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Attentional control and engagement with digital technology

Multiple demands comprise the efficiency of attentional control[1]. There is abundant evidence that when an individual attempts two or more attentionally demanding activities at the same time, the allocation of attention to the tasks is limited and performance suffers as a result[2]. Yet, recent technological innovations require many individuals to manage multiple digital technologies simultaneously or to switch attentional control between tasks[3]. The ability to multitask with various digital technologies involves dividing attention, switching between tasks, and keeping track of multiple strands of information in working memory.

Here we examine the impact of the quality of multitasking on attentional control. Using real world engagement with digital technology to address the issue, we found that active and passive digital technology users have qualitatively different profiles of attentional control. Active digital technology users prefer to process information in parallel, while passive digital technology users process information successively and so they find it easier to focus on a target and filter out distractions. These differing profiles of attentional control have implications for ways in which we best respond to demands in the workplace[4].

There are two competing theories to account for how multitasking impacts attentional control. One account is the bottleneck view where information is processed serially. As a result, attention can only be allocated to one task at a time and engaging in multiple tasks concurrently results in a bottleneck, which impairs cognitive performance[5]. An alternative account is a capacity-limited view where information is processed in parallel. However, there is a restricted scope in how attention can be allocated, which means that in order to do complete multiple tasks simultaneously, fewer demands must be made for each task[6,7].

Previous research indicates that the frequency of multimedia use results in differing profiles of attentional control[8,9]. For example, individuals who labeled as chronic have media multitaskers appear to adopt a more wide-ranging scope of assigning attention to tasks[9]. As a result, they appear to fail to inhibit distracting information. In contrast, individuals who multitask less frequently seem to process information serially and thus are able to allocate attentional resources fully on a single task. This approach allows them to filter out irrelevant information while performing efficiently in a task.

The aim of the present study was to build on such research on the effect of the quantity of multitasking and investigate the quality of multitasking. Specifically, we were interested to determine whether active or passive engagement with digital technology influences attentional control. We extend previous research in lab settings[7] (e.g., Tombu & Jolicoeur,2004) to look at real world engagement with digital technology to address the issue of how this impacts attentional control. To identify people who are active vs. passive users of digital technology, we developed a questionnaire-based active/passive index that reflected a person's interactions with different internet forms, such as Facebook and Twitter. The average number of hours a person spent consumed with these activities was calculated and individuals were classified as active digital technology users (ADT) if they scored one standard deviation or more above the mean and those who scored one standard deviation or less than the mean were classified as passive digital technology users (PDT).

Attentional control was measured on dimensions that represented the ability to allocate attention to target stimuli, accurately filter out distracters, and use working memory to switch between tasks. Participants viewed a number on a screen and had to allocate attention to respond to a target stimuli (the number ‘5’) while filtering out distracters (all other numbers). As a measure of task switching, another version was presented where the participant had to click on all other numbers except for the number 5. Switch costs were calculated as the accuracy of responses, a measure of false positives, omissions, and mean response times, across four trial blocks[10].

Results

Does active engagement with digital technology improve attentional control? Yes. A repeated measures ANOVA on accuracy rates across the four blocks revealed a significant difference [$F(3,609)=24.14$; $p<.001$] and a significant interaction [$F(3,609)=3.71$; $p=.01$]. Post-hoc pairwise comparisons indicated that the ADT users were significantly more accurate than the PDT group in Block 1 ($p=.01$).

The level of engagement with digital technology also impacted the number of false positives across the blocks [$F(3,609)=226.21$; $p<.001$] and the PDT users committed significantly fewer false positive errors compared to the ADT group [$F(1,203)=4.16$; $p=.04$], but not a significant interaction [$F(3,609)=2.17$; $p=.09$]. Switching costs were measured using post-hoc pairwise comparisons of the percentage of false positives between Block 1 and the subsequent blocks: both active (ADT) and passive engagers (PDT) performed signifincantly different across all comparisons ($p<.05$).

Inspection of omission errors revealed no significant group effects [errors across blocks: $F(1,609)=1.72$; $p=.16$; or engagement: $F(1,203)<1$]; but a significant interaction [$F(3,609)=3.97$; $p=.008$]. The PDT group missed more target stimuli compared to the active engagers in Block 1 ($p<.05$), but not in the subsequent blocks, which suggests that the PDT users were able to allocate their attentional resources effectively after Block 1. Switching costs as measured by the percentage of omission errors between Block 1 and the subsequent blocks indicated a significant difference in a linear fashion only for ADT users ($p<.05$).

Finally, there was a significant difference in response times across the blocks [$F(3,591)=113.98$; $p<001$], but not in engagement level [$F(1,203)<1$], nor interaction [$F(3,591)<1$]. There were significant switching costs in response times for both active (ADT) and passive engagers (PDT) across all comparisons ($p<.05$).

There were two key findings. First, the ADT users were more accurate and had fewer misses of the target stimuli in Block 1. In subsequent blocks, the passive engagers were able to allocate attentional resources efficiently and their performance matched the ADT group. The second key finding was that ADT users do not discriminate their attentional resources exclusively to the target stimuli and are less likely to ignore distractor stimuli. The ADT users seemed to adopt a capacity-sharing approach where information was processed in parallel[6,7] and they assigned similar levels of attentional control to the target and distractor stimuli. Their engagement with digital technology appeared to be exploratory and they assigned similar weight to incoming streams of information.

In contrast, the PDT users volitionally assign attentional control to targets and filter out distracters. They appeared to process information serially (the bottleneck account[5]). However, practice can make processing information more efficient, and thus reduces the amount of resources that need to be allocated to a task. Support for this view was evident in the shift in the PDT users' performance from Block 1 to subsequent blocks. In Block 1, they were less accurate and had more misses compared to the ADT users. However, with practice they were able to automatize some of the processing and there was no difference in accuracy between the ADT and PDT users in subsequent blocks. Thus the bottleneck effect was eliminated in the PDT users as a result of practice.

In summary, active and passive digital technology users have qualitatively different profiles of attentional control. ADT users prefer to process information in parallel and thus, may be at an advantage in a workplace environment that demands they manage multiple streams of information. In contrast, PDT users process information successively and so they find it easier to focus on a target and filter out distractions[11, 12]. These users may be at an advantage in a workplace environment that demands they frequently switch between tasks.

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