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Off-task behaviours run rampant across both online and laboratory data collection settings

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Standfirst

Off-task behaviours such as media multitasking and mind-wandering run rampant across online and laboratory studies. Given that many research approaches in cognitive science rely on the assumption that participants are fully attentive in these studies, addressing on-task disengagement is critical for understanding the true inner workings of the mind.

Over the past few years, scientists have needed to become more creative with their data collection. With the COVID-19 pandemic halting virtually all laboratory-based testing, researchers have turned towards online crowdsourcing methods (e.g., Amazon Mechanical Turk, CrowdFlower, Prolific) for quality data.

In principle, these alternatives to standard in-person testing serve their function well, as studies have shown strong overlap in performance between online and laboratory data collection[1,2]. However, recent work has surprisingly uncovered that a large proportion of participants engage in off-task behaviours during online studies. For example, when completing online surveys, 2–25% of individuals are said to engage in media multitasking[3,4], that is, multitasking wherein at least one of the tasks involves media (e.g., reading while watching TV or working while attending to social media). Equally concerning is that 9–85% of individuals media multitask while completing online experimental tasks (A. C. D., E. J. P., & D. S., in revision). Since off-task behaviours are known to impact overall data quality and performance[3,4], these findings have raised questions about the accuracy of conclusions drawn from online environments.

Given the high prevalence of off-task behaviour within online settings, one might wonder why there is an overlap in performance between online and laboratory studies, when the latter of the two methods do not allow participants to media multitask. The answer to this question might rest on the high level of off-task behaviours found even in laboratory settings, which in this context primarily involves mind wandering[5], that is, engaging in thoughts that are not tied to a specific task at hand. Indeed, participants routinely engage in mind-wandering from 10–60% of the time while completing laboratory tasks[6], and this behaviour also impacts overall data quality and performance[7]. Thus, off-task behaviours appear to be similarly common across both online and laboratory data collection, but they manifest differently depending on the experimental context—presenting as mind

wandering in the laboratory when a strong degree of experimental control can be applied, and as media multitasking online when distracting media options are more readily available. Supporting this idea, recent work has shown that when participants are given the opportunity to media multitask during an experimental task, mind wandering decreases as media multitasking increases[8]. Given the similar occurrence and possible trade-off in off-task behaviours across online and laboratory data collection, the important question that arises is not to what extent do online studies match laboratory findings, but to what degree do off-task behaviours pose a problem for the conclusions we draw from both online and laboratory settings—are cognitive scientists merely studying the disengaged mind?

The problem with on-task disengagement

The ubiquitous presence of off-task behaviours during online and laboratory experimental tasks pose a problem for cognitive scientists because these behaviours may undermine the assumptions underlying some of our most common, enduring, and cherished research approaches. Specifically, several approaches allow us to infer the inner workings of the mind by relying on the assumption that participants are fully attending to their experimental task. One of these involves the *study of mental chronometry*, which seeks to measure the time course of information processing at various stages of the cognitive architecture[9]. Another involves determining the *limits of cognitive processes* by studying the maximal capacity of cognitive resources[10] and memory stores[11]. Still another involves the *examination of individual differences*, whereby variations in individual behaviour are correlated with differences in cognitive abilities[12]. In these cases, if participants are devoting less than full attention to their experimental task, study interpretation becomes problematic because off-task behaviours can pull attentional resources away from the task[13], thus confounding measures for the speed of information processing, estimates of maximal capacity of cognitive processes, and

correlations of individual differences among cognitive abilities. Although there are a few approaches that can be used to account for participant inattention, these are based on one or more of the following (often implicit) assumptions.

Frequency of disengagement. One common assumption is that off-task behaviours occur infrequently during experimental studies and can either be safely ignored or they should present as outliers within the data (e.g., abnormally long response times) that can be removed. Although the true proportion of off-task behaviours in experimental studies remains unknown because they are often not directly measured, the available evidence suggests that these states are actually shockingly common, with 9–85% of participants media multitasking in online settings (A. C. D., E. J. P., & D. S., in revision) and mind wandering occurring 10–60% of the time when participants complete laboratory tasks[6]. With more studies now demonstrating the commonality of off-task behaviours, it is becoming abundantly clear that the assumption that individuals are generally attentive to their experimental task with only brief instances of inattention may be incorrect; rather, the common state seems to be an off-task mind that is corralled for short bursts of on-task attentional focus.

Impact of disengagement. Often dovetailing with the aforementioned notion is the assumption that off-task behaviours have a momentary impact on performance without any longer protracted effects. Accordingly, off-task behaviours can be localized to specific inattentive trials and filtered out. However, an inattentive moment may impact behaviour beyond a specific moment of inattention. For instance, returning attention to an on-task state after engaging in off-task behaviours involves a task-switch, which may entail a task-switch cost because the cognitive system may need to be reconfigured to optimally process the switched-to task[14]. As another example, the phenomenon of 'cascading inattention'[15]) suggests that missing some content due to inattention precludes one from fully understanding subsequently attended content, thereby impairing performance and

triggering additional bouts of inattention. As these examples suggest, the negative effects of off-task behaviours can impact performance beyond a momentary inattentive episode, and the extent of this impact may be difficult to determine.

Similarity of disengagement. An additional likely assumption is that off-task behaviours manifest similarly across individuals. This assumption allows researchers to apply the same inattention-based exclusion criteria across all participants and feel confident in the notion that they are studying a cognitive process that excludes bouts of inattention. However, specific inattentive states have been shown to correlate with a variety of variables that differ across individuals. For instance, higher media multitasking is associated with risk-taking and sensation-seeking[16], and greater mind wandering is linked to anxiety and depression[17]. These intersectional links pose several difficulties. More broadly, removing participants based on inattention-based criteria may result in exclusions that leave out groups of individuals who have particular characteristics and traits, thus biasing resulting samples of data. More specifically, when considering examinations of individual differences, off-task behaviours could become an important but statistically unaccounted for 'third' variable that leaves the resulting conclusions of correlation-based studies incomplete.

What should be done about on-task disengagement?

Given these considerations, we propose that the only realistic way that researchers can deal with disengagement in online and laboratory settings is to adopt the assumption that *off-task behaviours are going to occur*. This means facing issues of inattention head on by placing a greater emphasis on accurately measuring and accounting for off-task states, reducing moments of inattention by increasing on-task engagement, and crafting robust research questions that are resilient to the presence of off-task behaviour.

Measuring and accounting for off-task behaviour. There are fortunately a myriad of direct methods for measuring off-task behaviours that typically involve asking participants to self-report their attentional state throughout their task (e.g., with intermittent thought probes[5]) or at the end of the task (e.g., with questions about overall off-task engagement[18]). Researchers can also employ indirect methods to infer the presence of off-task states, by, for example, monitoring participants' behaviour in online or laboratory environments for signs of inattention. Along these lines, researcher could visually assess whether participants are looking away from their task display, monitor changes in size or focus of the task screen as an index of media multitasking[3,19], or examine variations in reaction time to infer the presence of mind wandering[20,21]. These methods may not capture all forms of off-task states, but they increase the likelihood that researchers will record as many off-task instances as possible. Critically, once suitably measured, researchers can take steps to statistically control for off-task behaviours during data analysis. For example, a further step could be to manipulate levels of off-task behaviours, such as by manipulating task difficulty[22] to better assess the role of inattention in cognitive studies. This degree of off-task measurement and control during research studies would go a long way towards assuaging concerns about the influences of off-task behaviour on primary cognitive metrics of interest.

Increasing on-task engagement. Enhancing motivation during experimental tasks is known to successfully reduce off-task behaviours and improve task performance[23,24]. Therefore, it may be useful to move beyond simply increasing financial incentives for participation and consider the myriad of other possible motivators that increase engagement. For example, prior work has shown that individuals participate in online studies for a variety of reasons in addition to financial gain, including enjoyment, to pass time, and to learn about oneself[1]. Another option would be to re-examine the types of tasks we rely on for studies of cognition, which typically use simplistic stimuli presented over many repeated trials. Although these parameters provide high reliability and strong

experimental control, they can result in tasks being monotonous and mind-numbingly boring, thereby increasing participants' desire to engage in off-task behaviours. Including experimental stimuli and tasks that have more overlap with the complexity, interestingness, and variety found in everyday life could prove beneficial in this regard.

Crafting robust research questions. Ultimately, a promising way forward might involve reframing research questions so that they do not hinge on the assumption of full on-task attention. At a minimum, relaxing this assumption would allow researchers to formulate questions that overlap with the dominant mode of attention in everyday life, which seems to be characterized by regular off-task states[25,26]. For example, a modified research question about the limits of cognitive processes might involve asking about the *functional* limits of a cognitive process in a particular everyday context (e.g., how attentive are students during in-class lectures). This modification acknowledges that in any given situation participants' performance might not reflect their actual maximal abilities, which shifts the focus from what a person can do, to what a person actually does in a given context.

Although these proposed solutions are not exhaustive, the complementary and converging routes discussed here are meant to encourage us as cognitive scientists to be more creative when it comes to crafting research questions, designing studies, and analyzing data. Recent years have seen an increased focus on pre-registration practices and open science protocols to increase the integrity of scientific work[27]. In the same vein, addressing the issue of inattention and off-task behaviours across online and laboratory settings will allow us to ensure that our scientific endeavours reflect the true inner workings of the mind.

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Competing Interests

The authors declare no competing interests.

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