propose that when a stimulus (e.g., own name) is regularly encountered, automatic attentional responses are developed and learnt as a function of repetition, therefore overtime attention is automatically drawn to that stimulus involuntarily, and without conscious intent.

The prioritisation of self-relevant stimuli is known as the self-reference effect – which refers to stimuli associated with the self that trigger processing biases such as increased attentional focus and perceptual prioritisation (Rogers, Kuiper, & Kirker, 1977). This effect was first demonstrated in studies using the dichotic listening task (e.g., Cherry, 1953). In these experiments, it was demonstrated that when self-relevant stimuli (e.g., one's own name, one's own face) is presented (either aurally or visually), attention is automatically captured and therefore effects performance on tasks requiring sustained attention (Cherry, 1953).

Ward et al. (2017) argues that smartphones operate as self-relevant stimuli – they are often relevant to an individual's goals (e.g., checking emails, connecting with friends via facebook), and have been encountered with sufficient frequency to have developed an automatic attentional response to its presence. The self- reference effect helps to explain why both Ward et al. (2017) and Thorton et al. (2014) found that when participants had their mobile phones present, face-down, on silent, and not touched throughout the task, cognitive performance was reduced. For example, based on this rationale, when participants in Thorton et al's. (2014) and Ward et al's. (2017) study were undertaking a cognitive task, the presence of a smartphone may have caused the participants attentional resources to be reallocated from the task at hand to inhibiting automatic attention towards the phone (increasing cognitive load), thus diminishing performance on the task requiring these resources (Ward et al., 2017).

Mediating effect of cravings

Building on the self-reference effect, the present study wishes to investigate whether cravings could be an alternative mechanism to partially explain the mere presence effect of smartphones on cognition. The term "craving" refers to selective desires to consume particular substances (in our study technologies), characterised by an intense motivational state (Kemps & Tiggemann, 2010). For the purpose of the present study, we conceptualise smartphone cravings as an intense state of motivation to use the smartphone device. Cravings for different types of substances (e.g., chocolate, coffee, cigarettes) have been shown to impair cognitive processes such as memory, visual processing and attention (Kemps, Tiggemann, & Grigg, 2008; Palmer, Sauer, Ling & Riza, 2017). For example, in one study Palmer et al., (2017) investigated the effects of caffeine cravings on memory and metacognitive judgements (i.e., an individual's knowledge of their own cognitive processes). Their study comprised of a between-groups design in which cravings were manipulated in the experimental group through a combination of abstinence, imagery and in-vivo exposure to consumption cues (Palmer et al., 2017). Results demonstrated that cravings impaired both memory performance and metacognitive judgments.

According to Robinson and Berridge's (1993) incentive salience theory, cravings are regulated by a sensitised neural system (e.g., the mesocorticolimbic dopamine system) that functions to attribute incentive salience to reward cues. Due to continued exposure to drug taking, a Pavlovian conditioned response occurs and as a result, craving-related stimuli automatically captures attention and elicits drug taking behaviours (Robin & Berridge, 1993). While the theory relates to licit and illicit drugs (e.g., cigarettes, heroin), the model has also been applied to food (e.g., chocolate) (Kemps & Tiggemann, 2009). Therefore, the present study will investigate whether craving-related biases extends to technological devices such as smartphones.

How do cravings decrease cognitive performance?

Tiffany's (1990) prominent model can be used to understand why cravings decrease cognitive performance. Tiffany's (1990) model proposes that cravings are produced as a result of repeated consumption behaviours and as a consequence these behaviours are stored in long-term memory as action schemata. For example, when people crave caffeine, overtime they develop sequences of behaviours to fulfil their cravings (e.g., going to the shop and buying a coffee). Eventually these behaviours become automatic when prompt by cues (e.g., seeing someone drink a coffee) and to inhibit these sequences of behaviour, cognitive resources are needed (Tiffany, 1990).

Similarly, we suggest that for smartphone users – over time, through repeated use the behaviours associated with smartphone use (i.e., checking emails, posting on facebook) become automatic if prompted by cues (e.g., the sight of one's own smartphone, seeing someone else on their smartphone, receiving a notification), and it is difficult for individuals to inhibit automatic behaviour (i.e., not pick up their phone and use it). The inhibition of these schemata requires cognitive resources, leaving reduced capacity available to perform other tasks (Tiffany, 1990). Thus, based on Tiffany's (1990) model we propose that by having the smartphone present, the smartphone acts as a cue for behaviours associated with using the phone (checking facebook, replying to a text message). Because this response is elicited automatically in order to inhibit this behavioural response, participants need to use up cognitive resources – leaving limited resources to engage in the decision-making task and therefore participants will use more heuristic-based decisions.

Moderating effect of smartphone dependency

As previously discussed, smartphones allow access to a number of social and informational networks (Wilmer et al., 2017). Given the advantages and convenience of smartphone technology, smartphones have become increasing popular in recent years, allowing individuals to be in 'constant connectivity' (Thorton et al., 2014). The popularity of smartphones has been attributed to the psychological (Walsh, White, & Young, 2008) and practical benefits (Ward et al., 2017) associated with using the device. For example, smartphone devices can enhance social inclusion and connectedness by facilitating social networks such as facebook and Instagram (Wilmer et al., 2017). Smartphones can also provide feelings of safety and security especially for women walking or driving alone at night because emergency services can be reached if needed (Carroll, Howard, Peck & Murphy, 2002). Furthermore, smartphones also include a number of practical benefits. For example, sending and receiving instant messages, photos and video clips, an endless amount of entertainment and the ability to access emails, and the internet (Ward et al., 2017).

Although smartphones provide psychological and practical benefits to an individual, problematic smartphone use is becoming increasingly apparent, with recent research suggesting that problematic use can lead to a number of negative outcomes – including higher rates of sleep disturbance (Thomee, Harenstam, & Hagberg, 2011), depressive symptoms (Lu et al., 2011), psychological distress (Beranuy, Oberst, Carbonell, & Chamarro, 2009), anxiety and social extroversion (Hong, Chiu, Haung, 2012). Investigating these negative outcomes, Cheever, Rosen, Carrier, and Chaves (2014) found that when participants had their mobile phones removed from their possession and put into another room, overtime participants felt progressively more anxious without their phones. In addition, Clayton, Leshner and Almond's (2015) study found that by restricting participants from answering their phones while undertaking a cognitive task, participants reported feeling anxious and experienced physiological effects such as increased heart rate. Cognitive performance was also reduced (Clayton et al., 2015).

Given the psychological and physiological effects present when an individual is unable to use their smartphone, researchers have suggested that problematic smartphone use may lead to addiction and dependence (Walsh et al., 2008). There is a body of psychological work emerging based on smartphone addiction, however, it is important to note that smartphone addiction is not formally recognised as a clinical disorder within the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (De-Sola Gutierrez, Rodriguez de Fonseca & Rubio, 2016). Instead the term "smartphone addiction" is used loosely throughout the psychological literature to describe a behavioural addiction comprised of uncontrolled, inappropriate, or excessive phone use that results in negative outcomes (Choliz, 2010).

In a review by De-Sola Gutierrez et al. (2016) the symptomology of problematic smartphone use found in a number of studies was compared to the DSM-5 criteria for compulsive gambling and substance use. A number of similarities were found between the symptoms involved with problematic mobile phone use and the DSM-5 criteria (De-Sola Gutierrez et al., 2016). One such symptom that was identified in the DSM-5 criteria for substance abuse and problematic phone use was cravings (De-Sola Gutierrez et al., 2016). Therefore, given the relationship between smartphone dependency and cravings, we also wish to investigate whether individual differences in smartphone dependency will moderate the effects of smartphone presence on cravings – such that the effect of smartphone presence on cravings would be stronger for people higher in smartphone dependence.

Aims and hypotheses

The aim of the present study is to replicate the effect of smartphone presence on cognition further by investigating its effect on decision-making. We also wish to explore whether the relationship between smartphone presence and increased heuristic use can be partially explained by cravings, and whether craving intensity varies depending on smartphone dependency. Therefore, the present study has three hypotheses:

1. There will be a significant difference between the smartphone condition (smartphones present) and the control condition (smartphones absent), with participants in the smartphone condition using more heuristic-based decisions on a decision-making task than those in the control condition.
2. The effect of smartphone presence will be mediated by differences in cravings, such that smartphone presence will cause an increase in cravings, which in turn will be associated with an increase in heuristic use.
3. The mediation effect described in hypothesis two will be moderated by smartphone dependency. That is, the effect of smartphone presence on cravings, will vary depending on smartphone dependency, such that participants with higher smartphone dependency scores will score higher in smartphone craving intensity.

Method

Participants

Fifty-one participants participated in the study, of which 29 were female and 22 were male. Ages ranged from 19 to 45 (M = 25.76, SD = 5.57). We recruited participants aged 18 – 50 to avoid older participants who may be less likely to be frequent smartphone users. The sample comprised of University students and members of the general public from both

Hobart and Launceston. The study was undertaken at the University of Tasmania Newnham and Sandy Bay campuses. Participants received a $20 Coles/Myer gift card for participating or 60 minutes course credit for first year psychology students. Ethical approval was gained through the University of Tasmania Human Research Ethics Committee (see Appendix A).

Power. We took several factors into account determining sample size. An a priori power analysis conducted with G-Power (Faul, Erdfelder, Lang & Buchner, 2007) indicated that approximately 50 participants per group would be required to detect a medium-sized effect (i.e., Cohen's *d* of 0.5) at an alpha level of .05 with .80 power. However, given that very little prior research has examined the effects of smartphone presence on cognition, there was insufficient basis for firm expectations about the potential size of the effect. In light of this, and logistical constraints associated with conducting a lab-based study, we followed the recommendations of Simmons, Nelson, and Simonsohn (2011) and set a desired minimum of 20 participants per group.

Materials and procedure

Allocation. Participants were randomly allocated into either the smartphone condition (smartphone present; $N = 27$) or the control condition (smartphone absent; $N = 24$). In order to do this, we used Microsoft excel to randomly generate a "smartphone" and "no smartphone" condition into sessions. When participants booked in for the study, the condition they were assigned to would depend on which day and time was available. Each session would have a minimum of one participant and a maximum of three participants at one time (due to lab-based constraints).

Information and consent. Before being able to take part in the study, all participants had to read and give their consent (see Appendix C). The information form that was used gave some detail about what was being investigated, but it did not disclose anything about smartphones (see Appendix B). Once the experiment was completed, participants were provided with a debriefing form which explained in detail the study's true aim (see Appendix D).

Demographic information. Participants were asked a number of questions about demographic information including: gender, age and smartphone questions. The smartphone questions were questions that assessed to what extent participants thought their smartphone affected their performance in the lab; whether they brought their smartphone along to the lab; whether their mobile phone was in fact a smartphone; what they spend the most time doing on their smartphone (e.g., social media, text messaging); how often they thought about their smartphone throughout the study; whether the smartphone was in the lab with them during the study; and upon waking, time intervals between checking their device. The purpose of these questions was to collect as much information about participants smartphone use/frequency, enabling us to identify possible confounding variables if needed. However, it was beyond the scope of this thesis project to assess all of these variables.

Decision-making measure. The use of heuristics in decision-making was measured using a set of 14 heuristic-and-biases tasks (Toplak, West, & Stanovich, 2011). These tasks reflect the following: rational thought, hypothetical thought, probabilistic reasoning, scientific reasoning, statistical reasoning and theory justification and are designed to measure rational-thinking tendencies. The heuristic-and-bias battery consisted of a casual base rate problem, two sample size problems, a regression to the mean problem, a gambler's fallacy problem, two conjunction problems, a covariation detection problem, a methodological reasoning problem, a Bayesian reasoning problem, a probabilistic reasoning problem, a probability matching problem, an outcome bias problem and a sunk cost bias problem. The answers to each question reflect which system of thought a participant was using (i.e., heuristics or analytical). Items were scored in terms of whether or not the participant used a heuristic (e.g., either heuristic or no heuristic). The overall score across all tasks indicate the overall degree of heuristic use.

Smartphone dependency measure. Smartphone dependency was measured using the Problematic Use of Mobile Phones Scale (PUMP; Merlo, Stone, & Bibbey, 2013). The PUMP is a 22-item questionnaire designed to measure problematic mobile phone use. Items on the PUMP represent different behavioural addiction symptomology such as: tolerance (*e.g., I need more time using my cell phone to feel satisfied than I used to need*), withdrawal (*e.g., It would be very difficult, emotionally, to give up my cell phone*), cravings (*e.g., when I am not using my cell phone, I am thinking about using it or planning the next time I can use it*), activities given up or reduced (*e.g., I have ignored the people I'm with in order to use my cell phone*), and use despite physical or psychological problems (*e.g., when I stop using my cell phone because it is interfering with my life, I usually return to it*). All items are rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The overall score (out of a possible score of 100) on the PUMP across each item indicates the level of dependency. The PUMP has been shown to have excellent internal reliability ($\alpha = 0.94$).

Cravings measure. Cravings were measured using the Craving Intensity Scale (Kemps et al., 2008). This asks participants to report their perceived level of cravings for a specified substance or item using a visual analogue scale ranging from 0% (no desire) to 100% (strong desire). The scale is 100mm long, and a craving score of 0-100 is calculated by measuring the distance in millimetres from the 0% anchor to the indicated response on the scale. The Cravings Intensity Scale has been adapted to measure cravings for various items including caffeine, chocolate, and cigarettes. Following prior studies using this scale (e.g., Kemps et al., 2008), cravings were measured retrospectively after all main dependent measures were collected, in order to avoid inadvertently inducing cravings in participants. The Craving Intensity Scale asked participants to indicate how strong their desire was to use their smartphone (1) when they first arrived in the lab, (2) during the task and (3) upon completion of the study. For the analysis we used retrospective reports of cravings experienced during the task (rather than on arrival or completion of the study) because these cravings most closely reflect the hypothesised mechanism.

Smartphone and control manipulation. All participants were asked to bring their mobile phones and some form of photo identification along to the study. Once participants in the smartphone condition were seated they were asked to take out their mobile phones. Participants were then instructed to go into their mobile phone settings where they were instructed to turn all vibrate notifications off. Participants were then instructed to place their mobile phones on the desk in front of them, on silent, and were informed that they would not be using the mobile phone for this part of the study.

By contrast, on arrival participants in the control condition were taken to a locker room located approximately 50 metres from the laboratory where the study was running and instructed to place their belongings into a locker. In order to ensure participants in the control condition were not worrying about their mobiles phones, all participants were provided with a key. Participants in the control condition were then given the same instructions as the smartphone condition where they were told that they would not be using the mobile phone for this part of the study. To reduce the potential salience of the mobile phone in both groups, photo identification was checked. All participants (in both conditions) were then verbally instructed to complete the study using a desktop computer. A customised LimeSurvey software (Version 2.06, Schmitz, 2015) program first instructed participants to read and complete an information sheet and consent form. Secondly, participants were instructed to complete a decision-making task involving reading some hypothetical scenarios and answering questions about the scenarios which included the 14 Heuristics-and-Bias tasks (Toplak et al., 2011). Once participants had competed the decision-making task they were then instructed to complete two questionnaires including the Craving Intensity Scale (Kemps et al., 2008) and the PUMP scale (Merlo et al., 2013). On completion, participants were debriefed about the study.

Design

The present study was a between-subjects, single-blind, randomly-allocated design with one predictor variable (condition: smartphone, control) and one outcome variable (decision-making performance). The study also included one moderation variable (smartphone dependency) and one mediation variable (smartphone cravings).

Statistical analysis

A moderated mediation analysis (see figure 1) was used to analyse and interpret the data. Moderation refers to a variable that affects the strength and/or the direction of the relationship between a predictor variable and an outcome variable (Preacher, Rucker & Hayes, 2007). Mediation refers to a third variable that accounts for the relationship between a predictor variable and an outcome variable (Hayes, 2013). Mediation analysis explores whether an assumed mediating variable accounts for a significant amount of the shared variance between the predictor variable and the outcome variable – the mediator changes in regard to the predictor variable, which in turn, affects the outcome variable (Preacher et al., 2007). Moderated mediation is a combination of moderation and mediation and in the present scenario, this reflects that a predictor variable (i.e., smartphone presence) affects an outcome variable (i.e., decision-making) via a mediator variable (i.e., cravings) which differs depending on levels of a moderator variable (i.e., smartphone dependency) (Hayes, 2013). Thus, the moderated mediation analyses used in the present study attempted to address whether the indirect effect (i.e., mediation; cravings) was dependent on another variable (i.e., moderation; smartphone dependency).

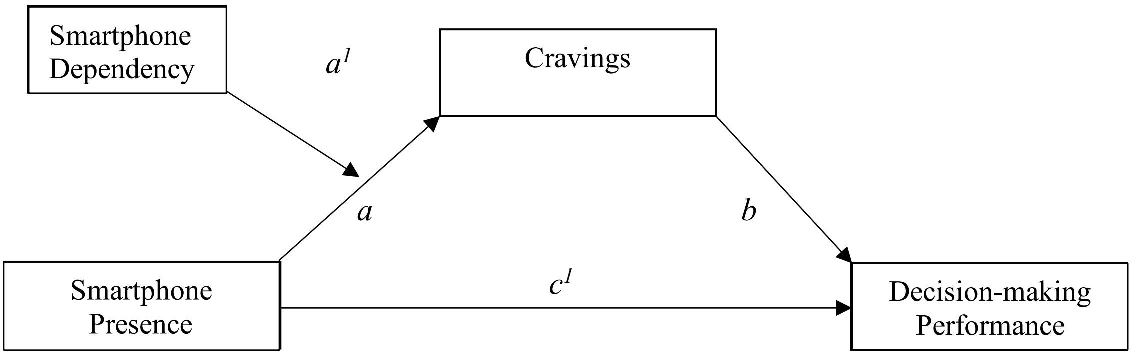

Figure 1. Moderated mediation model demonstrating the hypothesised effect of smartphone presence on the use of heuristics in decision-making. Smartphone presence is expected to increase cravings, and this effect should be stronger for participants higher in smartphone dependency. In turn, increases in cravings will translate to increased use in heuristics.

Results

Assumptions

Before statistical analyses were conducted, all data was assessed to ensure that assumptions had been met. The relevant assumptions that must be met for a moderated mediation are normal distribution of the outcome variable, linearity, and independence of observations (Preacher et al., 2007). Normal distribution of scores on the decision-making task were determined by visual inspection of a histogram – which revealed a normally distributed curve, with no outliers present. Importantly, neither the smartphone or control condition contained any outliers that could distort the group mean and create the impression of a difference in heuristic use. Inspection of scatterplots confirmed linear relationships and participants only took part once in the study which ensured independence of observations. Before running the moderated mediation analysis, one participant was excluded for not completing all items on the smartphone dependency scale (i.e., the PUMP; Merlo et al., 2013).

Descriptive statistics

Table 1

Means (and standard deviations) for the smartphone and control conditions

Condition		N	M	SD
No smartphone condition	Cravings	24	12.92	25.96
	Heuristic Total	24	6.33	2.51
	PUMP Total	24	57.88	15.99
Smartphone condition	Cravings	27	13.70	23.56
	Heuristic Total	27	7.59	1.80
	PUMP Total	26	60.15	15.71

Moderated mediation

The present study conducted a moderated mediation analysis to explore the mechanism underlying the relationship between smartphone presence and decision-making performance. In order to analyse all three hypotheses in SPSS, we made use of the PROCESS macro developed by Hayes (2013). Model 7 in PROCESS (Hayes, 2013; see figure 1) was used to test the indirect relationship between smartphone presence and decision-making performance through cravings, when moderated by smartphone dependency and the direct relationship between smartphone presence and decision-making performance. In order to test this association, we generated 95% bootstrap confidence intervals for the indirect effects using 1,000 bootstrap samples. Bootstrapping is recommended for moderated mediation and is the process of random sampling with replacement, it allows estimation of the sampling distribution using random sampling (Preacher et al., 2007).

For the first path of the moderated mediation (path *a*), smartphone manipulation did not affect cravings, B = - 0.52, 95% CI [12.99, 11.94], p = .93. These results indicate that by having a smartphone present, face down, on silent, and placed on the desk in front of participants throughout the task, did not affect how much a participant experienced cravings to use the device.

For the next path (path a^1), the effect of smartphone manipulation on cravings was not moderated by smartphone dependency, *B* = 0.02, 95% CI [0.78, 0.82], *p* = .96. These findings suggest that the relationship between smartphone presence and cravings did not depend on whether or not a participant was more dependent on their smartphone.

For path *b*, craving scores were not related to decision-making performance, *B* = -0.004, 95% CI [- 0.03, 0.02], *p* = .76. This finding suggests that differences in cravings had no effect on the amount of heuristics participants used. For the indirect pathway (i.e., the moderated mediation; *ab*), cravings did not mediate the relationship between smartphone presence and decision-making performance, indicted by a trivial indirect effect at all levels of smartphone dependency. This applied for low levels of smartphone dependency *B* = 0.003, 95% BCI [- 0.10, 0.21], medium levels of smartphone dependency *B* = 0.002, 95% BCI [-0.10, 0.19], and high levels of smartphone dependency, *B* = 0.0007, 95% BCI [- 0.27, 0.37]. Confidence intervals surrounding the indirect effect of cravings and smartphone dependency included zero, this indicates that no significant indirect effect was observed.

Although the data offered no support for the hypothesised moderated mediation model, smartphone presence did affect the use of heuristics. For the direct pathway (path c^1), there was a significant direct effect of smartphone presence on decision-making performance, such that smartphone presence increased the use of heuristics, *B* = 1.33, 95% CI [0.07, 2.58], *p* = .04, Cohen's *d* = 0.58, with participants in the smartphone condition using significantly more heuristic-based decisions (*M* = 7.59, *SD* = 1.80) than participants in the control condition (smartphone absent) (*M* = 6.33, *SD* = 2.51). These results suggest that smartphone presence increased the use of heuristic-based decision-making, but not by increasing cravings for smartphone use. Furthermore, although the difference in heuristic use between conditions represented a moderate effect size, it is important to note that the difference was small in absolute terms. On average, participants in the smartphone condition used heuristic-based decisions on 1-2 additional items out of 14.

Additional exploratory analysis

Although we found no effect of smartphone presence on cravings when moderated by smartphone dependency (i.e., path a^1), additional exploratory analysis revealed a strong relationship between smartphone dependency and cravings, such that the more dependent one was on their smartphone the more cravings they experienced, $B = 0.81$, 95% CI [0.41, 1.21], $p < .001$. This finding suggests that regardless of whether the smartphone was present or absent, participants who were more dependent on their smartphone experienced a more intense desire to use the device throughout the decision-making task.

Discussion

The present study aimed to replicate previous findings demonstrating that the mere presence of one's smartphone impairs cognitive performance (i.e., Thorton et al., 2014; Ward et al., 2017), and to extend this research to examine these effects on decision-making tasks that test the use of heuristics. We also investigated whether the relationship between smartphone presence and increased heuristic use could be partially explained by cravings, and whether craving intensity varies depending on smartphone dependency.

Assessing the role of smartphone presence on decision-making, the present study demonstrated a significant difference between the smartphone condition (smartphone present) and the control condition (smartphone absent). As expected, when smartphones were present, participants used significantly more heuristic-based decisions. This finding provides support for the first hypothesis and also adds support for previous research by Thorton et al. (2014) and Ward et al. (2017). However, it is important to note that the effect between the two conditions was small in absolute terms (i.e., smartphone presence increased the use of heuristics, but only by about 1-2 instances out of a series of 14 decision-making problems). Therefore, although smartphone presence increased heuristic use, it did not produce a situation where decision-making was dominated by heuristic processes.

Participants tendency to employ more heuristic-based decisions when the smartphone was present rather than when it was absent is consistent with dual process theories of decision-making (Evans, 2003; Petty & Cacioppo, 1986). Like in previous studies looking at the relationship between cognitive load and decision-making (e.g., Beilock & DeCaro, 2007; Rieskamp & Hoffrage, 2008), our data suggests that when smartphones are present, cognitive load is increased and as a result, heuristic-based decision-making occurs more often.

The second hypothesis exploring the mediating effect of cravings was not supported. Cravings provided no support for the underlying mechanism explaining the relationship between smartphone presence and decision-making performance. The third hypothesis, exploring the moderating effect of smartphone dependency on craving intensity was also not supported. The relationship between smartphone presence and craving intensity did not vary depending on smartphone dependency. However, there was a relationship between smartphone dependency and craving intensity, such that participants with high PUMP scores demonstrated higher craving intensity regardless of whether the smartphone was present.

Moderated meditation effect of smartphone dependency and cravings

Previous studies by Thorton et al. (2014) and Ward et al. (2017) have investigated the relationship between smartphone presence and cognition, demonstrating that by merely having a phone present (on silent, face down and not touched throughout a cognitive task) is cognitively draining; and impairs performance on a number of cognitive tasks (i.e., working memory, fluid intelligence). However, these studies have not explored in detail the mechanism that could be underpinning this relationship. The present study attempted to do this by investigating whether cravings when moderated by smartphone dependency could help to partially explain the relationship between smartphone presence and decision-making performance. However, we were unsuccessful in explaining the relationship between smartphone presence and decision-making, finding no moderated mediation. These findings suggest that the mechanism described in Tiffany's (1990) model of cravings does not account for the effect of smartphone presence on cognition. That is, although the smartphone may have acted as a cue for behaviours associated with using the device (e.g., scrolling facebook, texting a friend, picking the phone up), inhibiting these behavioural responses to use the smartphone was not because participants had a strong desire to use the device throughout the study.

Another alternative explanation to not finding a mediating effect of cravings when moderated by smartphone dependency may be due to the present study not having a strong enough craving induction. Typically, cravings are experimentally induced via abstinence, imagery or exposure (Kemps et al., 2008). Abstinence involves participants abstaining from using a craving-related substance for a certain amount of time before undertaking an assessment (Tidey, Colby, & Xavier, 2014). Imagery craving induction requires participants to imagine using a craved substance (Heishman, Saha, & Singleton, 2004), and exposure involves direct exposure with a craved substance (Tiffany, Carter, & Singleton, 2000). The present study used an exposure induction (i.e., smartphone sitting on the desk in front of participants) because it may have been difficult to get participants to go for long periods of time without using their smartphone (i.e., we rely on it to tell the time, receiving important calls) and imagery would not have worked in our experimental design. Furthermore, the whole study was designed around the 'mere presence effect' of smartphone presence, so exposure was the most logical way to induce cravings. Given that people interact with their smartphones up to eighty-five times a day (Perlow, 2012), we reasoned that those who were dependent would crave the use of their smartphones after only a short time without having to use abstinence. Nevertheless, we cannot rule out the possibility that a stronger manipulation (e.g., one involving prolonged abstinence from one's smartphone) might trigger cravings to use one's smartphone.

Furthermore, although we found no moderated mediation, we did find a strong relationship between smartphone dependency and craving intensity, such that those who experienced high levels of smartphone dependency had high craving intensity to use the device throughout the study. These findings suggest that people do indeed experience cravings to use their smartphone when they are dependent on it, however, this craving effect occurs regardless of whether the smartphone is present or absent. An explanation for this finding might be that cravings to use the smartphone occurred via internal cues (e.g., thinking about needing to reply to a text message) rather than external cues such as the smartphone being present (Green, Rodgers, & Elliman, 2000).

Alternative mechanism: the self-reference effect

While we were unable to demonstrate a moderated mediation effect of smartphone dependency and cravings, it is likely that the self-reference effect is one mechanism underlying this relationship (Ward et al., 2017). As previously discussed, it has been proposed that smartphones operate as self-relevant stimuli, they are frequently relevant to an individual's goals (i.e., checking emails, connecting with friends via facebook) and have been regularly encountered enough times (through constant repetition) to have developed an automatic attentional response to its presence (Ward et al., 2017). Thus, over time the smartphone draws on attention automatically and without conscious intent (Truong & Todd 2017). This idea is consistent with research showing that notifications from one's smartphone triggers a response from the same automatic attentional system that reacts to the sound of one's own name (Roye, Jacobsen, & Schroger, 2007).

Based on this rationale, when participants in the present study were undertaking the decision-making task, instead of their attention being drawn to the phone because they had an intense desire to use the device (i.e., cravings), their attention was drawn to the device because it was relevant to the self. For example, when participants were in front of the computer screen undertaking the decision-making task their attention kept being drawn to the smartphone rather than the task at hand because the smartphone was more relevant to the self. As a result of attention being reallocated from the decision-making task to inhibiting automatic attentional resources towards the smartphone, participants had to use up cognitive resources – leaving less cognitive capacity to engage in the decision-making task. Because heuristic-based decision-making takes up less cognitive capacity, participants used more heuristics when their smartphones were present than when they were absent.

Observed effects of smartphone presence on decision-making

When people are actively engaging with their smartphones (i.e., text messaging or scrolling social media) it is not surprising that performance on other tasks may be impaired (e.g., Strayer & Johnson, 2001). However, the potential that the mere presence of a smartphone can also serve as a distractor, seems to be equally problematic. The present study was able to provide evidence for the mere presence effect of smartphones on decision-making performance. Even when participants smartphones were face down, on silent and not touched throughout the entire experiment, the mere presence of these devices where still able to drain cognitive resources away from the task at hand. These findings are consistent with recent research from Ward et al. (2017) and older research by Thorton et al (2014) and expand on the mere presence effect by showing that the effect is also relevant to decision-making.

Our findings and previous findings suggest at least one simple solution to this problem: separation from your smartphone whilst engaging in activities that require cognitive resources. Although recommending separation from one’s smartphone may be contrary to previous findings suggesting that being separated from one's smartphone negatively affects cognitive performance because it increases anxiety (e.g., Cheever et al., 2014). Participants in the present study were not separated from their phones long and were told that they would be using their phones later in the study. Therefore, we suggest that periods of separation may allow people to perform better on tasks requiring cognitive resources by reducing interruptions and by increasing available cognitive resources.

Implications of research findings and future directions

The human cognitive system is able to operate in a world that is filled with a vast amount of information at any given time (Truong & Todd, 2017). However, this system has limited capacity, and, as a result, an individual's ability to process meaningful information is constrained to processing small amounts of information at once whilst simultaneously filtering out irrelevant information (Chelazzi et al., 2013). This limited capacity shapes a wide range of behaviours and determines how we encounter the environment on a daily basis (Ward et al., 2017).

The present study's findings indicate that the mere presence of one's smartphone may further restrain peoples already limited cognitive capacity by draining attentional resources needed in order to make decisions. Given that smartphones in daily life are so commonly present, the mere presence effect of a smartphone observed in our study demonstrates the ability of these devices to affect decision-making performance. This may be problematic because decision-making is a crucial part of life. For example, on a daily basis, we are inundated by decisions that prompt our behaviour in all different domains (e.g., consumer choice, risk management).

General implications. Our results demonstrate that the mere presence of one's smartphone causes a small increase in the use of heuristics in absolute terms, however, there are many situations where a small increase in the tendency to use heuristics might have important implications for decision-making. For example, a small increase in heuristic use could have important consequences in everyday situations such as driving, and for professionals whose role involves making judgements and decisions in political, economic, or military settings.

Educational implications. Given the high rate of young people owning a smartphone and their high reliance (Perlow, 2012), according to our data (more broadly), and a growing body of research demonstrating that the mere presence of a smartphone impairs performance on a variety of cognitive tasks (i.e., Thorton et al., 2014; Ward et al., 2017); an additional implication may be relevant to the effect smartphones could be having in schools. For example, because most young people own a smartphone, and findings from a number of studies suggest that students almost always report having their mobile phones with them in class (Gingerich & Lineweaver, 2014), the mere presence of these devices within the classroom context may be undermining learning and academic performance. Future research could look at how the mere presence effect of smartphones may be affecting children and young people's cognitive processing.

Advertising implications. A further implication relevant to our findings are the potential for people to become more susceptible to deceptive advertising. For example, according to the Petty and Cacioppo's (1986) elaboration likelihood model, the availability of cognitive resources predicts the likelihood that people will use the peripheral route to persuasion (leading to errors in judgment) rather than the central route. Consistent with our data, when smartphones are present a preference for system 1 processing (e.g., heuristic-based) may occur and thus people may not fully elaborate on advertising messages – leading to errors and biases in judgment (Petty & Cacioppo, 1986). Future research could investigate how the mere presence effect of smartphones may be affecting susceptibility to deceptive advertising.

Limitations

It is important to acknowledge the limitations of this research, in addition to those already mentioned (e.g., the results may not generalise to stronger craving manipulation involving abstinence). The present study only considered decision-making from one perspective: the use of heuristics in the context of dual process theories. Although this is a highly influential framework for examining decisions, that might be relevant to social and economic problems, there are many other ways to examine decision-making processes and other types of decisions. For example, we did not consider more deliberative decisions, such as those people make in legal situations where they are required to weigh the evidence. Future research could explore whether the mere presence effect of one's smartphone can also be applied to other types of decision-making. Future research could also examine how the presence of one's smartphone affects the use of heuristics in more realistic decision-making tasks (rather than the vignette-based problems used in the present study).

Given that previous research has found that separation from one's mobile phone can induce anxiety (e.g., Cheever et al., 2014), it is possible that our study underestimated the effect of smartphone presence on decision-making performance. For example, if the control condition (with their smartphones locked in a locker in a separate room) were experiencing anxiety by being separated from their smartphones then this may have also increased cognitive load (similar to the smartphone condition) and thus the effect between conditions may have been smaller. Future research could take a measure of smartphone separation anxiety and use it as a covariate variable in the analysis to see whether the difference between the two conditions is greater once anxiety has been controlled for.

The retrospective measure of state cravings used in the present study required participants to think back to various points during the experiment and self-report the level of cravings they were experiencing. This measure may be limited because it relies not only on self-report, but also on participants memory for their craving state at specific times (i.e., cravings before the study commenced, cravings during the study and cravings once the study was completed), which clearly introduces scope for noise in the measure. However, this type of retrospective measure has been used widely in research as a method for measuring cravings without alerting participants to the issue of cravings before key measures have been collected (Kemps et al., 2008).

In addition, there may be scope to better measure smartphone dependency as a moderating factor in future research. Although the PUMP scale is an established measure of smartphone dependency (Merlo et al., 2013), a measure of smartphone use that focuses more on a healthy obsession with one's phone (rather than problematic phone use) might offer better insight into how the effects of smartphone presence on cognition might be moderated by smartphone dependency.

Summary

In conclusion, the 'mere presence effect' of smartphones on cognitive performance is a new area of research. Although we found no moderated mediation effect of smartphone dependency and cravings, similar to prior research by Thorton at al. (2014) and Ward et al. (2017), our study was successful in demonstrating that the mere presence effect of smartphones does indeed affect decision-making performance. Consistent with dual process theories of decision-making, the presence of smartphones increased cognitive load and thus participants used more heuristic-based decisions. While smartphones allow us to connect with friends via social media apps, give us unlimited access to all sorts of entertainment and information and provide us with a tool that keeps us in 'constant connectively'; our research highlights the potentially costly side effect that smartphones may be having in today's society.

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Appendices

Appendix A: Ethics Approval Letter

Dear Dr Palmer

Ethics Ref No: H0017515
Project title: Relationship between mobile phone use and memory and decision-making

The above Minimal Risk application has been approved by the Chair of the Tasmania Social Sciences Human Research Ethics Committee, on behalf of the full committee. Approval is for four years and conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

A copy of the approval letter is attached for your records.

The Ethics Committee wishes you all the best with the project.

Kind regards

Ailin Ding

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Administration Officer Ethics

Appendix B: Information Sheet

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UTAS

U N I V E R S I T Y   O F   T A S M A N I A

A Study Investigating Different Types of Decision-making Processes

Information Sheet for Participants

1. Invitation

You are invited to participate in a research study examining factors that affect decision-making processes. The study is being conducted by Laura Bailey who is completing her Honours in Psychology, and Dr Matthew Palmer of the School of Psychology.

2. What is the purpose of this study?

The purpose of the study is to enhance our understanding of the factors which influence decision-making processes and the ability to make accurate decisions.

3. Why have I been invited to participate?

For this experiment, we are looking for people aged 18 - 50.
Your participation would contribute to research and understanding in this area. Participation in this study is voluntary – you are entirely free to choose to participate or not, and there will be no consequences if you decide not to participate. If you do participate, any information you provide will be anonymous and no participants in the experiment will be individually identifiable.

4. What will I be asked to do?

Participation would require approximately 60 minutes of your time on only one occasion and would take place in a room in the Psychology building on the University of Tasmania campus. The study involves reading information about hypothetical scenarios and answering some questions about the scenarios. Additionally, participants will be asked to complete some brief questionnaires. The tasks will take approximately 60 minutes to complete in total.

5. Are there any possible benefits from participation in this study?

We do not expect that the study will directly benefit participants. However, there may be benefits for the wider community. If we are able to determine whether something impairs decision-making performance, this research may lead to a better understanding of the area of decision-making, as well as broadening our knowledge of scientific experimentation.

6. Are there any possible risks from participation in this study?

There are no specific risks anticipated with participation in this study. However, if you find that you are becoming distressed or fatigued you can discontinue the task at any time. Additionally, you will be provided with support from the experimenters or, alternatively, we will arrange for you to see a counsellor at no expense.

7. What if I change my mind during or after the study?

That's fine - you are free to withdraw from the study at any time, and without providing an explanation. If you choose to withdraw during the study, your responses will be destroyed. If you complete the study, you will not be able to withdraw your data because it will be stored in anonymous form (and so we will not be able to identify which responses are yours).

8. What will happen to the information when this study is over?

The data from this study will be kept in secure storage on the University of Tasmania premises for a period of five years after any publications (e.g., in academic journals) that involve the data. After this period, the data will be archived. Only the researchers will have access to the raw data. The data will be stored anonymously. All responses will be anonymous and no identifying information will be collected from participants.

9. How will the results of the study be published?

The results of the study will be published in an honours thesis. Once the study has been completed, you will be able to access the results by visiting the website below:
http://www.utas.edu.au/psychology/research/research-project-reports
No individual participants will be identifiable in the publication of the results.

10. What if I have questions about this study?

If you would like to discuss any aspect of this study please feel free to contact Laura Bailey by email: lbailey2@utas.edu.au or Dr Matthew Palmer by email: matthew.palmer@utas.edu.au.
We would be happy to discuss any aspect of the research with you. Once the information has been analysed a summary of the findings may be obtained on request. You are welcome to contact us at that time to discuss any issue relating to the research study.

Thank you for taking the time to consider this study.
If you wish to take part in it, please sign the attached consent form.

This information sheet is for you to keep.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H12507.

Appendix C: Participant Consent Form

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UTAS

A Study Investigating Different Types of Decision-making Processes

Participant Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves participating in a decision-making task in which I will read information about hypothetical scenarios and answer some questions about the scenarios. Additionally, I understand that the researcher will ask me to complete some brief questionnaires. These tasks will take approximately 60 minutes in total to complete.
5. I understand that participation involves no foreseeable risks.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results and will then be destroyed unless I give permission for my data to be archived.

   I agree to have my study data archived. (Note that your data will be stored anonymously.)

   Yes ☐ No ☐
7. Any questions that I have asked, have been answered to my satisfaction.
8. I understand that the researchers will maintain confidentiality and that any information I supply to the researcher will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment as my data will be anonymous.

Participant's name: ____

Participant's signature: ____

Date: ________________________

Statement by Investigator

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ____

Investigator's signature: ____

Date: ________________________

Appendix D: Debrief Form

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UTAS

UNIVERSITY OF TASMANIA

Thank you for participating in this research. Your time is very much appreciated.
In this study, we are investigating factors that influence memory and decision-making. In particular, we are interested in how the presence of a smart phone might influence memory and decisions.

It's not surprising that smartphones can be distracting. Using your smartphone can obviously interfere with other things, like driving or paying attention in class. What is more surprising is that recent research suggests that simply having your phone next to you, even if you are not using it, can be distracting on simple cognitive tasks like paying attention to something on a computer screen. In our research, we are testing whether having your phone nearby – even if you are not using it – affects performance on memory and decision-making tasks that are a little more complex (e.g., involving the ability to make decisions based on logic and calculations of probability). Given the enormous popularity of smart phones, and the fact that people make many decisions with their phone nearby, it is important to understand how decisions and memory might be affected by the mere presence of a smartphone. Although you were told beforehand that this study was about factors that influence memory and decision-making, you were not told that this study was investigating whether the presence of a smartphone influences memory and decision-making. This is because knowing the purpose of this study can influence the way people respond. In this case, if you knew that this study was about smartphones, that knowledge may have influenced your responses (even if you were trying not to be influenced). This would potentially lead to misleading results and conclusions from the study.

Thank you again for participating in this research. If you have any questions about this research or would like to withdraw your data from this study, please feel free to contact us.
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Jim Sauer jim.sauer@utas.edu.au