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COMMENT

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Is boredom a source of noise and/or a confound in behavioral science research?

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Behavioral researchers tend to study behavior in highly controlled laboratory settings to minimize the effects of potential confounders. Yet, while doing so, the artificial setup itself might unintentionally introduce noise or confounders, such as boredom. In this perspective, we draw upon theoretical and empirical evidence to make the case that (a) some experimental setups are likely to induce boredom in participants, (b) the degree of boredom induced might differ between individuals as a function of differences in trait boredom, (c) boredom can impair participants' attention, can make study participation more effortful, and can increase the urge to do something else (i.e., to disengage from the study). Most importantly, we argue that some participants might adjust their behavior because they are bored. Considering boredom's potential for adding noise to data, or for being an unwanted confound, we discuss a set of recommendations on how to control for and deal with the occurrence and effects of boredom in behavioral science research.

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When studying affect, cognition, and behavior, scientists often use "artificial tasks in sensory and socially deprived environments" (Shamay-Tsoory and Mendelsohn, 2019). While such settings maximize experimental control, they might unwillingly introduce inner states that alter participants' behavior. Such unintended factors can be considered noise if their occurrence is equally distributed throughout the study sample, yet they might, in the worst case, introduce systematic bias that potentially leads to wrong inferences. Due to the way prototypical research settings are designed, one state that is very likely to occur is boredom, a sensation whose effect on human affect, cognition, and behavior has been shown in numerous studies (Raffaelli et al., 2018; Jangraw et al., 2023).

In this comment, we draw upon theoretical and empirical evidence to make the case that (a) a critical number of participants report being bored when taking part in studies, (b) the degree of boredom that is experienced differs as a function of inter-individual differences in trait boredom, and (c) boredom can impair participants' attention, can make study participation more effortful, and can increase the urge to do something else (i.e., to disengage from the study). When surveyed, participants report adjusting their behavior because they are bored, and they feel this might bias study outcomes. Taking these facts into account, we argue that state boredom—if introduced uniformly across participants and study groups—has the potential to introduce noise, which decreases the precision of measurements (Nebe et al., 2023). More critically, if different conditions or study groups vary *systematically* in state or trait boredom, boredom can act as a confounding variable, potentially biasing study outcomes.

Our comment is data-supported: Substantiating these theory-driven propositions, we present data that support the claim for the (unintended) role of boredom in behavioral science research. To this end, we surveyed two samples drawn from the population of participants that provide the backbone for many results from behavioral science research: University students ($n = 113$) and paid online workers ($n = 419$). Across both samples, boredom was reported as a corollary of study participation, and 53% of the participants think that—based on their personal experiences as participants in studies—study outcomes might be altered because participants were bored. Thus, while determining the magnitude of boredom's unwanted role in research requires further empirical research, a substantial portion of research participants feel it matters.

Taken together, we provide conceptual and empirical support for the hypothesis that boredom can be an unaccounted factor that might add noise to data or act as a confound in behavioral studies. Building on this, we discuss a set of ideas on how to control for and deal with the occurrence and effects of boredom in behavioral science research. However, to better understand why boredom might be such a relevant factor to be considered in research settings, it is crucial to define *what* boredom is and *when* it occurs.

What is boredom and why does it matter?

Boredom is a ubiquitous human experience (Harris, 2000) that occurs in a plethora of different situations (Chin et al., 2017). Boredom can be understood as a state during which one feels that the action one is currently taking is not adequately aligned with one's aims (i.e., inadequate function utilization). Boredom occurs when the reward prediction error has been minimized and things seem entirely predictable (Schultz, 2017; Wolff et al., 2022). This state is particularly likely to occur when an activity is perceived as meaningless (Pekrun et al., 2010; Westgate and Wilson, 2018) and when task demands do not align with one's capabilities, preferences, and perceived energy levels (Wolff et al., 2022; Fox, 2022), and/or when one perceives a lack of agency (Raffaelli et al., 2018). In contrast, when an activity aligns with one's preferences, within one's capabilities, and matches perceived levels of energy, boredom tends not to arise (Wolff et al., 2022).

Crucially, boredom matters. Theoretical and empirical work has shown that boredom is an aversive sensation (Westgate and Steidle, 2020) that acts as an internal signal to change one's ongoing course of action (Wolff and Martarelli, 2020). More specifically, functional accounts of boredom propose that boredom triggers exploration (i.e., it orients our attention off task) and thereby assume that boredom has a key role in navigating the trade-off between exploration and exploitation (Danckert, 2019; Bieleke and Wolff, 2021). By acting as a push toward exploration, boredom is understood as to increase the urge to do something else (Wolff and Martarelli, 2020), and as a state of heightened sensitivity to rewards (Milyavskaya et al., 2019). Importantly, when one cannot escape the boring situation, boredom is frequently accompanied by an increased feeling of effort that is required to stay concentrated on the task at hand (Eastwood et al., 2012). Possibly as a means to escape a boring task, research has shown that boredom causes participants to rush through it, by prioritizing speed over accuracy (Bieleke et al., 2021). Importantly, this tendency to rush through a boring task varies as a function of inter-individual differences in trait boredom (Bieleke et al., 2021). Thus, by acting as a signal that change is needed, boredom plays an important role in the regulation of goal-directed behavior.

Attesting to the influential role boredom plays in human functioning, a substantial body of research has underscored the effect that boredom has on affect, behavior, and cognition across various domains (Raffaelli et al., 2018). To use some of the most drastic examples, boredom has been linked to sadistic aggression (Pfattheicher et al., 2021), self-harming behavior (Wilson et al., 2014), self-induced pain (Nederkoorn et al., 2016), gambling (Blaszczynski et al., 1990), and premature death (Britton and Shipley, 2010). On a mechanistic level, research has shown that boredom begets a negative affect (van Hooft and van Hooff, 2018) and is linked to impaired self-regulation (Struk et al., 2016), attention (Hunter and Eastwood, 2018), and decision-making (Yakobi and Danckert, 2021). Taken together, boredom alters how people feel, think, and act. But *why* would people be bored when they participate in research studies?

Boredom in behavioral science studies

When studying phenomena of interest, researchers strive to maximally control ancillary factors that might distort findings. For example, they may systematize their interaction with participants, keep participants in the dark with respect to the true research question to avoid biased responses, or use highly standardized tasks to maximize experimental control and internal validity. With respect to frequently employed experimental tasks, participants might be asked to passively process a stream of presented stimuli, categorize a stream of stimuli, or solve tasks that substantially exceed their capabilities. Furthermore, to fully tap into the latent construct of interest and to optimize reliability, researchers often employ lengthy multi-item questionnaires.

Paradoxically, these legitimate efforts of researchers to minimize external confounding factors and to measure the construct of interest as precisely as possible might be an ideal breeding ground for boredom. Per design, it is likely that many research studies employ protocols during which participants feel that (part of) the tasks have little meaning to them or lack agency. Likewise, study demands are often tailored to a very specific research question (e.g., to find out the smallest pitch difference people can discriminate) which might create under-challenging and over-challenging tasks. All these features contribute to being bored (Westgate and Wilson, 2018), and as such, many behavioral science studies are likely to induce some degree of boredom.

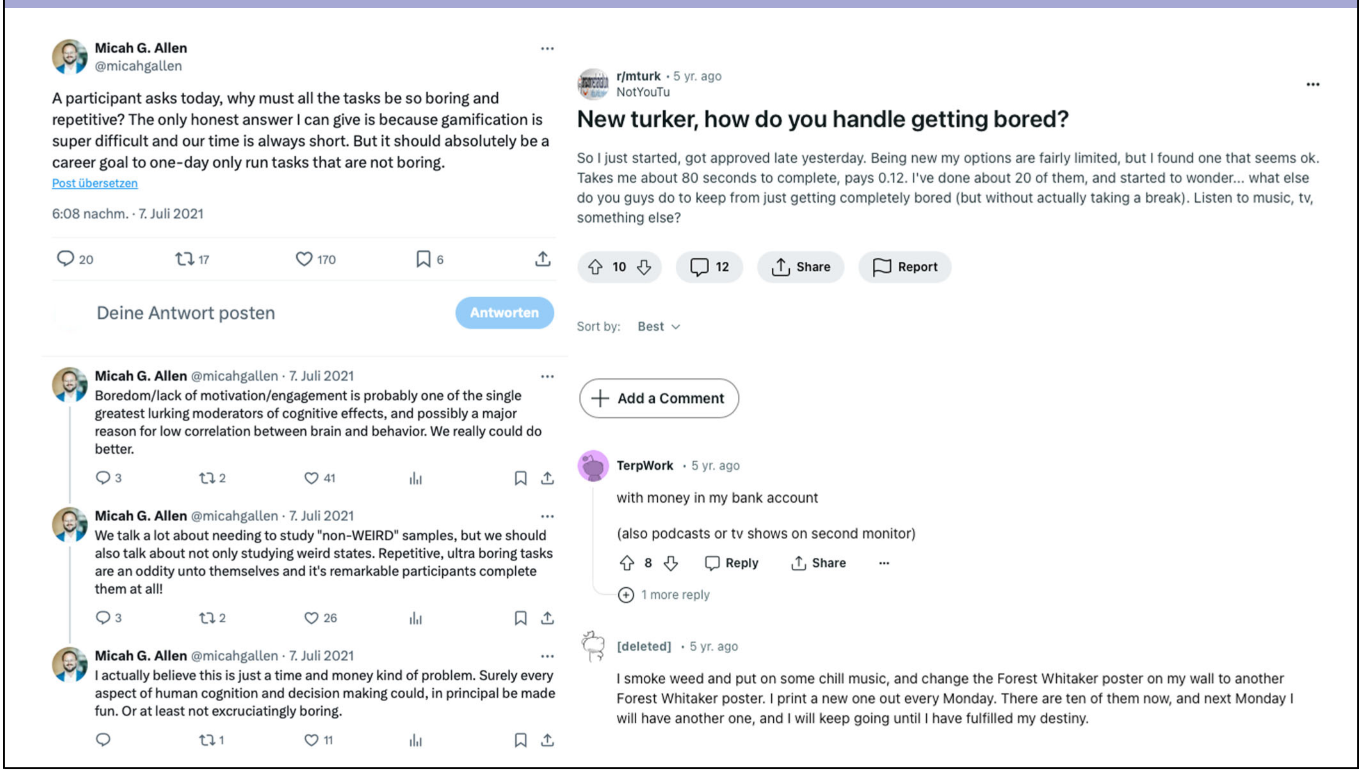
The occurrence of boredom among participants has been reported anecdotally by academics, as well as by research participants. For example, researchers discuss the problem of boring experiments, and study participants exchange ideas on how to cope with boredom during study participation on social media platforms (see Box 1 for two examples). In fact, in light of the negative affective consequences of being bored, the issue of boring participants out during study participation has even been raised as an ethical concern (D'Angiulli and Smith LeBeau, 2002). However, research on the actual occurrence and relevance of boredom in behavioral science studies is scarce, thereby making it hard to assess the degree to which boredom might act as a source of noise or as a confounding variable. Importantly, emerging evidence suggests that participants do experience boredom during study participation and that this can affect their behavior.

For example, categorization tasks, such as the Stroop task are among the most widely used experimental paradigms to study the effects of interference on reaction time, thereby offering insights into how the human brain processes information (MacLeod, 1991). However, to tap into these processes, participants have to categorize a large number of stimuli that are sequentially presented on a computer screen for a prolonged duration. Considering the conditions under which boredom is likely to occur, such a repetitive computerized task might not only tap into human information processing but might also be boring for participants. Indeed, a recent study found that self-reported boredom increased linearly during a ten-minute Stroop task (Bieleke et al., 2021). Consistent with the conceptual considerations about boredom's function, boredom was associated with a reduced threshold parameter in a drift-diffusion model, indicating that bored participants were adjusting their behavior to get the task over with.

Beyond computerized experimental tasks, boredom is also likely in survey research. Especially in personality research, questionnaires can comprise 200 items and more. For example, the NEO Personality Inventory consists of 240 items, the Minnesota Multiphasic Personality Inventory-2 Restructured consists of 338 items and the California Psychological Inventory even comprises 434 items. While such comprehensive questionnaires might provide a more accurate representation of the construct of interest, to participants, a seemingly endless string of questions might be boring and lead to careless responses (Gibson and Bowling, 2020). Research shows that careless responding increases the further participants have progressed into a questionnaire (Bowling et al., 2021), indicating that data quality might deteriorate throughout a survey.

Further indirect evidence on how boredom can alter human affect, cognition, and behavior and how this might have substantial ramifications for study outcomes comes from work on mood decline and media multitasking among research participants. A high-powered study (N of nearly 29'000 participants) showed a gradual decline in mood during rest and simple tasks over time (Jangraw et al., 2023). Although this work focused on mood drifts, the researchers highlight how boredom, as a negative affective state, might contribute to declining mood among research participants over the course of a study. Indirect evidence for an impact of boredom on behavior during study participation also comes from a study showing high rates of distraction by media multitasking during online studies (average of 38%, ranging from 9% to 85% across different studies with an N of nearly 3'000 participants) (Drody et al., 2023). It is conceivable that

Box 1 | Researchers (left panel; https://tinyurl.com/32h4yxhf) and research participants (right panel; https://tinyurl.com/3yc8jspd) publicly discuss the occurrence and relevance of boredom during studies along with ideas and examples on how to reduce boredom or cope with it



media multitasking is a response to boredom in online settings. This interpretation aligns well with the strategies on how to handle boredom during study participation that are discussed by participants in online platforms (Box 1). If changes in affect, cognition, and behavior occur in uniform fashion across the study sample, this adds noise to the data, if not accounted for. Yet, if changes in affect, cognition, and behavior differ as a function of an experimental manipulation but the manipulation also differs in inducing boredom, it is hard to disentangle to what degree the changes be attributed to the focal construct of interest, and to what degree they reflect effects of boredom.

The impact of boredom critically varies across experiments and research contexts. An important question arises: could boredom act as a systematic confound, introducing bias, or does it add noise to the data? When boredom arises from experimental manipulation, such as studies comparing challenging and easy tasks, boredom might systematically skew the results, acting as a confound (Mangin et al., 2021). In other cases, boredom might not bias the results but make the data nosier. Bias skews data in a particular direction (e.g., turning an easy task into a challenging task due to boredom), whereas noise enhances variability (e.g., increased variance in reaction times, including both faster and slower responses under boredom conditions), which translates into a more imprecise measurement of the construct at hand, with negative impact on statistical power. Thus, while bias has repeatedly attracted attention as being problematic, noise also holds importance, and should not be overlooked (Nebe et al., 2023).

Taken together, anecdotal, conceptual, and scattered direct and indirect empirical evidence supports the hypothesis that boredom might be a frequent occurrence among research participants. And considering boredom's function and effects it is highly likely that bored participants behave differently than those who are not bored. However, to better gauge the general applicability of this claim, it is important to empirically study and thus quantify the occurrences and effects of boredom in research studies in future studies. Here, as a first step, we asked people who have participated in a variety of studies how they generally feel during study participation and if they think boredom matters in this context.

Boredom in behavioral science studies: what do participants say?

To this end, we conducted a brief online self-report study about the self-reported occurrence and estimated the relevance of boredom among study participants. Specifically, we wanted to assess if participants perceive study participation as boring, if boredom exerts the effects it is theorized to have (i.e., urge to do something else and make it more effortful to stay concentrated), and if perception and effects differ as a function of individual differences in trait boredom. Most importantly, we were interested if participants reported adjusting their behavior because of boredom, and if they think this alters study outcomes. We report more information about the procedure and the samples in Appendix A.

Across a student ($n = 113$) and a paid online worker ($n = 419$) sample, we found support for the hypothesis that participants experience boredom as a challenge during study participation (*boredom (item)*: "While participating in (online) studies I get very bored" [10-point Likert scale, 1 = strongly disagree to 10 = strongly agree]; mean = 5.32, SD = 2.88, minimum = 1, maximum = 10, skewness = −0.04). While at first sight, an average boredom rating of 5.32 on a scale from 1 to 10 might not seem high, it is comparable to boredom ratings in research that has investigated and highlighted the effects of boredom on cognition, affect, and behavior (Bieleke et al., 2021; Mangin et al., 2021; Pickering et al., 2023; Martarelli et al., 2023). In the same vein, recent work has shown that even relatively minor levels of boredom can cause performance crises (Weich et al., 2022). Consistent with this, across both samples, 47.37% of respondents agreed or strongly agreed that boredom affects their behavior or performance during study participation (*own behavior*: "Boredom affects my behavior and/or performance in (paid online) studies." [5-point Likert scale, 1 = strongly disagree to 5 = strongly agree], mean = 3.21, SD = 1.16, minimum = 1, maximum = 5, skewness = −0.34), and 53.01% agreed or strongly agreed to the statement that boredom alters study outcomes (*study outcomes*: "Boredom alters the findings of paid online studies", [5-point Likert scale, 1 = strongly disagree to 5 = strongly agree], mean = 3.4, SD = 1.18, minimum = 1, maximum = 5, skewness = −0.05). Only 28.2% rejected or strongly rejected that boredom affects their participation behavior and performance in studies, and 21.8% rejected or strongly rejected that boredom affects study outcomes. While the latter statements of participants only reflect naïve, subjective estimations that need to be tested objectively and more rigorously in future studies, it is nevertheless noteworthy that—from a participant's subjective perspective—boredom matters.

Consistent with theoretical propositions, being bored during studies was reported to require a higher level of concentration (*concentration*: "Because I am bored, I find it harder to concentrate" [5-point Likert scale, 1 = strongly disagree to 5 = strongly agree]; mean = 3.17, SD = 0.81, minimum = 2, maximum = 4, skewness = −0.31). Also, boredom was reported to evoke thoughts of doing something else (*disengage*: "Because I am bored, I would prefer to do something else" [5-point Likert scale, 1 = strongly disagree to 5 = strongly agree]; mean = 3.33, SD = 1.24, minimum = 1, maximum = 5, skewness = −0.31) and the need to mount more willpower to complete the study (*effort*: "Because I am bored, I have to apply more effort to participate appropriately" [5-point Likert scale, 1 = strongly disagree, 5 = strongly agree]; mean = 3.44, SD = 1.19, minimum = 1, maximum = 5, skewness = −0.52), see Fig. 1.

Beyond descriptive statistics, positive associations emerged between a trait measure of boredom (*boredom trait*, measured via the Short Boredom Scale of Boredom, SBPS) (Struk et al., 2017), boredom during study participation (*boredom (AEQ)*, measured via the Boredom Scale of the Achievement of Emotions Questionnaire, (Pekrun et al., 2011), and the single item measure *boredom (item)* described above), reported consequences of boredom (single item measures *concentration, effort, disengage*), and the estimated effects boredom has on participant behavior and study outcomes (single item measures *own behavior, study outcomes*). Descriptively, the associations in the paid online worker sample were stronger when compared to the student sample, which might be related to differences in demographic characteristics (e.g., the MTurk sample was on average 16 years older as compared to the student sample), highlighting the need to consider such differences between study populations. As an example, we found significant, medium to strong positive associations between trait boredom and boredom in studies (AEQ) both in the student ($r = 0.34$) and in the paid online worker ($r = 0.81$) samples. This suggests that individual differences in trait boredom (boredom proneness) might differentially impact the experience of boredom during research studies. Another association that turned out to range from medium to strong was the significant positive relationship between boredom in research studies and the urge to disengage from the task at hand, both in the student ($r = 0.31$) and in the paid online worker ($r = 0.63$) sample. Notably, paid online workers believed that study outcomes are altered due to boredom during study participation (AEQ; $r = 0.62$); this association was not significant in the

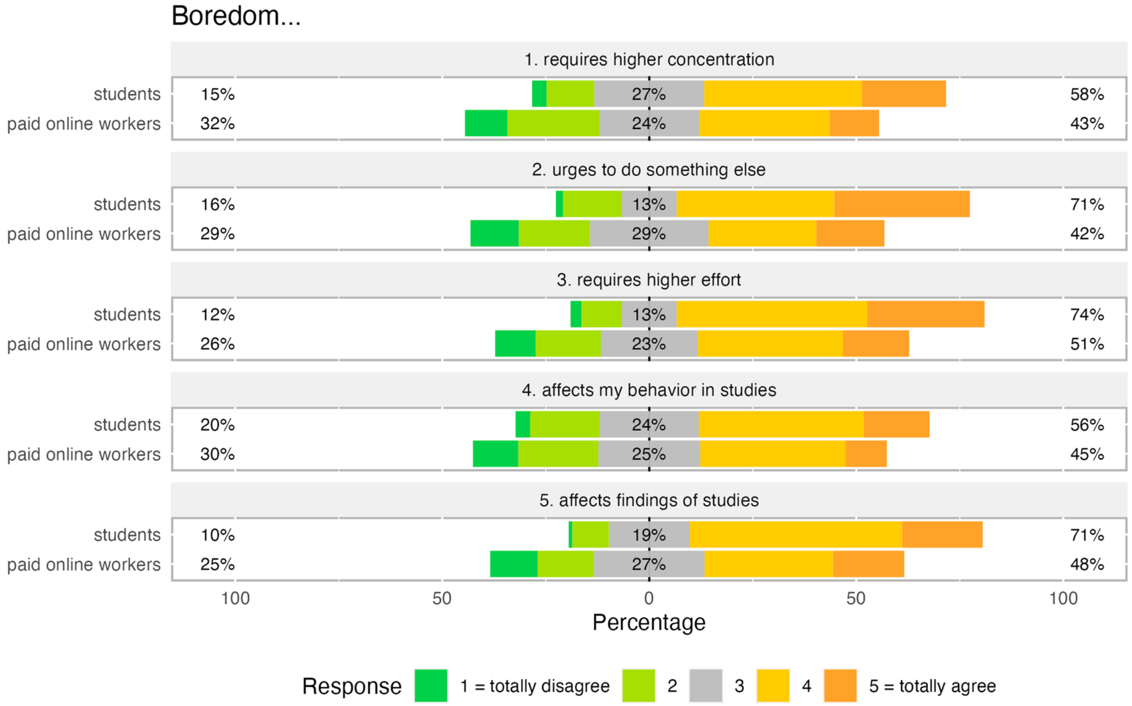


Fig. 1 Ratings of student ($n = 113$) and paid online worker ($n = 419$) samples on the perceived effects of boredom on their own behavior and performance, as well as on the findings of scientific studies. The numbers on the left reflect the proportion of the horizontal bar that is green or light green, representing the percentage of answers we deem unproblematic (i.e., where boredom does not matter); the numbers in center reflect the gray proportion of the bar and refer to the percentage of answers that are neither decidedly unproblematic nor problematic (i.e., boredom could matter but not very much); the numbers on the right reflect the orange or red proportion of the bar and refer to problematic answers (i.e., indicating that boredom alters behavior and study outcomes).

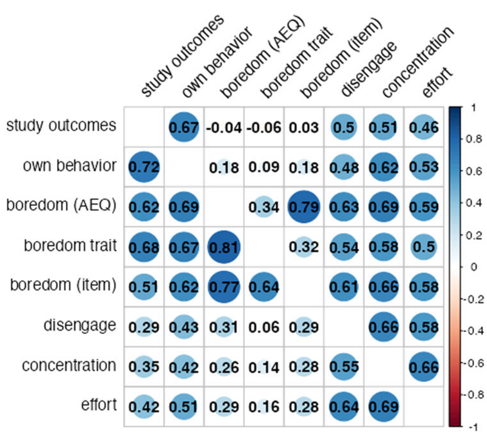


Fig. 2 Combined correlation matrix of Pearson's correlation coefficients between trait boredom as well as estimated effects of state boredom during studies on behavior and performance, as well as on study outcomes in the student ($n = 113$; upper right) and in the paid online workers ($n = 419$, lower left) samples. Blue circles indicate the strength of the correlation.

student sample. The associated correlation matrix for both samples is depicted in Fig. 2.

Taken together these results provide first support for the notion that boredom might be a relevant factor in behavioral science studies. On the one hand, if distributed uniformly across the study or the study sample, boredom can add noise to the data, that cannot be accounted for (hence, enters the error term), if it is not assessed. On the other hand, when studying subpopulations that differ in their boredom proneness, when comparing experimental conditions that systematically vary in their perceived average "boringness", or when perceived boredom substantially coincides with changes in variables of interest (e.g., decreases in attention and increases in boredom), boredom can be considered a confounder that might bias study outcomes. To what extent do these differential effects of boredom occur in behavioral science studies and whether they impact, or bias study outcomes should be studied more rigorously in the future.

What can be done about boredom as a potential study confound?

In the previous sections, we have made the conceptual and empirical case for the notion that boredom is prevalent among research participants and that this might add noise or act as a confound in research studies. As concluding remarks, we would like to highlight three implications that we deem critical considering the arguments presented above.

First, in between-subjects designs, there is a risk that inter-individual differences in trait boredom might affect experimental results. While such differences might not matter in most studies due to random assignment to study conditions, there are various instances in which random assignment of participants to groups is not possible or feasible, or in which one compared populations that might differ in one aspect (e.g., depressive symptoms), which has been related to trait boredom in the past. As an example, in our data, the extent of trait boredom in the student sample ($n = 113$) was relatively low (mean = 1.98, SD = 0.72, minimum = 1 of 1, maximum = 4.25 of 5, skewness = 1.06), in contrast, the paid online workers ($n = 419$) exhibited higher trait boredom scores (mean = 3.18, SD = 0.98, minimum = 1 of 1, maximum = 5 of 5, skewness = −0.57). Another example is studies that compare younger and older adults; indeed, age-related differences in the experience of boredom exist, as it seems that

Box 2 | Boredom in research and how to tame it

1. Trait boredom may differ between different populations, as well as within the same population.
Exemplary illustration of the potential problem. If one were to compare the effects of a physical exercise intervention on cognition between patients and a control group, a priori differences in trait boredom might lead to a biased estimate of the intervention effect.
Possible solutions. Assess trait boredom to test whether different populations that are to be compared in the experiment differ regarding this feature, and control for it if necessary. Different domain-general trait boredom scales exist. A widely used boredom proneness questionnaire is the Boredom Proneness Scale [BPS] (Farmer and Sundberg, 1986). This questionnaire was shortened in the BPS-SF (Vodanovich et al., 2005) as well as in the SBPS (Struk et al., 2017). More recently, other domain-general measures have been developed, such as the Harthous Boredom Proclivity Scale [HBP] (van Tilburg et al., 2019) and the Boredom Avoidance and Escape Scale [BAE] as well as the Dealing with Boredom Scale [DWB] (Bieleke et al., 2022). In addition, domain-specific trait boredom scales have been developed, such as for academic boredom or sport-specific boredom (Vodanovich and Watt, 2016). Those might for example be useful in intervention studies, to control for pre-existing differences in the generalized disposition towards the construct of interest.
2. State boredom may differ between experimental conditions.
Exemplary illustration of the potential problem. One might want to measure if, compared to an easy non-demanding task, a self-control demanding task would impair subsequent performance. A possible effect might be offset if the non-demanding task is more boring than the self-control demanding task and participants would perform worse because they are bored (Wolff and Martarelli, 2020). If the effect occurs under these conditions, it might not necessarily undermine interpretation; this design could in fact represent an especially conservative test of the hypothesis. However, the risk of misinterpreting null results due to unaddressed boredom remains a significant concern. While conservatism can have advantages, this is not always the case, especially in areas where mixed and null results prevail (e.g., ego depletion research area, Hagger et al., 2016). Misinterpreting null results due to unaddressed boredom could lead to misleading conclusions, potentially impacting subsequent research or practical applications. Thus, it is important to note that boredom could act as a confound (amplifying effects) or as a counter-confound (nullifying effects), with both potentially obscuring the true effect.
Possible solutions. One option is to assess state boredom and control it, if necessary. Different options to assess state boredom exist. Widely used scales are the State Boredom Measure [SBM] of Todman (2013) and the Multidimensional State Boredom Scale Short-Form [MSBS-SF] (Hunter et al., 2016) and its variations (e.g., the MSBS-15 (Baratta and Spence, 2015)). Further options are probe-caught methods that stop participants throughout a task by asking them to report their experience of boredom at a particular moment (e.g., (Blondé et al., 2022)). To limit the length of the questionnaires, participants need to fill in and thus counteract potential boredom, single-item scales may be a good choice if test criteria are met. Another option would be to design experimental conditions in a way that ensures they are "equally boring". This would assure high internal validity. If external validity matters, construct experimental conditions that resemble everyday life in their degree of boringness.
3. State boredom may change over the course of the study.
Exemplary illustration of the potential problem. When conducting a survey study with an extensive questionnaire battery, then boredom-induced gradual response degradation might yield systematically less valid answers in the latter part of the study.
Possible solutions. Construct studies ensuring that participants do not get bored easily. One possible approach is to consider gamification techniques, which may lead to more engagement and interest in various contexts (Feyisetan et al., 2015). Other options might be to use rewards and incentives, or to avoid repetitive tasks and to insert breaks in the study. While these methods might temporarily alleviate boredom, boredom is likely to return over time. Another possible approach is to highlight the meaning and relevance of research studies, as meaning has been shown to be inversely related to boredom (van Tilburg and Igou, 2012). Finally, also here, an option is to assess boredom over time to control for its effects.

boredom peaks in younger adults and dimmish with age (Spaeth et al., 2015). Also, there is evidence that different patient populations exhibit higher boredom proneness as compared to healthy individuals, e.g., individuals suffering from depression, alcohol abuse disorder, or psychotic disorders (Seiler et al., 2023). If within-subjects designs are not possible, we suggest that it is worthwhile to assess trait boredom (see Box 2 for further illustrations and possible solutions).

Not only trait boredom might differ between populations, but also condition-induced state boredom. The possibility of systematic differences in *condition boringness* has been discussed particularly with respect to the comparison between an experimental condition and a supposedly neutral control condition (Wolff and Martarelli, 2020). Such differences in *condition boringness* are plausible in many research settings, in which control conditions are designed to be as supposedly neutral, non-demanding, and uni-informative as possible (e.g., resting, or passively viewing stimuli on a screen). To illustrate, research on self-control often employs demanding cognitive tasks (e.g., an incongruent Stroop task) and uses a structurally similar task as a non-demanding control task (e.g., a congruent Stroop task) to study the effects of completing a demanding cognitive task. However, if one task is perceived to be more boring than the other task, then boredom might act as an unwanted confound that could alter findings in unforeseen ways, by offsetting or amplifying differences in the studied variables. Indeed, recent work points towards the occurrence and relevance of such differences in experimental research (Mangin et al., 2021). Various self-report measures to assess state boredom have been developed and validated, that could be used to assess inter-condition differences in state boredom (see Box 2). Retrospective state scales that assess boredom at the end of a task have successfully been used in boredom research (Chan et al., 2018), as well as probe-caught methods, that interrupt a task with questions such as "how bored are you right now?" (Merrifield and Danckert, 2014). A methodology to our knowledge not yet used to assess state boredom is self-caught methods, in which participants voluntarily indicate whether they are bored (Martarelli and Jost, 2023). More research is needed to investigate which of the above-presented options poses an optimal solution, as well as whether asking about boredom influences the experience of boredom itself (cf. discussion on measurement reactivity (French and Sutton, 2010; König et al., 2022)).

Finally, we suggest controlling for the occurrence of state boredom in experimental sessions because the experience of boredom has been shown to change not only between persons but also within persons over the course of a task (see Box 2). Thus, while an increase in boredom over the course of an experiment is unlikely to be a confound (in the sense that it systematically biases findings in one condition and not another), it might nevertheless make data noisier and the resulting estimates less precise. Consistent with this, the issue of careless responses by participants who get bored as a function of survey length has received substantial research interest outside the lab already

(Maniaci and Rogge, 2014). Thus, keeping track of participant boredom throughout a study might be worthwhile for research in and outside the lab.

Taken together, we believe that boredom is a frequently neglected factor in behavioral science studies. To put it in an exaggerated way: As excited as researchers are when they design well-controlled experimental studies, as bored might be the participants who complete the tasks. Researchers need to be aware of state and trait boredom as a factor that possibly adds noise to the data or might even bias study outcomes. The fact that study participants are exposed to highly artificial situations (Shamay-Tsoory and Mendelsohn, 2019) that fulfill key elements that evoke boredom and that they themselves report experiencing boredom should be taken into account when designing studies. The question of when, and to which amount boredom occurs during behavioral research studies should thus be targeted more rigorously in future research.

Data availability

Data and the analysis scripts associated with this manuscript are available from the associated Open Science Framework Project (https://osf.io/syj23/).

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References

Baratta PL, Spence JR (2015) A riddle, wrapped in a mystery, inside an enigma … or just multidimensional? Testing the multidimensional structure of boredom. In: Härtel CEJ, Zerbe WJ, Ashkanasy NM (eds) Research on emotion in organizations. Emerald Group Publishing Limited, pp. 139–172

Bieleke M, Barton L, Wolff W (2021) Trajectories of boredom in self-control demanding tasks. Cogn Emot 35(5):1018–1028. https://doi.org/10.1080/02699931.2021.1901656

Bieleke M, Ripper L, Schüler J, Wolff W (2022) Boredom is the root of all evil—or is it? A psychometric network approach to individual differences in behavioural responses to boredom. R Soc Open Sci 9(9):211998. https://doi.org/10.1098/rsos.211998

Bieleke M, Wolff W (2021) It's not a bug, it's boredom: effortful willpower balances exploitation and exploration. Behav Brain Sci 44:e33. https://doi.org/10.1017/S0140525X20001053

Blaszczynski A, McConaghy N, Frankova A (1990) Boredom proneness in pathological gambling. Psychol Rep. 67(1):35–42. https://doi.org/10.2466/pr0.1990.67.1.35

Blondé P, Sperduti M, Makowski D, Piolino P (2022) Bored, distracted, and forgetful: the impact of mind wandering and boredom on memory encoding. Q J Exp Psychol 75(1):53–69. https://doi.org/10.1177/17470218211026301

Bowling NA, Gibson AM, Houpt JW, Brower CK (2021) Will the questions ever end? Person-level increases in careless responding during questionnaire completion. Organ Res Methods 24(4):718–738. https://doi.org/10.1177/1094428120947794

Britton A, Shipley MJ (2010) Bored to death? Int J Epidemiol 39(2):370–371. https://doi.org/10.1093/ije/dyp404

Chan CS, van Tilburg WAP, Igou ER, Poon CYS, Tam KYY, Wong VUT, Cheung SK (2018) Situational meaninglessness and state boredom: cross-sectional and experience-sampling findings. Motiv Emot 42(4):555–565. https://doi.org/10.1007/s11031-018-9693-3

Chin A, Markey A, Bhargava S, Kassam KS, Loewenstein G (2017) Bored in the USA: experience sampling and boredom in everyday life. Emotion 17(2):359–368. https://doi.org/10.1037/emo0000232

Danckert J (2019) Boredom: Managing the delicate balance between exploration and exploitation. In: Ros Velasco J (ed.) Boredom is in your mind. Springer International Publishing, Cham, pp. 37–53

D'Angiulli A, Smith LeBeau L (2002) On boredom and experimentation in humans. Ethics Behav 12(2):167–176. https://doi.org/10.1207/S15327019EB1202_4

Drody AC, Pereira EJ, Smilek D (2023) A desire for distraction: uncovering the rates of media multitasking during online research studies. Sci Rep. 13(1):781. https://doi.org/10.1038/s41598-023-27606-3

Eastwood JD, Frischen A, Fenske MJ, Smilek D (2012) The unengaged mind: defining boredom in terms of attention. Perspect Psychol Sci 7(5):482–495. https://doi.org/10.1177/1745691612456044

Farmer R, Sundberg ND (1986) Boredom proneness–the development and correlates of a new scale. J Pers Assess 50(1):4–17. https://doi.org/10.1207/s15327752jpa5001_2

Feyisetan O, Simperl E, Van Kleek M, Shadbolt N (2015) Improving paid microtasks through gamification and adaptive furtherance incentives. In: Proceedings of the 24th International Conference on World Wide Web. International World Wide Web Conferences Steering Committee, Florence Italy, pp. 333–343

Fox JI (2022) Schopenhauer on boredom. Br J Hist Philos 30(3):477–495. https://doi.org/10.1080/09608788.2022.2025575

French DP, Sutton S (2010) Reactivity of measurement in health psychology: how much of a problem is it? What can be done about it? Br J Health Psychol 15(3):453–468. https://doi.org/10.1348/135910710X492341

Gibson AM, Bowling NA (2020) The effects of questionnaire length and behavioral consequences on careless responding. Eur J Psychol Assess 36(2):410–420. https://doi.org/10.1027/1015-5759/a000526

Hagger MS, Chatzisarantis NLD, Alberts H, Anggono CO, Batailler C, Birt AR, Brand R, Brandt MJ, Brewer G, Bruyneel S, Calvillo DP, Campbell WK, Cannon PR, Carlucci M, Carruth NP, Cheung T, Crowell A, De Ridder DTD, Dewitte S, Elson M, Evans JR, Fay BA, Fennis BM, Finley A, Francis Z, Heise E, Hoemann H, Inzlicht M, Koole SL, Koppel L, Kroese F, Lange F, Lau K, Lynch BP, Martijn C, Merckelbach H, Mills NV, Michirev A, Miyake A, Mosser AE, Muise M, Muller D, Muzi M, Nalis D, Nurwanti R, Otgaar H, Philipp MC, Primoceri P, Rentzsch K, Ringos L, Schlinkert C, Schmeichel BJ, Schoch SF, Schrama M, Schütz A, Stamos A, Tinghög G, Ullrich J, vanDellen M, Wimbarti S, Wolff W, Yusainy C, Zerhouni O, Zwienenberg M (2016) A Multilab Preregistered Replication of the Ego-Depletion Effect. Perspect Psychol Sci 11(4):546-73. https://doi.org/10.1177/1745691616652873

Harris MB (2000) Correlates and characteristics of boredom proneness and boredom 1. J Appl Soc Psychol 30(3):576–598. https://doi.org/10.1111/j.1559-1816.2000.tb02497.x

Hunter A, Eastwood JD (2018) Does state boredom cause failures of attention? Examining the relations between trait boredom, state boredom, and sustained attention. Exp Brain Res 236(9):2483–2492. https://doi.org/10.1007/s00221-016-4749-7

Hunter JA, Dyer KJ, Cribbie RA, Eastwood JD (2016) Exploring the utility of the multidimensional state boredom scale. Eur J Psychol Assess 32(3):241–250. https://doi.org/10.1027/1015-5759/a000251

Jangraw DC, Keren H, Sun H, Bedder RL, Rutledge RB, Pereira F, Thomas AG, Pine DS, Zheng C, Nielson DM, Stringaris A (2023) A highly replicable decline in mood during rest and simple tasks. Nat Hum Behav. https://doi.org/10.1038/s41562-023-01519-7

König LM, Allmeta A, Christlein N, Van Emmenis M, Sutton S (2022) A systematic review and meta-analysis of studies of reactivity to digital in-the-moment measurement of health behaviour. Health Psychol Rev 16(4):551–575. https://doi.org/10.1080/17437199.2022.2047096

MacLeod CM (1991) Half a century of research on the Stroop effect: an integrative review. Psychol Bull 109(2):163–203. https://doi.org/10.1037/0033-2909.109.2.163

Mangin T, André N, Benraiss A, Pageaux B, Audiffren M (2021) No ego-depletion effect without a good control task. Psychol Sport Exerc 57:102033. https://doi.org/10.1016/j.psychsport.2021.102033

Maniaci MR, Rogge RD (2014) Caring about carelessness: participant inattention and its effects on research. J Res Personal 48:61–83. https://doi.org/10.1016/j.jrp.2013.09.008

Martarelli C, Jost N (2023) Methodological approaches to boredom and its measurement. PsyArXiv https://doi.org/10.31234/osf.io/62xr7

Martarelli C, Weibel D, Popic D, Wolff W (2023) Time in suspense: investigating boredom and related states in a virtual waiting room. PsyArXiv https://doi.org/10.31234/osf.io/uprcd

Merrifield C, Danckert J (2014) Characterizing the psychophysiological signature of boredom. Exp Brain Res 232(2):481–491. https://doi.org/10.1007/s00221-013-3755-2

Milyavskaya M, Inzlicht M, Johnson T, Larson MJ (2019) Reward sensitivity following boredom and cognitive effort: a high-powered neurophysiological investigation. Neuropsychologia 123:159–168. https://doi.org/10.1016/j.neuropsychologia.2018.03.033

Nebe S, Reutter M, Baker DH, Bölte J, Domes G, Gamer M, Gärtner A, Gießing C, Gurr C, Hilger K, Jawinski P, Kulke L, Lischke A, Markett S, Meier M, Merz CJ, Popov T, Puhlmann LM, Quintana DS, Schäfer T, Schubert A-L, Sperl MF, Vehlen A, Lonsdorf TB, Feld GB (2023) Enhancing precision in human neuroscience. eLife 12:e85980. https://doi.org/10.7554/eLife.85980

Nederkoorn C, Vancleef L, Wilkenhöner A, Claes L, Havermans RC (2016) Self-inflicted pain out of boredom. Psychiatry Res 237:127–132. https://doi.org/10.1016/j.psychres.2016.01.063

Pekrun R, Goetz T, Daniels LM, Stupnisky RH, Perry RP (2010) Boredom in achievement settings: Exploring control–value antecedents and performance

outcomes of a neglected emotion. J Educ Psychol 102(3):531–549. https://doi.org/10.1037/a0019243
Pekrun R, Goetz T, Frenzel AC, Barchfeld P, Perry RP (2011) Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). Contemp Educ Psychol 36(1):36–48. https://doi.org/10.1016/j.cedpsych.2010.10.002
Pfattheicher S, Lazarević LB, Westgate EC, Schindler S (2021) On the relation of boredom and sadistic aggression. J Pers Soc Psychol 121(3):573–600. https://doi.org/10.1037/pspi0000335
Pickering T, Wright B, Schücker L, MacMahon C (2023) Active or passive? Investigating different types of cognitive fatigue. Can J Exp Psychol Rev Can Psychol Expérimentale. https://doi.org/10.1037/cep0000312
Raffaelli Q, Mills C, Christoff K (2018) The knowns and unknowns of boredom: a review of the literature. Exp Brain Res 236(9):2451–2462. https://doi.org/10.1007/s00221-017-4922-7
Schultz W (2017) Reward prediction error. Curr Biol 27(10):R369–R371. https://doi.org/10.1016/j.cub.2017.02.064
Seiler JP-H, Zerr K, Rumpel S, Tüscher O (2023) High state boredom vastly affects psychiatric inpatients and predicts their treatment duration. Transl Psychiatry 13(1):350. https://doi.org/10.1038/s41398-023-02650-9
Shamay-Tsoory SG, Mendelsohn A (2019) Real-life neuroscience: an ecological approach to brain and behavior research. Perspect Psychol Sci 14(5):841–859. https://doi.org/10.1177/1745691619856350
Spaeth M, Weichold K, Silbereisen RK (2015) The development of leisure boredom in early adolescence: Predictors and longitudinal associations with delinquency and depression. Dev Psychol 51(10):1380–1394. https://doi.org/10.1037/a0039480
Struk AA, Carriere JSA, Cheyne JA, Danckert J (2017) A short boredom proneness scale: development and psychometric properties. Assessment 24(3):346–359. https://doi.org/10.1177/1073191115609996
Struk AA, Scholer AA, Danckert J (2016) A self-regulatory approach to understanding boredom proneness. Cogn Emot 30(8):1388–1401. https://doi.org/10.1080/02699931.2015.1064363
Todman M (2013) The dimensions of state boredom: Frequency, duration, unpleasantness, consequences and causal attributions. Educ Res Int 1(1):32–40
van Hooft EAJ, van Hooff MLM (2018) The state of boredom: frustrating or depressing? Motiv Emot 42(6):931–946. https://doi.org/10.1007/s11031-018-9710-6
van Tilburg WAP, Igou ER (2012) On boredom: lack of challenge and meaning as distinct boredom experiences. Motiv Emot 36(2):181–194. https://doi.org/10.1007/s11031-011-9234-9
van Tilburg WAP, Igou ER, Maher PJ, Moynihan AB, Martin DG (2019) Bored like hell: religiosity reduces boredom and tempers the quest for meaning. Emotion 19(2):255–269. https://doi.org/10.1037/emo0000439
Vodanovich SJ, Wallace JC, Kass SJ (2005) A confirmatory approach to the factor structure of the boredom proneness scale: evidence for a two-factor short form. J Pers Assess 85(3):295–303. https://doi.org/10.1207/s15327752jpa8503_05
Vodanovich SJ, Watt JD (2016) Self-report measures of boredom: an updated review of the literature. J Psychol 150(2):196–228. https://doi.org/10.1080/00223980.2015.1074531
Weich C, Schüler J, Wolff W (2022) 24 h on the run—does boredom matter for ultra-endurance athletes' crises? Int J Environ Res Public Health 19(11):6859. https://doi.org/10.3390/ijerph19116859
Westgate EC, Steidle B (2020) Lost by definition: why boredom matters for psychology and society. Soc Personal Psychol Compass 14(11). https://doi.org/10.1111/spc3.12562
Westgate EC, Wilson TD (2018) Boring thoughts and bored minds: the MAC model of boredom and cognitive engagement. Psychol Rev 125(5):689–713. https://doi.org/10.1037/rev0000097
Wilson TD, Reinhard DA, Westgate EC, Gilbert DT, Ellerbeck N, Hahn C, Brown CL, Shaked A (2014) Just think: the challenges of the disengaged mind. Science 345(6192):75–77. https://doi.org/10.1126/science.1250830
Wolff W, Martarelli CS (2020) Bored into depletion? Toward a tentative integration of perceived self-control exertion and boredom as guiding signals for goal-directed behavior. Perspect Psychol Sci 15(5):1272–1283. https://doi.org/10.1177/1745691620921394
Wolff W, Radtke VC, Martarelli C (2022) Same same but different—what is boredom actually? PsyArXiv https://doi.org/10.31234/osf.io/jze5kqu
Yakobi O, Danckert J (2021) Boredom proneness is associated with noisy decision-making, not risk-taking. Exp Brain Res 239(6):1807–1825. https://doi.org/10.1007/s00221-021-06098-5

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