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The brain in your pocket: Evidence that Smartphones are used to supplant thinking ☆

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ABSTRACT

With the advent of Smartphone technology, access to the internet and its associated knowledge base is at one's fingertips. What consequences does this have for human cognition? We frame Smartphone use as an instantiation of the extended mind—the notion that our cognition goes beyond our brains—and in so doing, characterize a modern form of cognitive miserliness. Specifically, that people typically forego effortful analytic thinking in lieu of fast and easy intuition suggests that individuals may allow their Smartphones to do their thinking for them. Our account predicts that individuals who are relatively less willing and/or able to engage effortful reasoning processes may compensate by relying on the internet through their Smartphones. Across three studies, we find that those who think more intuitively and less analytically when given reasoning problems were more likely to rely on their Smartphones (i.e., extended mind) for information in their everyday lives. There was no such association with the amount of time using the Smartphone for social media and entertainment purposes, nor did boredom proneness qualify any of our results. These findings demonstrate that people may offload thinking to technology, which in turn demands that psychological science understand the meshing of mind and media to adequately characterize human experience and cognition in the modern era.

> *"...the medium is the message... the personal and social consequences of any medium - that is, of any extension of ourselves - result from the new scale that is introduced into our affairs by each extension of ourselves, or by any new technology."*
>
> [McLuhan (1964), p. 8]

1. Introduction

McLuhan (1964) turned the attention of the world to the impact that technological change can impart by famously proclaiming "the medium is the message." The internet, although now ubiquitous, is a recent addition to our society that has afforded unprecedented access to information of nearly every possible kind. This easily accessible online knowledge base has largely supplanted other media in terms of acquiring knowledge for daily life. As such, few, if any, media have been as monumental as the internet. First bounded by wires, next by proximity to a router, the advent and rise of the Smartphone means that the internet and the massive knowledge base it contains now knows no bounds for billions. Soon the number of Smartphones in use will be in the billions and the anticipated power of such devices is expected to continue to grow at a rate reminiscent of science fiction rather than science fact (Miller, 2012). Smartphones have undeniably become a medium with a very important message – a message that has yet to be deciphered.

1.1. The extended mind

The extended mind – the notion that the mind goes beyond grey matter – is an idea that allows an understanding of human cognition as acting in a coupled system with the environment (Clark & Chalmers, 1998; Clark, 2008). In the seminal work on this topic, Clark and Chalmers (1998) define an extended cognitive system as an external object that serves to accomplish a function that would otherwise be attained via the action of internal cognitive processes. A simple example is the jotting down of a number on paper, rather than maintaining that same information in memory. The technological properties of Smartphones provide an exciting and interesting new means of externalization. Such devices go

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beyond assisting memory through simple maintenance, as has long been done with various media, and in fact accomplish much in the way of the storage and retrieval of memory as well.

Given the significance of the central tenet of this idea, as well as the staggering efficiency with which 'cognitive' functions can now operate externally, it is surprising how little work has directly explored Smartphones within such a framework. Empirical support for the notion that the internet, an integral component of the Smartphone's utility, acts as an extension of the mind comes from research demonstrating that people think of, and use, the internet as a transactive, or external, memory source (Sparrow, Liu, & Wegner, 2011). One can easily probe the depths of the internet, as opposed to one's own mind to retrieve information, thus limiting the use of effortful cognitive processes.

1.2. Cognitive miserliness and dual-process theories

Parallel to this work, a long tradition of reasoning research has demonstrated that humans are "cognitive misers" (Kahneman, 2011; Stanovich, 2004), a term adopted from early information processing frameworks (Dawes, 1976; Taylor, 1981). Empirical evidence shows that people tend to eschew costly analytic thought in favor of comparatively effortless intuitive processing (for reviews, see Baron, 1998; Evans, 1989; Evans & Over, 1996; Kahneman, 2003; Kahneman, Slovic, & Tversky, 1982; Shafir & Tversky, 1995; Stanovich & West, 2000). Consider the following example from the Cognitive Reflection Test (CRT; Frederick, 2005):

> A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? _____ cents.

The bat and ball problem cues an intuitive response (i.e., 10 cents) that can be shown to be obviously incorrect using a very simple mathematical operation (.10 + 1.00 + .10 = 1.20). However, college students and participants recruited online nonetheless tend to have a great deal of difficulty correctly solving the problem – with typical scores falling around 33% correct (Campitelli & Gerrans, 2014; Frederick, 2005).

The difficulty that people have with problems like the above example is easily understood under a dual-process perspective of cognitive functioning (e.g., Evans & Stanovich, 2013). Dual-process theories distinguish between autonomously cued intuitive or "Type 1" processes that require few cognitive resources on the one hand and more deliberative "Type 2" processes that require working memory capacity on the other (Evans & Stanovich, 2013; see also Evans, 2009; Sloman, 1996; Stanovich, 2009; Thompson, Prowse Turner, & Pennycook, 2011). Under this explanation, performance on the bat and ball problem is relatively low because the features of the problem cause Type 1 processing to rapidly output a response that requires resource demanding Type 2 processes to override. Thus, in other words, the miserly nature of human cognition lends itself to an overreliance on simple heuristics and mental shortcuts (Kahneman, 2011; Kahneman et al., 1982).

1.3. Hypothesis

One potential consequence of the accessibility of Smartphone technology is that the general disinclination and/or inability to engage analytic thinking may now be applicable not only to reliance on intuitive and heuristic thinking, but also to no thinking at all. A straightforward prediction follows from this line of reasoning: There should be a relation between these two forms of cognitive miserliness, such that those more prone to rely on intuitive cognitive heuristics should be more prone to heavy Smartphones use. We tested this prediction in three studies.

2. Study 1

As an initial test of the proposed association between Smartphone (SP) use and heuristic thinking, we gave participants a set of "heuristics and biases" problems that have been used extensively in previous research. Each problem is designed to cue an incorrect intuitive response that is difficult to override and is therefore considered at least partially reflective of analytic cognitive style (otherwise referred to as thinking disposition, see Stanovich, 2009). Participants were also asked to indicate if they own a Smartphone and, if so, how much time they spend on it generally and using search engines in particular.

2.1. Method

2.1.1. Participants

Participants in Study 1 were Americans recruited through *Mechanical Turk*™, an online marketplace where 'workers' can sign up for paid studies (Buhrmester, Kwang, & Gosling, 2011). Participants who failed an attention check question were excluded from analysis. For this, participants were shown a list of activities and asked to write "I read the instructions" in the "other" box if they were, in fact, reading the instructions. The final sample included 190 individuals (94 females, M_{age} = 35).

2.1.2. Measures

These data were collected as part of a larger set of studies on political ideology, religious beliefs, and moral values. As such, additional measures were included in the study session that are not of interest here, and are thus not reported.

2.1.2.1. Cognitive. Cognitive measures for Study 1 included 4 syllogisms (De Neys & Franssens, 2009), 4 base-rate problems (De Neys & Glumicic, 2008), and a 14 item "heuristics and biases" battery (Toplak, West, & Stanovich, 2011). Individual items for the cognitive measures can be found in Supplementary materials. An overall cognitive style score was computed by taking the mean of the three measures.

2.1.2.2. Smartphone use. After answering a set of demographic questions, participants were asked to indicate whether they own a Smartphone (SP). Those who responded affirmatively were asked to indicate roughly how many minutes they spend per day (a) on their SP and (b) on their SP specifically using search engines.

2.2. Results

Performance did not significantly differ between SP owners (N = 131) and non-owners (N = 47) on any of the cognitive measures, t's < 1.5, p's > .18. To assess the predicted association between performance and SP use, SP owners were broken up into three roughly equivalent usage groups (low, medium, and high). This approach was taken in lieu of correlational analyses because it is not influenced by outliers and as a consequence does not require case exclusion. We computed an overall performance score on the cognitive style measures and compared the three usage groups using one-way ANOVA's (see Table 1). There were main effects of SP usage group, $F(2, 128) = 9.61$, $MSE = .03$, $p < .001$, $\eta_p^2 = .13$, and SP search engine usage group, $F(2, 128) = 10.76$, $MSE = .03$, $p < .001$, $\eta_p^2 = .14$ (see Table 1). Follow-up t-tests revealed that there was no difference between low and medium usage groups for general SP use, $t < 1$. However, all three search engine use groups differed, all t's > 2.68, p's < .01.

The main effect of SP usage group held for each of the individual cognitive style measures: Syllogisms, $F(2, 128) = 3.65$, $MSE = .134$,