Gender and comorbidity moderate the relationship between mood disorder symptoms and effortful avoidance performance

Abstract

We must often decide how much effort to exert or withhold to avoid undesirable outcomes or obtain rewards. In depression and anxiety, levels of avoidance tend to be excessive and reward-seeking is reduced. Yet outstanding questions remain about the links between motivated action/inhibition and anxiety and depression symptoms, and whether they differ between men and women. Here we examined the relationship between anxiety and depression symptoms and performance on effortful active and inhibitory avoidance (Study 1) and reward seeking (Study 2) in humans. Undergraduates and paid online workers ($N_{Avoid} = 545$, $N_{Reward} = 310$; $N_{Female} = 368$, $N_{Male} = 450$, $M_{Age} = 22.58$, $Range_{Age} = 17\text{-}62$) were assessed on the Beck Depression Inventory (BDI-II) and the Beck Anxiety Inventory (BAI) and performed an instructed online avoidance or reward-seeking task. Participants had to make multiple presses on active trials and withhold presses on inhibitory trials to avoid an unpleasant sound (Study 1) or obtain points towards a monetary reward (Study 2). Overall, men deployed more effort than women in both avoidance and reward-seeking, and anxiety symptoms were negatively associated with active reward-seeking accuracy. Gender moderated the relationship between anxiety symptoms and inhibitory avoidance, such that women with higher anxiety showed reduced inhibitory avoidance accuracy. Anxiety symptoms predicted poorer active avoidance performance for those high in depression symptoms only. Our results illuminate effects of gender and symptom comorbidity in the relationship between mood disorder symptoms and the motivation to actively and effortfully respond to obtain positive and avoid negative outcomes.

Keywords: avoidance, reward, effort, depression, anxiety

Word count: 6824

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Significance statement

We often need to take effortful action, or withhold action, to avoid unpleasant outcomes or obtain rewards. Depression and anxiety can impact these behaviours' effectiveness, but the role of depression in avoidance and anxiety in reward-seeking is not well understood. Gender differences in avoidance and reward-seeking have also not been examined. Here, we present a task in which participants had to make or withhold button presses to avoid hearing an unpleasant sound or to obtain a reward. Men deployed more effort than women in avoidance, and women with higher levels of anxiety symptoms had lower inhibitory avoidance accuracy than men. Our results illuminate gender differences in how depressive and anxiety symptoms impact our ability to avoid threats and obtain rewards.

Introduction

Avoidance and reward-seeking behaviours

Living organisms are motivated to avoid potential threats or to acquire rewards respectively. Often achieving these goals requires action, but it can also require refraining from action. For example, we may take action to remove a threat's potential harm through active avoidance, or we may decide that withholding action is the best way to let the threat pass by, as in inhibitory avoidance (Krypotos, Effting, Kindt, & Beckers, 2015; LeDoux, Moscarello, Sears, & Campese, 2017). Alternatively, in a situation that offers the possibility of reward, we may take action to approach the reward through active reward-seeking or, instead, inhibit pre-potent reward seeking to wait for a larger reward (Capuzzo & Floresco, 2020; Cools, 2008). Research suggests that the expression of similar behavioral actions (including inhibition) is dependent on the motivational context (aversive vs. appetitive), which influences the likelihood of selecting a specific action in a specific motivational context (Wang & Delgado, 2021). However, in neuropsychiatric research, depressive disorders are often studied with regard to reward-seeking contexts, and anxiety disorders with regard to avoidance contexts, with little emphasis on the other motivational context. Symptoms of anxiety and depression have been associated with avoidance, typically operationalized via active avoidance and via questionnaires, as threats are overestimated (Bishop & Gagne, 2018; Browning, Behrens, Jocham, O'Reilly, & Bishop, 2015; Cléry-Melin et al., 2011; Mkrtchian, Aylward, Dayan, Roiser, & Robinson, 2017; Ottenbreit, Dobson, & Quigley, 2014). In depression, reward-seeking may also be impaired due to a lack of motivation to obtain rewards (Bishop & Gagne, 2018; Slaney et al., 2021). Past research has established the importance of avoidance and reward-seeking behaviours in helping us navigate our environment and stay safe (Krypotos et al., 2015; LeDoux et al., 2017). However, active vs. inhibitory subtypes of these behaviours have not typically been distinguished – especially through objective measures of observable behavior. Furthermore, anxiety and depression are often comorbid (Brown, Campbell, Lehman, Grisham, & Mancill, 2001), and this comorbidity has been linked to excessive avoidance behaviours (Ottenbreit et al., 2014). However, the role of comorbidity in affecting active vs. inhibitory avoidance, or reward-seeking, has not been examined.

Gender may also be an important variable in this relationship. For example, gender differences have been identified in the presentation and incidence of mood and anxiety disorders, such that women have higher rates of depression and present more often with depression than men (Altemus, Sarvaiya, & Neill Epperson, 2014; Kessler, 2006; Parker & Brotchie, 2010) and have rates of anxiety disorders that are twice as high as those of men (McLean, Asnaani, Litz, & Hofmann, 2011; Pittig, Treanor, LeBeau, & Craske, 2018). However, we do not know how these gender differences manifest themselves in avoidance or reward-seeking behaviours. Although mood and anxiety disorders are often comorbid, they also manifest with distinct symptoms and courses that would require distinct strategies to treat in a clinical context (Goldstein-Piekarski, Williams, & Humphreys, 2016; McLean et al., 2011). In the present study, we ask how mood disorder symptoms impact active vs. inhibitory avoidance and reward-seeking behaviours in a population of young adults with depressive and anxiety symptoms ranging from minimal to severe.

The role of mood disorder symptoms and gender differences in avoidance and reward-seeking

It has been proposed that mood and anxiety disorder symptoms shift the perceived value and costs of avoidance and reward-seeking in sub-optimal ways. The Altered Computations Underlying Decision Making (ACDM) framework (Bishop & Gagne, 2018) proposes that anxiety is linked to underestimation of the effort cost in avoiding an aversive outcome and that depression is linked to overestimation of the effort cost in obtaining a reward. These effort costs interact with the perceived value of avoidance or reward-seeking to inform one's decision on whether or not to engage in the behaviour. Past experimental work has also identified impairments in physical effort deployment for reward in populations with depression (Pessiglione, Vinckier, Bouret, Daunizeau, & Le Bouc, 2018; Treadway, Buckholtz, Schwartzman, Lambert, & Zald, 2009; see Culbreth, Moran, & Barch, 2018 for a review) and anxiety (Wang & Delgado, 2021). However, work linking mood and anxiety disorders to impairments in adaptive avoidance and reward-seeking often focuses on these avoidance and reward-seeking behaviours as unitary processes. As such, we still do not know how shifts in perceived effort costs linked to mood and anxiety disorders manifest themselves in active or inhibitory avoidance or reward-seeking.

To better understand the degree to which depressive and anxiety symptoms contribute to active and inhibitory forms of avoidance or reward-seeking a rigorous assessment of effort deployment in these behaviors is needed. People with Major Depressive Disorder (MDD) choose high-effort options less often on effort-based decision making tasks involving reward. This behaviour is potentially symptomatic of a larger-scale motivational deficit (Pessiglione et al., 2018; Treadway, Bossaller, Shelton, & Zald, 2012; Treadway et al., 2009). If maladaptive effort deployment is a primary characteristic of mood and anxiety disorders, then we might expect active avoidance and reward-seeking to be impaired more than inhibitory forms of these behaviours overall (Culbreth et al., 2018). Anxiety, especially in the context of depressive symptoms, has been shown to impair our sensitivity to rewards (Auerbach et al., 2022; Dillon et al., 2014), although whether anxiety's impact on reward-seeking differs for active or inhibitory behaviours is not yet clear.

Additionally, individual differences in the presentation and severity of mood and anxiety disorders - beyond the mere presence or absence of the disorder - may manifest with different patterns of active vs. inhibitory behaviours depending on the motivational context. Among these differences, gender differences are especially prominent. Women generally present with more depressive symptoms (Parker & Brotchie, 2010) and experience depression comorbid with anxiety more often than men (Kessler, 2006; McLean et al., 2011; Ottenbreit et al., 2014). Thus, the impact of mood and anxiety disorders on our ability to avoid aversive outcomes and seek out rewarding outcomes may be linked to gender differences that affect the motivational deficits these disorders present. If gender differences in depressive and anxiety symptom presentation - as captured on self-report scales (Beck, Steer, & Brown, 1996) - are predicted by differences in accuracy and effort deployment on active and inhibitory avoidance and reward-seeking tasks, this may help elucidate how observed gender differences in depressive and anxiety symptoms map on to real-life behavioural changes.

In order to bring our understanding of mood disorder symptoms into a framework that acknowledges differences in active vs. inhibitory avoidance and reward-seeking behaviours, we must consider both anxiety and depression in a framework that directly investigates their impact on these behaviours,, and how they might interact to impair effective avoidance and reward-seeking. While the relationships between anxiety and avoidance (Bishop & Gagne, 2018; Levita, Hoskin, & Champi, 2012; Norbury, Robbins, & Seymour, 2018), and depression and reward-seeking (Rizvi, Pizzagalli, Sproule, & Kennedy, 2016; Slaney et al., 2021; Treadway et al., 2012) are well established, those between anxiety and reward-seeking, as well as depression and avoidance, have yet to be fully characterized. As depression and anxiety can be highly comorbid (Goldstein-Piekarski et al., 2016; Ottenbreit et al., 2014), parsing which aspects of avoidance and reward-seeking behaviors are affected uniquely by depressive symptoms, anxiety symptoms, or their common pathophysiological substrates (Insel et al., 2010), would be important in informing future depression and anxiety treatments.

An effortful avoidance and reward-seeking study

Despite established gender differences in the prevalence and presentation of mood disorder symptoms (Kessler, 2006; Parker & Brotchie, 2010; Thompson & Bland, 2018), it is not known how the relationship between mood and anxiety disorder symptoms and avoidance and reward-seeking differs by gender. Gender differences in motivational deficits may lead to unique patterns in active and inhibitory behaviours, but this has not been examined either. As such, in this work, we ask 1) whether anxiety and depression symptoms predict accuracy and effort deployment on active/inhibitory avoidance vs. reward-seeking and 2) whether the relationship between mood disorder symptoms and accuracy is moderated by gender.

To address these questions, the present study examined both avoidance and reward-seeking, each with two non-clinical samples - undergraduates and online workers - with a broad distribution of mood disorder symptoms. Both studies were reverse-translated with modification from a series of rodent studies investigating deficits in active and inhibitory avoidance and reward-seeking behaviours (Capuzzo & Floresco, 2020; Piantadosi, Yeates, & Floresco, 2018). Our studies are the first to combine intermixed active and inhibitory avoidance (Levita et al., 2012) or reward-seeking trials with increasing effort requirements throughout the task, requiring participants to switch between withholding physical effort on inhibitory trials and deploying increasing amounts of effort on active trials in each task. This design allows us to directly compare performance on active and inhibitory trials in the context of increasing effort demands. Increasing effort demands may also pull out differences in choosing an active vs. inhibitory strategy.

Materials and Methods

Participants

We powered each study to detect a moderate-sized main effect of $d = 0.15$ obtained with a previous study of $N = 217$ participants using the `fabs` R package (Biesanz, 2020), resulting in a target sample size of $N = 549$. Demographic information for all studies can be found in Table 1. For each study, we collected data from two samples: an undergraduate population and an online worker population. The study was approved by the research ethics board at a location which will be identified if the article is published.

Study 1 (Avoidance)

We recruited undergraduate participants at a location which will be identified if the article is published. These participants received one percentage point towards their grade in a psychology course of their choosing for completing the study. Of these participants, $N = 311$ finished the study, of which $N = 38$ were excluded for not completing the pre-task survey, having below 50% accuracy on active or inhibitory avoidance trials, spending over 100 s on any given attention check, or not responding to all Beck Anxiety Inventory (BAI) questions. As such, data from $N = 273$ participants was used in the data analysis.

Additionally, we recruited paid online workers from around the world ($N = 310$) on the Prolific online study platform (https://www.prolific.co/). These participants received GBP £8.07 for completing the study. Of these participants, $N = 294$ finished the study, of which $N = 22$ were excluded for not completing the pre-task survey, having below 50%

accuracy on active or inhibitory avoidance trials, spending over 100 s on any given attention check, or not responding to all Beck Anxiety Inventory (BAI) questions. As such, data from $N = 272$ participants was used in the data analysis.

Study 2 (Reward-seeking)

We recruited undergraduate participants at a location which will be identified if the article is published. These participants received one percentage point towards their grade in a psychology course of their choosing and a CAD $5.00 gift card from Starbucks for completing the study. Of these participants, $N = 83$ finished the study, of which $N = 43$ were part of a separate analysis with different stimuli that is beyond the scope of this paper and $N = 7$ were excluded for not completing the pre-task survey, having below 50% accuracy on active or inhibitory avoidance trials, spending over 100 s on any given attention check, or incorrectly responding to a pre-task attention check. As such, data from $N = 36$ participants was used in the data analysis.

Additionally, we recruited paid online workers from around the world ($N = 309$) on the Prolific online study platform. These participants received GBP £8.07 and a £2.69 bonus for completing the study. Of these participants, $N = 300$ finished the study, of which $N = 26$ were excluded for not completing the pre-task survey, having below 50% accuracy on active or inhibitory avoidance trials, spending over 100 s on any given attention check, or incorrectly responding to a pre-task attention check. As such, data from $N = 274$ participants was used in the data analysis.

Overall, the excluded sample was 29.17% female and 70.83% male, while the analyzed sample was 45.97% female and 54.03% male.

Materials and Methods

Stimulus presentation

We used PsychoPy 2020.1.2 (RRID: SCR_006571) via the Pavlovia online study platform (Peirce et al., 2019). Participants completed the study on their own computers; they were not allowed to complete the study on mobile devices or tablets.

Stimuli

Cues indicating active or inhibitory trials were dark blue squares and circles with a thin black border and were generated by PsychoPy 2020.1.2 (Peirce et al., 2019) (Fig. 1); they subtended a visual angle of about 11.5° x 11.5°. All stimuli were presented against a grey background (RGB value [0,0,0] on a scale from -1 to 1). If participants responded incorrectly on any trial in the avoidance studies, an aversive sound was played for 2000 ms. The aversive sounds were randomly selected from a set of eight screeching and scraping sounds created by our lab and ranked as highly aversive by four independent raters and in a pilot study.

Participants completed a series of questionnaires before beginning the main task. These were the State-Trait Anxiety Inventory, form Y-2 (STAI Y-2) (Spielberger, 2008); the Beck Depression Inventory II (BDI-II) (Beck et al., 1996); the Beck Anxiety Inventory (BAI) (Steer & Beck, 1997); the Behavioral Activation for Depression Scale (BADS) (Kanter, Mulick, Busch, Berlin, & Martell, 2007); the Generalized Anxiety Disorder Scale (GAD-7) (Spitzer, Kroenke, Williams, & Löwe, 2006); and the Behavioural Inhibition Scale and Behavioural Activation Scale (BIS/BAS) (Carver & White, 1994). In our data analysis, we looked at results from the BDI-II and BAI as these clinically validated scales most directly capture participants' levels of current depressive and anxiety symptoms. The BADS, GAD-7, and BIS/BAS capture specific behavioural facets of depression and anxiety that are less relevant to understanding overall effects of mood and anxiety disorders on avoidance and reward-seeking and were not analyzed in this study. We used the BAI as our primary measure of anxiety symptoms as it is the most widely used and validated among the anxiety scales we included (Fydrich, Dowdall, & Chambless, 1992) and as its structure parallels that of the BDI-II.

Procedure

Avoidance task

A graphical overview of the avoidance task is provided in Fig. 1A.

After calibrating their physical effort capability and the volume of the aversive stimuli in the task, participants read instructions indicating the shape to which they would have to respond with multiple spacebar presses as well as the shape to which they would have to withhold their response. They also heard an example of the aversive sound that would be played if they made an incorrect decision during the task.

Participants then began a series of practice trials in order to gain exposure to the stimuli and types of responses they would have to make (Fig. 1A). This consisted of five trials in which participants had to make an active avoidance response - pressing the spacebar several times to avoid hearing an unpleasant sound; five trials in which participants had to make an inhibitory avoidance response - not pressing the spacebar to avoid hearing an aversive sound; and ten trials that intermixed these active and inhibitory trials.

On each trial, participants first viewed a grey screen with a white fixation cross for a mean duration of 2000 ms with a standard deviation (SD) of 1200 ms, jittered according to a normal distribution with these parameters on each trial. Participants then saw a visual cue - either a blue circle or a blue square - for 2000 ms. The cues used for active and inhibitory trials were pseudorandomly intermixed between participants. While this cue was on-screen, participants had to press the spacebar multiple times on active avoidance trials or withhold pressing on inhibitory avoidance trials. On active trials, the number of presses required was set according to the average number of presses made during the two effort calibration trials, such that participants who pressed fewer times during the calibration would have to press fewer times to achieve criterion during the task. The initial criterion was 5 presses given an average of 18 or fewer presses during calibration; a criterion of 6 presses given an average of 19-33 presses inclusive during calibration; and 7 presses given an average of 19 or more presses during calibration.

If participants made an incorrect decision (pressing an insufficient number of times on active trials or pressing at all on inhibitory trials), participants heard an aversive sound and saw a fixation cross for 2000 ms. This aversive sound was taken from a set of ten sounds created by our lab and rated as highly aversive. All sounds were scraping sounds that had unpleasant psychoacoustic properties shown to reliably induce aversive responses (Neumann & Waters, 2006) at a variety of frequencies. If participants made a correct decision (pressing a sufficient number of times on active trials or not pressing on inhibitory trials), they saw a fixation cross surrounded by a white border on the edges of the screen for 500 ms.

After completing the practice trials and viewing a final screen reminding them of the instructions, participants began the main task. This consisted of up to 168 active avoidance trials and 72 inhibitory avoidance trials (70% active and 30% inhibitory), pseudorandomized such that no more than 6 active trials or 3 inhibitory trials appeared in a row. On the 15th trial and every 40 trials thereafter, an attention check appeared asking participants to press a key corresponding to the letter they heard, to ensure that they were attending to the task and able to hear auditory stimuli. Every 20 trials, the number of button presses required on active trials increased by one press - this increased the effort demands on active trials across the task. The task continued until the participant responded correctly on half or less than half of the last 20 active trials - at this point, the breakpoint was reached and the participant was thanked for completing the task.

Reward-seeking task

A graphical overview of the reward-seeking task is provided in Fig. 1B.

The design of the reward-seeking task was identical to that of the avoidance task, with the following exceptions. First, the practice blocks were based on criterion-based advancement in order to increase consistency with the design of other reward-seeking studies in our lab. Participants had to achieve at least 80% accuracy in each of the active, inhibitory, and intermixed reward-seeking trial blocks in order to advance; each block would repeat until they achieved each criterion. Second, if the participant made a correct decision during a trial, they would see a screen indicating that they had gained 5 points along with a sum of their points thus far; if the participant made an incorrect decision during a trial, they would see a screen indicating that they had gained 0 points along with a sum of their points thus far. Both screens appeared for 1500 ms. Undergraduate participants received a CAD $5 gift card as a reward in addition to course credit for completing the task; online workers received a GBP £2.69 payment as a reward in addition to their payment for completing the task. Last, as this task did not incorporate audio, no volume check or audio-based attention check was included.

Data analysis

All data was analyzed using R 4.1.1 “Kick Things” (R Development Core Team, 2011) through RStudio (Booth et al., 2018). On each behavioural task, we measured 1) accuracy on active and inhibitory trials, operationalized as the proportion of correct responses on each trial type; 2) effort on each trial type, operationalized as the number of presses made relative to criterion on each trial; 3) participants’ depressive and anxiety symptoms, operationalized as their BDI (Beck et al., 1996) and BAI (Steer & Beck, 1997) scores respectively; 4) participants’ sensitivity (d') and criterion (β); and 5) breakpoint, operationalized as the trial number on which the participant responded correctly on half or less than half of the last 20 active trials. For each study, we combined undergraduate and online worker samples to obtain a gender-balanced sample. All analyses were Bonferroni corrected for multiple comparisons. All confidence intervals were based on 1000 bootstrap replications using the `confintr` R package (Mayer, 2022).

Results

Demographics

Participant's reported gender and sex heavily overlapped, with 97.53% overlap in women and 97.67% overlap in men on the avoidance tasks and 98.84% overlap in women and 97.80% overlap in men on the reward-seeking task. For this reason, the following results are expressed in terms of gender only. Women reported higher levels of depressive symptoms ($t(723.12)$ = -3.84, $p < .001$, $d = 0.27$) and anxiety symptoms ($t(706.44)$ = -4.71, $p < .001$, $d = 0.34$) than men across samples (Table 2, Fig. 2A, 5A). Across both studies, 20.92% of women and 15.11% of men were on medication for depression, and 19.29% of women and 14.89% of men were on medication for anxiety.

Avoidance task

We first compared participants' accuracy on active and inhibitory avoidance trials by gender using a 2x2 within-between ANOVA (Trial Type x Gender) (Fig. 2B) (Table 3). A main effect revealed that, on average, participants were more accurate on inhibitory than on active trials ($F(1, 522) = 405.53$, p < .001, $\eta^2 = 0.25$; Table 4). There was a main effect of gender ($F(1, 522) = 5.85$, $p = .02$, $\eta^2 = < .01$) as well as a gender interaction such that men had higher accuracy than women on active but not inhibitory avoidance trials ($F(1, 522) = 4.87$, $p = .03$, $\eta^2 < .01$).

Depression and anxiety symptoms were not significantly associated with inhibitory or active avoidance accuracy (Table 4). However, given observed gender differences in both depression/anxiety disorder symptoms and task performance, we conducted a series of moderation analyses using the PROCESS macro (Hayes, 2017) as implemented in `bruceR`

(Bao, 2021) to examine whether gender moderated the relationship between accuracy and anxiety and depressive symptoms (Fig. 3B). We found that gender moderated the relationship between anxiety symptoms (as measured in BAI scores) and inhibitory avoidance accuracy ($F(1, 541) = 4.29$, $p = .04$; Fig. 3A). Increased BAI scores were associated with lower inhibitory avoidance accuracy in females but not males; this relationship was not observed for BDI scores. For the full results of the moderation analysis, see Table 5.

To further examine the relationship between accuracy and anxiety and depressive symptoms, we tested whether BAI scores predicted accuracy in men and women separately. Outside of the moderation analysis after Bonferroni correction, BAI scores overall predicted inhibitory but not active avoidance performance accuracy (Fig. 3B, ($t(543) =$ -3.01, $p = .04$, $r =$ -0.13)). Additionally, higher BAI scores predicted lower inhibitory avoidance performance accuracy in women but not men (Fig. 3B; ($t(260) =$ -3.73, $p = .01$, $r =$ -0.23, *95% CI* [-0.36, -0.09])).

We also conducted an interactive regression analysis to investigate whether the relationship between anxiety symptoms and active and inhibitory avoidance accuracy differed as a function of the level of depressive symptoms (Fig. 4). In active avoidance, the relationship between anxiety symptoms (BAI scores) and accuracy for all participants was a function of their level of depressive symptoms (BDI scores) ($t(541) =$ -2.65, $p = .01$); however, this was not the case in inhibitory avoidance ($t(541) =$ -0.87, $p = .39$). As such, only those with higher levels of depressive symptoms were impaired in active avoidance, and not those with higher levels of anxiety symptoms but lower levels of depressive symptoms.

To account for participants' bias to deploy effort and engage in active as opposed to inhibitory avoidance in general, we calculated sensitivity (d') and criterion (β) and repeated the moderation analyses on these alternative outcome performance measures. Sensitivity reflects participants' ability to correctly distinguish between active and inhibitory trials and deploy the required amount of effort on active trials only. Criterion reflects participants' bias towards an active or inhibitory response. Gender did not moderate the relationship between anxiety or depressive symptoms and sensitivity or criterion. However, BAI scores predicted sensitivity in women but not men ($t(260) = -3.55$, $p = .01$, $r = -0.21$, *95% CI* [-0.36, -0.08])).

Additionally, we explored the extent to which the amount of effort that participants deployed to avoid aversive outcomes changed across the task (Fig. 8A). A a 2x2 within-between ANOVA (Block x Gender) (Table 6) revealed that participants deployed increasing amounts of effort during the task to meet increasing effort requirements ($F(1, 522) = 405.53$, $p < .001$, $\eta^2 = 0.25$), and that men deployed more effort than women across the task ($F(1, 522) = 5.85$, $p = 0.016$, $\eta^2 = < .01$).

Last, we examined whether participants' breakpoint in the task was explained by their levels of mood and anxiety disorder symptoms in avoidance. After Bonferroni correction, BAI and BDI scores did not predict overall active or inhibitory avoidance performance in either men or women (BAI: ($t(543) = -2.44$, $p = .24$, $r = -0.10$, *95% CI* [-0.19, -0.02]); BDI: ($t(543) = -2.15$, $p = .51$, $r = -0.09$, *95% CI* [-0.17, -0.01])).

Reward-seeking task

We first compared participants' accuracy on active and inhibitory reward-seeking trials by gender (Fig. 6A) using a 2x2 within-between ANOVA (Trial Type x Gender) (Table 7). A main effect revealed that, on average, participants were more accurate on inhibitory than on active trials ($F(1, 292) = 58.86$, p $< .001$, $\eta^2 = 0.07$). There was no main effect of gender ($F(1, 292) = 2.61$, $p = .11$, $\eta^2 = 0.01$) but there was a gender interaction such that men had higher accuracy than women on active but not inhibitory reward-seeking trials ($F(1, 292) = 7.61$, $p = .01$, $\eta^2 = 0.01$).

Given observed gender differences in both depressive/anxiety symptoms and task performance, we again conducted a series of moderation analyses to see whether gender moderated the relationship between accuracy and anxiety and depressive symptoms. Anxiety was associated with reduced active reward seeking accuracy in the total sample. However, we found no gender moderation of the relationship between anxiety or depressive symptoms and active or inhibitory reward-seeking accuracy, and BDI scores did not interact with active or inhibitory reward-seeking accuracy (Table 8, Table 9, Fig. 6A).

To further elucidate the relationship between accuracy and anxiety and depressive symptoms, we evaluated whether BAI and BDI scores predicted accuracy in men and women separately. After Bonferroni correction, BAI and BDI scores did not predict overall active or inhibitory reward-seeking performance in either men or women (Fig. 6B). We also conducted an interactive regression analysis to investigate whether the relationship between anxiety symptoms and active and inhibitory reward-seeking accuracy differed as a function of their level of depressive symptoms (Fig. 7). In active reward-seeking, the relationship between anxiety symptoms (BAI scores) and accuracy for all participants was not a function of their level of depressive symptoms (BDI scores) ($t(306) = 0.45$, $p = .66$); this was also not the case in inhibitory reward-seeking ($t(306) = -0.78$, $p = .44$).

To evaluate participants' bias to deploy effort and engage in active as opposed to inhibitory reward-seeking, we again calculated sensitivity (d') and criterion (β) and performed the moderation analysis using these alternative outcome measures of performance. Gender did not moderate the relationship between anxiety or depressive symptoms and sensitivity or criterion.

Additionally, we explored how the effort that participants deployed to obtain reward changed across the task (Fig. 8B). A a 2x2 within-between ANOVA (Block x Gender) (Table 10) revealed that participants deployed increasing amounts of effort during the task to meet increasing effort requirements ($F(1, 292) = 58.86$, p $= < .001$, $\eta^2 = 0.07$), and revealed no gender differences in effort deployment ($F(1, 292) = 2.61$, p $= .11$, $\eta^2 = 0.01$).

Last, we examined whether participants' breakpoint in the task was explained by their levels of mood and anxiety disorder symptoms in reward-seeking. After Bonferroni correction, BAI and BDI scores did not predict overall active or inhibitory reward-seeking performance in either men or women (BAI: ($t(308) = -0.31$, $p = 1.00$, $r = -0.02$, *95% CI* [-0.12, 0.04]); BDI: ($t(308) = -0.75$, $p = 1.00$, $r = -0.04$, *95% CI* [-0.12, 0.04])).

Discussion

Summary

In the present study, we investigated gender differences in active and inhibitory avoidance behaviours. Additionally, we explored how mood and anxiety disorder symptoms negatively impact active vs. inhibitory avoidance and reward-seeking behaviours. Lastly, we examined whether accuracy and effort deployment in avoidance and reward-seeking are associated with depressive and anxiety symptoms, and whether the relationship between accuracy and mood disorder symptoms is moderated by gender. Anxiety symptoms interacted with participants' depressive symptoms level in active avoidance but not in active reward-seeking or in inhibitory avoidance or reward-seeking, such that participants' anxiety symptoms negatively impacted their accuracy more if they also had a high level of depressive symptoms. Compared to men, women showed higher levels of self-reported depression and anxiety. Throughout active avoidance and reward-seeking trials, men made more effortful responses than women. Gender moderated the relationship between anxiety symptoms and inhibitory avoidance. Women showed lower performance in inhibitory avoidance than men as a function of higher levels of anxiety symptoms, with no corresponding effect for depressive symptoms. In contrast, higher levels of anxiety were associated with lower active reward-seeking performance in both men and women. Our findings illuminate gender differences in active and inhibitory subtypes of avoidance and reward-seeking behaviours where effort was required to obtain the desired outcome.

Interpretation of results

Based on previous findings, we can speculate that the gender differences are driven at least in part by mood and anxiety disorder symptoms. In particular, the observed gender difference in inhibitory avoidance performance could reflect more general gender differences in stress tolerance. Parker and Brotchie (2010) argued that women have a higher predisposition (diathesis) to stress than men and, in our study, women reported higher anxiety symptoms than men. In our avoidance task, it is advantageous to act to avoid an aversive outcome - especially given high levels of anxiety symptoms (Bishop & Gagne, 2018). As such, inhibiting responding may be especially difficult given a combination of high anxiety symptoms and a decreased tolerance for stress in women compared to men. Furthermore, this gender difference in diathesis could drive a reduced ability to inhibit effort when needed - an impairment in shifting from an active to an inhibitory strategy given higher levels of anxiety symptoms (Gustavson, Altamirano, Johnson, Whisman, & Miyake, 2017). Given the observed interaction of lower accuracy at higher depressive and anxiety symptom levels in active avoidance, increased comorbidity of depressive and anxiety symptoms in women could also partly explain these results - although this interaction was not significantly observed in the presence of gender differences in inhibitory avoidance.

Beyond inhibitory avoidance, the observed gender differences in effort and accuracy on active avoidance and reward-seeking trials could reflect gender differences in effort deployment. Men made more effortful responses relative to criterion than women on active avoidance trials. This could be caused by women having smaller wrists with which to generate physical force than men (Morse, Jung, Bashford, & Hallbeck, 2006), as well as increased testosterone in men - which is associated with increased physical effort deployment during competitions (Losecaat Vermeer, Riečanský, & Eisenegger, 2016). Although our tasks did not have competitive elements, participants may still have completed the task with an eye towards maximizing performance. Since deploying more effort in the task would increase one's chance of staying above criterion, this increased effort deployment could explain the increased active trial accuracy for men across the avoidance and reward-seeking tasks. It is important to qualify that gender has a significant cultural component, and cultural factors could also play a role in gender differences in effort deployment - perhaps via effects of a lower tolerance for stress on effort deployment (Parker & Brotchie, 2010).

We also found that the effects of anxiety symptoms on active avoidance accuracy depended on an interaction between anxiety symptoms and depressive symptom level, such that only those with higher levels of depression symptoms who were also high in anxiety were impaired. This suggests a role for comorbidity between anxiety and depressive symptoms in people's ability to deploy effort to actively avoid an unpleasant outcome (Brown et al., 2001). As such, when those with mood disorder symptoms attempt to avoid aversive outcomes, impairments to effort deployment necessary for avoidance may be driven by features of anxiety symptoms and depressive symptoms together, as opposed to one mood disorder or another independently. Past work has only predicted increases in effort deployment in avoidance given anxiety and decreases in effort deployment in general given depression (Bishop & Gagne, 2018). As such, the observed impairment given symptoms of both mood disorders sheds light on how comorbid mood disorder symptoms can impact avoidance behaviours. Importantly, this relationship was not observed in inhibitory avoidance or in active or inhibitory reward-seeking. In inhibitory avoidance, mood disorder effects were specific to anxiety symptoms in women only, and only anxiety symptoms significantly impacted active reward-seeking accuracy. As such, it may be that an anxious subtype of depressive symptoms uniquely impacts our ability to deploy effort to avoid an unpleasant outcome. This is inconsistent with previous findings by Wurst et al. (2021) suggesting that there were no significant differences in fear learning – which may be a process involved in avoidance – between those with anxious and non-anxious depression.

However, as our task's difficulty is bound by increasing effort and not learning, and as we were looking at a non-clinical sample, such effects of comorbidity may not have come out in the context of our study.

The relationship between higher anxiety symptoms and reduced active reward-seeking performance is novel, as past work has primarily focused on the relationship between depressive symptoms and reward-seeking and has not focused on subtypes of avoidance (Bishop & Gagne, 2018). The ways in which depressive symptoms drive reduced reward sensitivity are well-established (Slaney et al., 2021), but it was previously not clear whether anxiety symptoms would drive greater success in obtaining rewards (through underestimation of the effort required to obtain a reward) or reduced reward-seeking performance (through inefficient allocation of effort that results in increased fatigue). In our task, participants' performance on effortful active trials was reduced given higher anxiety symptoms, suggesting that the form of anxiety symptoms participants faced may not have driven increased effort deployment or reduced effort costs. This finding runs counter to past work suggesting that trait anxiety is associated with impairments in shifting away from an effortful task (Gustavson et al., 2017). As we evaluate participants' current as opposed to trait anxiety, this pattern of results could be explained by anxiety-related impairments to effort deployment that are reflected in measures of anxiety as a personality trait.

Similarly, the relationship between higher anxiety symptoms and reduced inhibitory avoidance performance differs from previous predictions of improved avoidance given anxiety symptoms, such as those of Bishop and Gagne (2018). However, Bishop and Gagne framed this relationship in terms of active and not inhibitory avoidance, as they predicted that underestimations of effort cost would drive excessive avoidance behaviours. Anxiety symptoms may be associated with impairments to inhibitory avoidance precisely because of this bias towards action given the possibility of aversive outcomes, an effect that could be driven by a perceived lack of control over outcomes in the task (Wang & Delgado, 2021).

Additionally, we did not observe a relationship between depressive symptoms and accuracy or effort deployment in reward-seeking, as has previously been observed (Bishop & Gagne, 2018). The effort demands of the task may not have deterred people with high depressive symptoms from working for a reward, which could be explained by the depressive symptoms experienced by participants not impacting effort deployment.

Overall, participants had lower accuracy in avoidance compared to reward-seeking; this could be a function of differences in motivation to engage in avoidance or reward-seeking. Motivation to complete the tasks can be driven in part by participants' valuations of task-relevant stimuli (Bishop & Gagne, 2018). A major difference between our tasks arises in the outcome of an incorrect decision. In avoidance, an incorrect decision is associated with an aversive sound; in reward-seeking, it is associated with not receiving points. Although the salience of an aversive sound may suggest that it is more motivating and would therefore be associated with increased accuracy, hearing it may also be more demotivating - especially for participants with mood disorder symptoms. Hearing the aversive sound repeatedly could be a salient indicator of a lack of control over task outcomes (Wang & Delgado, 2021).

Limitations

There are some limitations to our interpretation of our findings. First, since the dichotomy of the task demands is between effortful active trials and inhibitory trials that require no effort, we cannot compare the effects of high vs. low effort demands on inhibitory avoidance or reward-seeking behaviours. As such, our interpretation of the relationship between effort deployment and mood disorder symptoms only extends to active trials. Accuracy in the task was likely tied to participants' effort capabilities, as increased effort deployment was required throughout the task on active trials to meet the criterion level of effort and make the correct response on the trial. However, we calibrated the criterion to participants' effort ability and considered accuracy on inhibitory as well as active trials to reduce the reliance of task outcomes on individual differences in effort deployment. Additionally, as the proportion of active trials was greater than that of inhibitory trials, participants may have become fatigued on the majority of trials in the task, increasing over time. This fatigue from effort deployment, combined with boredom (from the task being repetitive) could be difficult to disentangle from other shifts in motivation to deploy effort throughout the task (e.g. those related to the value of avoidance or reward-seeking). However, as fatigue is likely to arise in most physically effortful tasks, our tasks still reflect real-world physical effort demands. Furthermore, as this study took place online, the study had to use repeated keyboard presses instead of other, more continuous or better-controlled measures of physical effort such as a grip squeeze (Aridan, Malecek, Poldrack, & Schonberg, 2019). However, repeated button presses have been validated as being physically effortful and have been used in in-person contexts (Gold et al., 2013).

Future work

Future studies could build on our findings by investigating how patterns of information about specific aspects of effortful avoidance and reward-seeking are instantiated in key brain regions. The posterior anterior cingulate cortex (pACC) and ventral striatum encode information about prospective gains given physical effort requirements (Aridan et al., 2019). These regions - and their homologues in rodents - have been shown to be differentially necessary for active vs. inhibitory avoidance (Piantadosi et al., 2018) and reward-seeking (Capuzzo & Floresco, 2020). Investigating how these regions represent information on prospective gains and losses relative to effort costs could illuminate how we weigh the benefits and costs of deploying effort to obtain rewards and avoid aversive outcomes. Additionally, separating out different factors contributing to effort deployment through a computational modelling approach would be important to understand the individual contributions of various factors to participants' performance. These factors could include action biases (Mkrtchian et al., 2017), perceived value of avoidance or reward (Bishop & Gagne, 2018); or fatigue (Pessiglione et al., 2018). Furthermore, it would be helpful to evaluate whether subscales of mood disorder symptoms - potentially linked to subtypes such as anxious depression (Wurst et al., 2021) - pull out factors that drive participants' behaviours in avoidance and reward seeking. This analysis could further illuminate our observed gender differences - for example, to evaluate whether reduced inhibitory avoidance performance in women given increased anxiety symptoms is reflective of an anxious subtype of depression (Wurst et al., 2021).

Conclusion

Our studies address outstanding questions of whether accuracy and effort deployment on avoidance and reward-seeking predict mood disorder symptoms, and whether the relationship between accuracy and mood disorder symptoms is moderated by gender. We separate out active and inhibitory avoidance and reward-seeking behaviours in a context that allows for direct comparisons between them, instead of considering avoidance and reward-seeking behaviours as unitary wholes. We highlight gender differences in each of these subtypes of avoidance and reward-seeking given varying levels of mood disorder symptoms, contextualizing past work on gender differences in these symptoms (Parker & Brotchie, 2010). In particular, we are the first to examine these proposed gender differences in an active and inhibitory avoidance and reward-seeking context. These findings could inform clinical interventions to address maladaptive deployment of avoidance and lack of motivation for reward-seeking, targeted by gender. Additionally, we link active avoidance and reward-seeking to motivation for physical effort deployment given varying levels of mood and anxiety disorders. As many tasks in life require physical effort deployment, understanding where it can be impaired is an important pursuit. Our findings underscore the importance of considering individual differences in the ways in which avoidance and reward-seeking can be impaired in life.

Data and code availability

The data and materials for all experiments, as well as the code used to generate this manuscript and conduct all analyses, are available at [URL redacted for double-blind review].

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Table 1

Demographic information for all participants.

Study	$N_{recruited}$	$N_{analyzed}$	N_{female}	N_{male}	N_{other}	M_{age}	$Range_{age}$
1 (Avoidance, undergraduate)	357	273	175	86	12	20.42	17-32
2 (Avoidance, paid global)	310	272	87	176	9	24.06	18-57
3 (Reward-seeking, undergraduate)	114	36	28	8	0	20.67	18-26
4 (Reward-seeking, paid global)	309	274	78	180	16	25.18	18-62

Table 2

Mean and SD Beck Depression Inventory II (BDI) and Beck Anxiety Inventory (BAI) proportion scores (score divided by total possible score).

Task	Gender	$M_{BDIprop}$	$SD_{BDIprop}$	$M_{BAIprop}$	$SD_{BAIprop}$
Avoidance	Female	0.30	0.19	0.30	0.22
	Male	0.23	0.16	0.23	0.19
Reward-seeking	Female	0.29	0.19	0.28	0.21
	Male	0.26	0.17	0.22	0.17

Table 3

ANOVA of accuracy on active and inhibitory avoidance trials.

Effect	df_n	df_d	F	p	sig.	η^2
Gender	1	522	5.85	0.016	*	$< .01$
Trial Type	1	522	405.53	$< .001$	***	0.25
Gender:Trial Type	1	522	4.87	0.028	*	$< .01$

Table 4

Relationship between accuracy and mood disorder symptoms on active and inhibitory avoidance trials.

Trial Type	Comparison	df	*t*	*p*	sig.
Active avoidance	BDI~accuracy	541	-0.32	0.75	
	BAI~accuracy	541	-1.37	0.17	
Inhibitory avoidance	BDI~accuracy	541	-0.87	0.38	
	BAI~accuracy	541	-0.73	0.47	

Table 5

Gender moderation of relationship between accuracy and mood disorder symptoms on active and inhibitory avoidance trials.

Trial Type	Comparison	df_n	df_d	t	p	sig.
Active avoidance	Gender moderation of BDI~accuracy	1	541	0.01	0.92	
	Gender moderation of BAI~accuracy	1	541	0.28	0.59	
Inhibitory avoidance	Gender moderation of BDI~accuracy	1	541	1.04	0.31	
	Gender moderation of BAI~accuracy	1	541	4.29	0.04	*

Table 6

ANOVA of effort deployment on active avoidance trials by gender.

Effect	df_n	df_d	F	p	sig.	η^2
Gender	3.00	516.00	7.08	< .001	***	0.03
Block	3.37	1740.44	294.38	< .001	***	0.1
Gender:Block	10.12	1740.44	0.77	0.659		< .001

Table 7

ANOVA of accuracy on active and inhibitory reward-seeking trials.

Effect	df_n	df_d	F	p	sig.	η^2
Gender	1	292	2.61	0.107		0.01
Trial Type	1	292	58.86	$< .001$	***	0.07
Gender:Trial Type	1	292	7.61	0.006	**	0.01

Table 8

Relationship between accuracy and mood disorder symptoms on active and inhibitory reward-seeking trials.

Trial Type	Comparison	df	*t*	*p*	sig.
Active reward-seeking	BDI~accuracy	306	-0.52	0.61	
	BAI~accuracy	306	-2.56	0.01	*
Inhibitory reward-seeking	BDI~accuracy	306	-0.54	0.59	
	BAI~accuracy	306	-0.83	0.41	

Table 9

Gender moderation of relationship between accuracy and mood disorder symptoms on active and inhibitory reward-seeking trials.

Trial Type	Comparison	df_n	df_d	t	p	sig.
Active reward-seeking	Gender moderation of BDI~accuracy	1	306	0.56	0.46	
	Gender moderation of BAI~accuracy	1	306	3.30	0.07	
Inhibitory reward-seeking	Gender moderation of BDI~accuracy	1	306	0.12	0.73	
	Gender moderation of BAI~accuracy	1	306	0.00	0.96	

Table 10

ANOVA of effort deployment on active reward-seeking trials by gender.

Effect	df_n	df_d	F	p	sig.	η^2
Gender	3.00	379.00	2.03	0.11		0.01
Block	3.39	1283.92	387.02	< .001	***	0.16
Gender:Block	10.16	1283.92	0.43	0.936		< .001

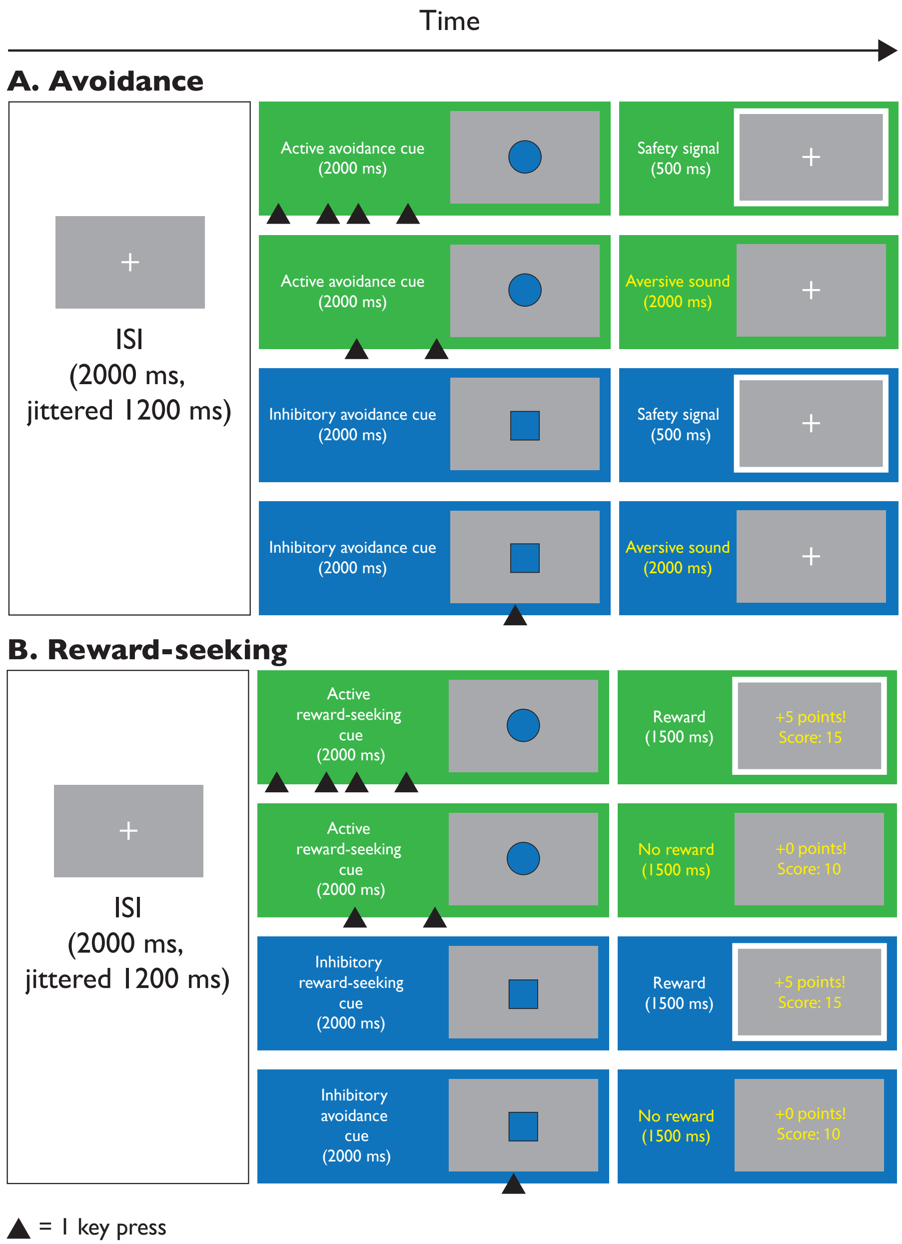


Figure 1

A diagram of the active and inhibitory avoidance and reward-seeking tasks. In the avoidance task (A), after an inter-stimulus interval (ISI) with a fixation cross onscreen, participants were presented with a cue associated with active or inhibitory avoidance. For the active avoidance cue, participants had to respond with repeated spacebar presses to avoid hearing an aversive sound. For the inhibitory avoidance cue, participants had to withhold responding to avoid hearing an aversive sound. In the reward-seeking task (B), after the ISI, participants were presented with a cue associated with active or inhibitory reward-seeking. For the active reward-seeking cue, participants had to respond with repeated spacebar presses to obtain points towards a monetary reward. For the inhibitory reward-seeking cue, participants had to withhold responding to obtain points towards a monetary reward. ISI = Inter-stimulus interval.

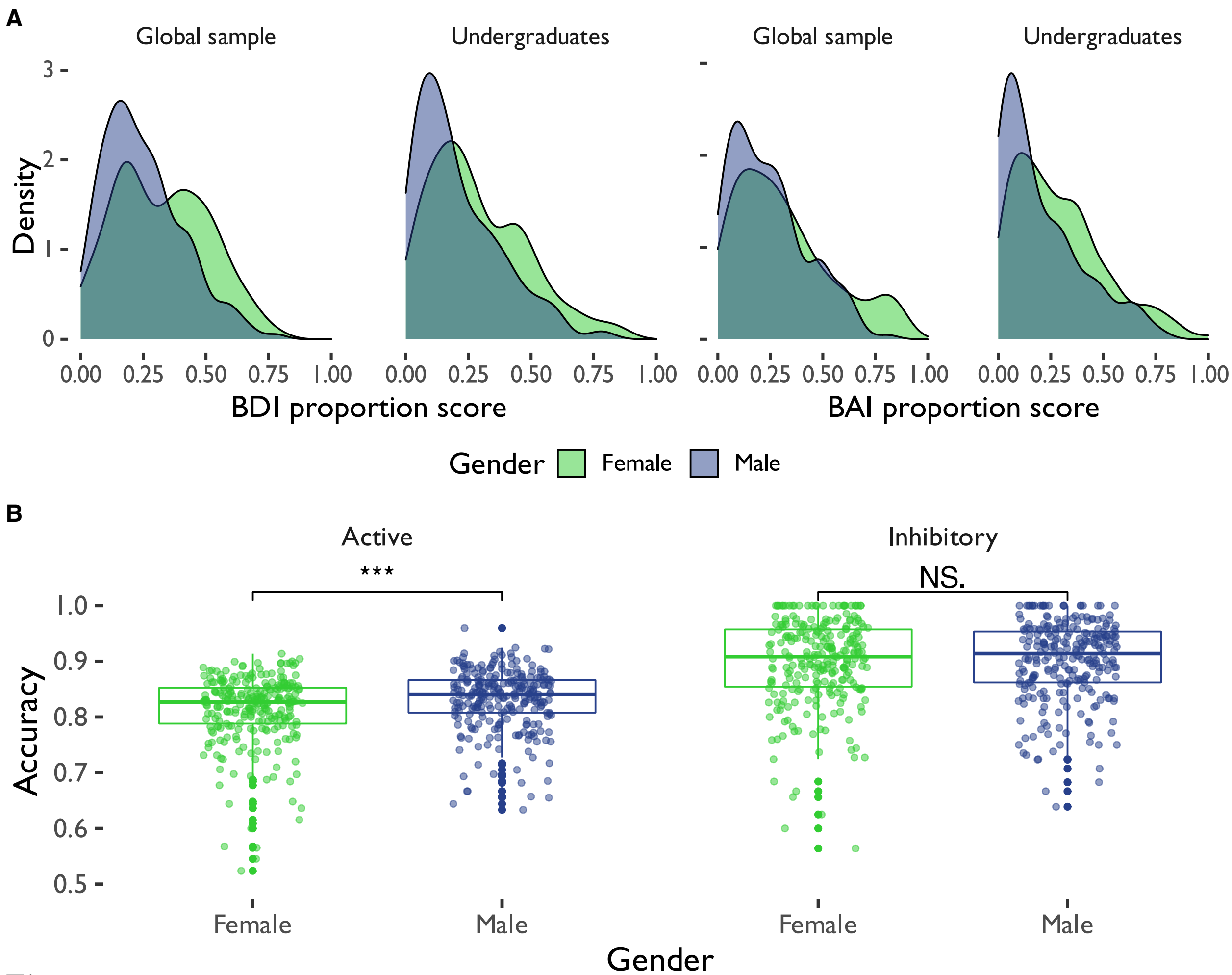


Figure 2

(A) Distribution of anxiety (BAI) and depressive symptom (BDI) proportion scores (score divided by total possible score) by gender and sample. (B) Accuracy by gender on active and inhibitory avoidance, and moderation of the relationship between accuracy and anxiety (BAI) scores by gender. Dots represent average accuracy on each trial type by participant. BAI = Beck Anxiety Inventory, BDI = Beck Depression Inventory.

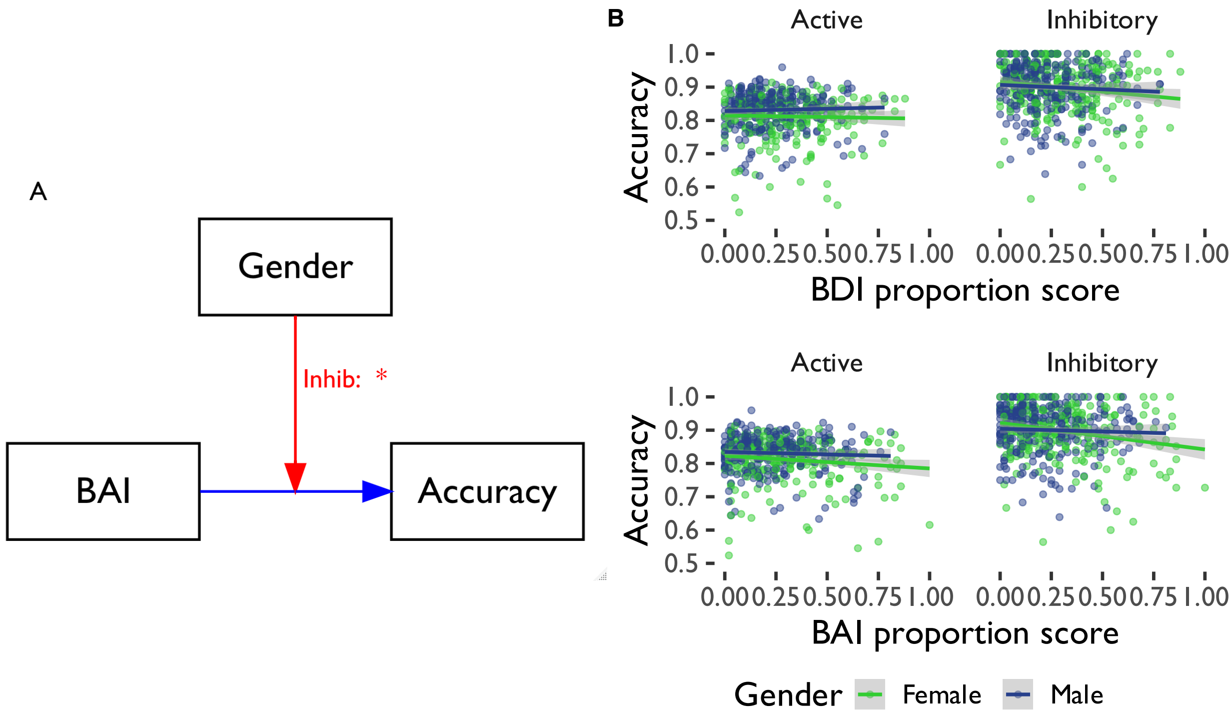


Figure 3

(A) Moderation of the relationship between accuracy and anxiety (BAI) proportion scores by gender in active and inhibitory avoidance. Gender significantly moderated the relationship between anxiety symptoms (BAI proportion scores) and inhibitory avoidance accuracy. (B) Accuracy by gender on active and inhibitory avoidance. BAI = Beck Anxiety Inventory. Proportion scores are scores divided by total possible score.

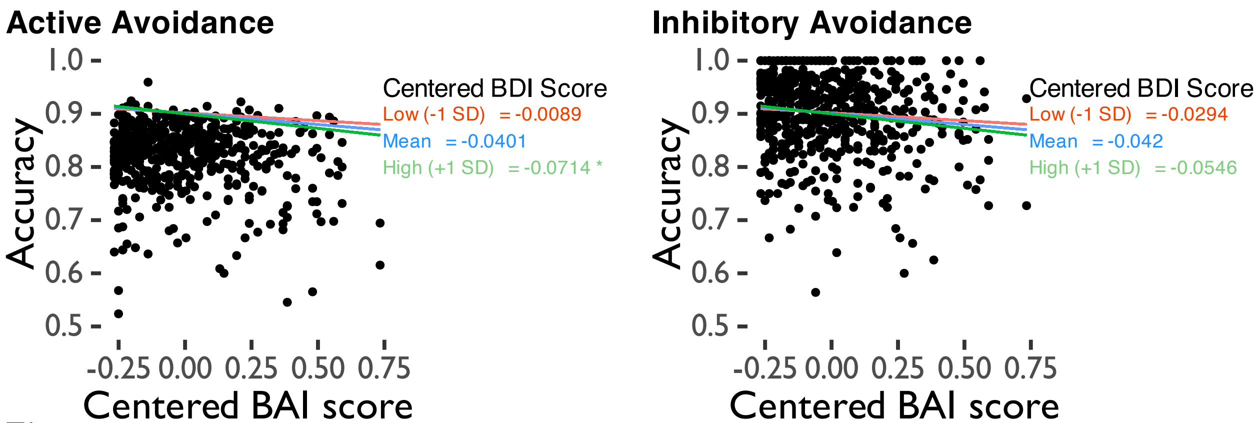


Figure 4

Interactive regression analysis output for active and inhibitory avoidance. BAI = Beck Anxiety Inventory, BDI = Beck Depression Inventory. Numbers on right indicate coefficients for regression lines at each level of BDI score (centred 1 standard deviation below the mean, at the mean, and 1 standard deviation above the mean).

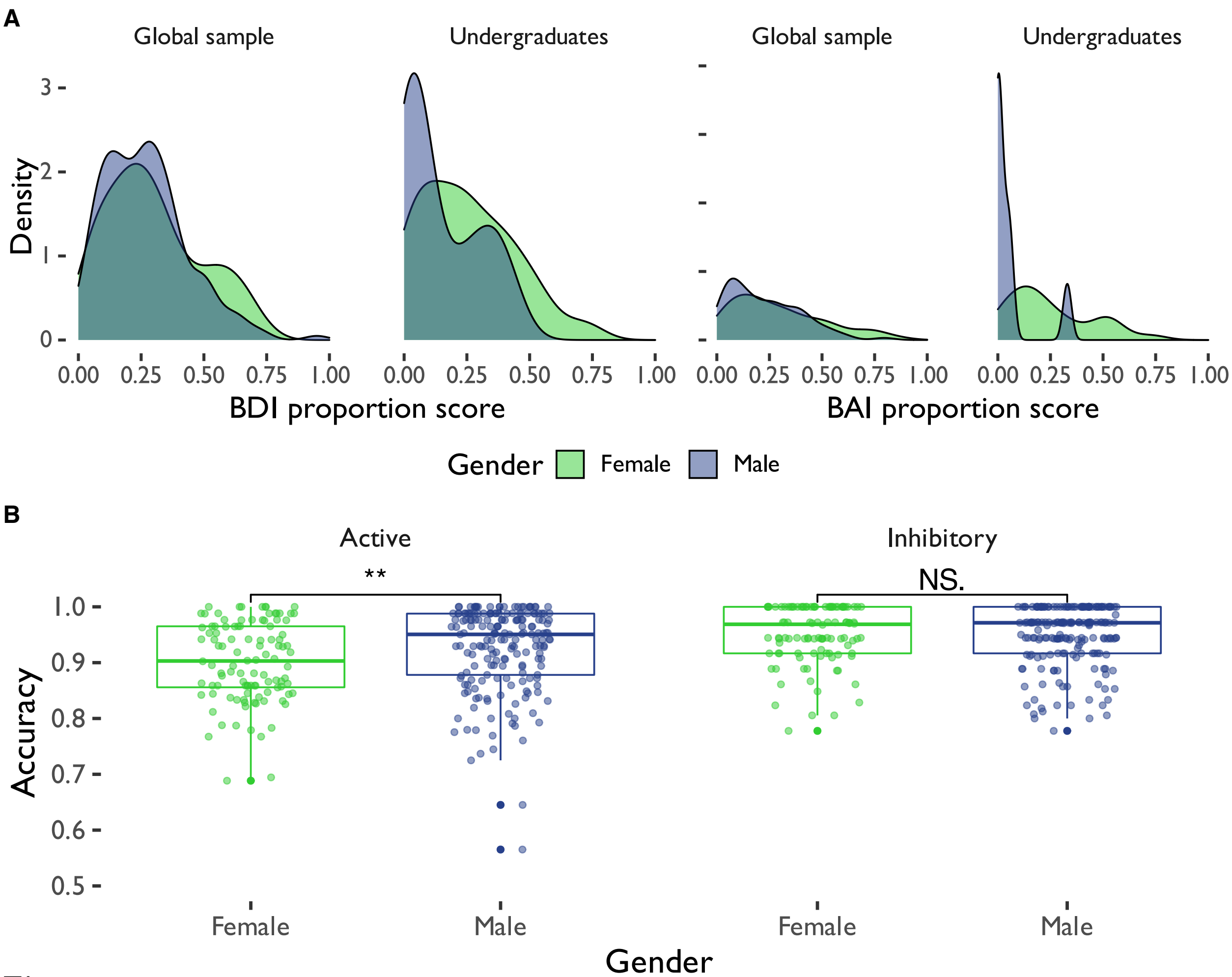


Figure 5

(A) Distribution of anxiety (BAI) and depressive symptom (BDI) scores by gender and sample. (B) Accuracy by gender on active and inhibitory reward-seeking, and moderation of the relationship between accuracy and anxiety (BAI) scores by gender. Proportion scores are scores divided by total possible score. BAI = Beck Anxiety Inventory, BDI = Beck Depression Inventory.

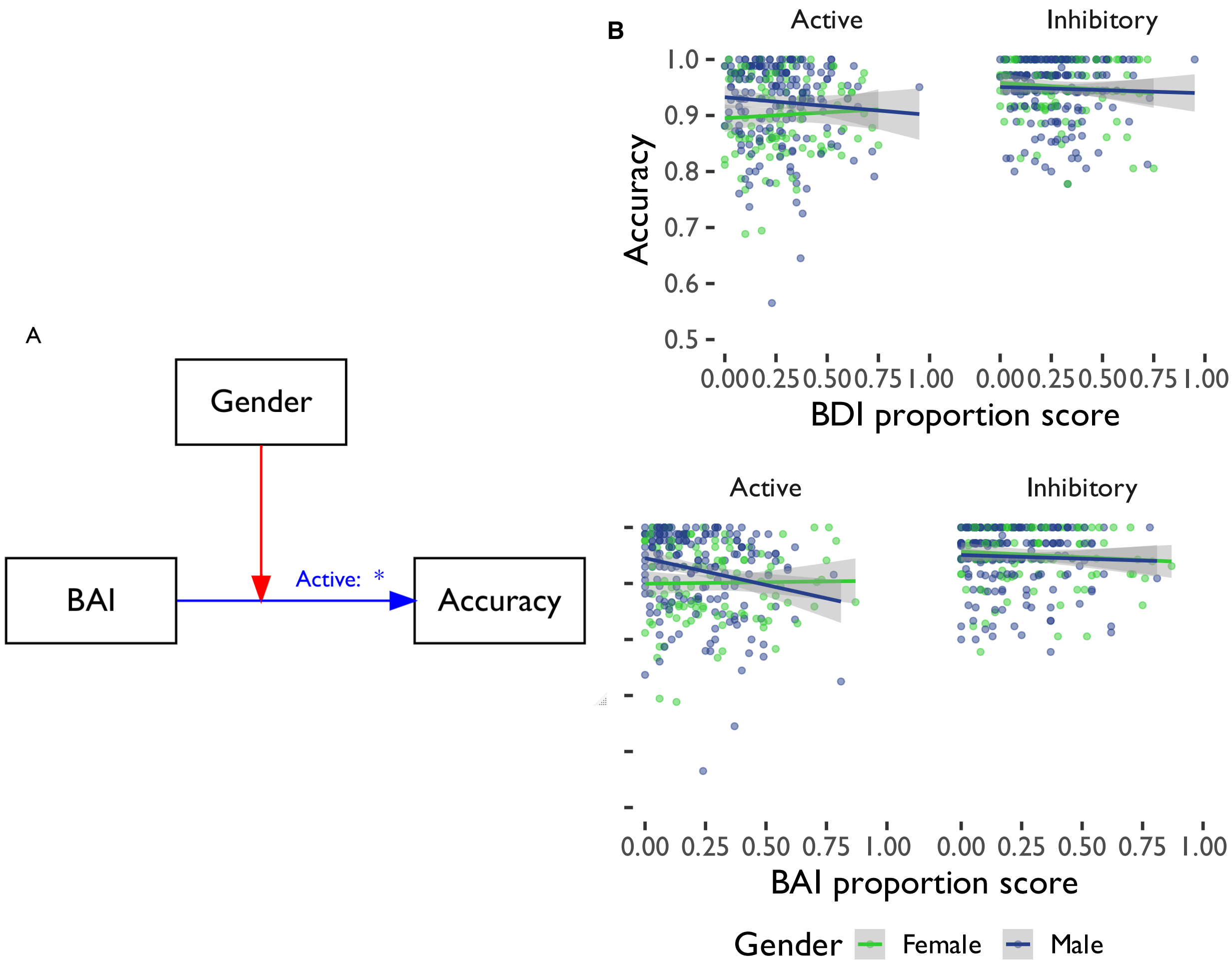


Figure 6

(A) Moderation of the relationship between accuracy and anxiety (BAI) proportion scores by gender on active and inhibitory reward-seeking. Anxiety symptoms (BAI proportion scores) were significantly associated with active reward-seeking accuracy. (B) Accuracy by gender on active and inhibitory reward-seeking. BAI = Beck Anxiety Inventory. Proportion scores are scores divided by total possible score.

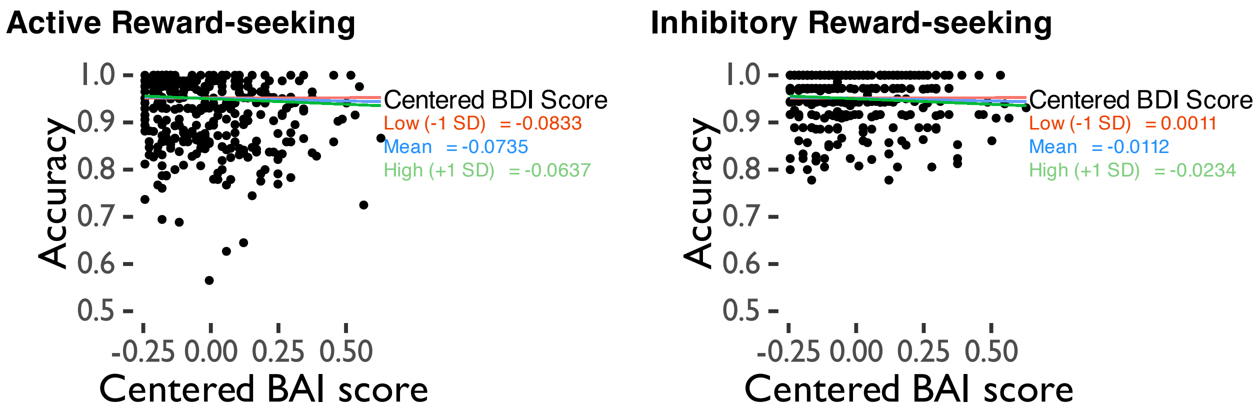


Figure 7

Interactive regression analysis output for active and inhibitory reward-seeking. BAI = Beck Anxiety Inventory, BDI = Beck Depression Inventory. Numbers on right indicate coefficients for regression lines at each level of BDI score (centred 1 standard deviation below the mean, at the mean, and 1 standard deviation above the mean).

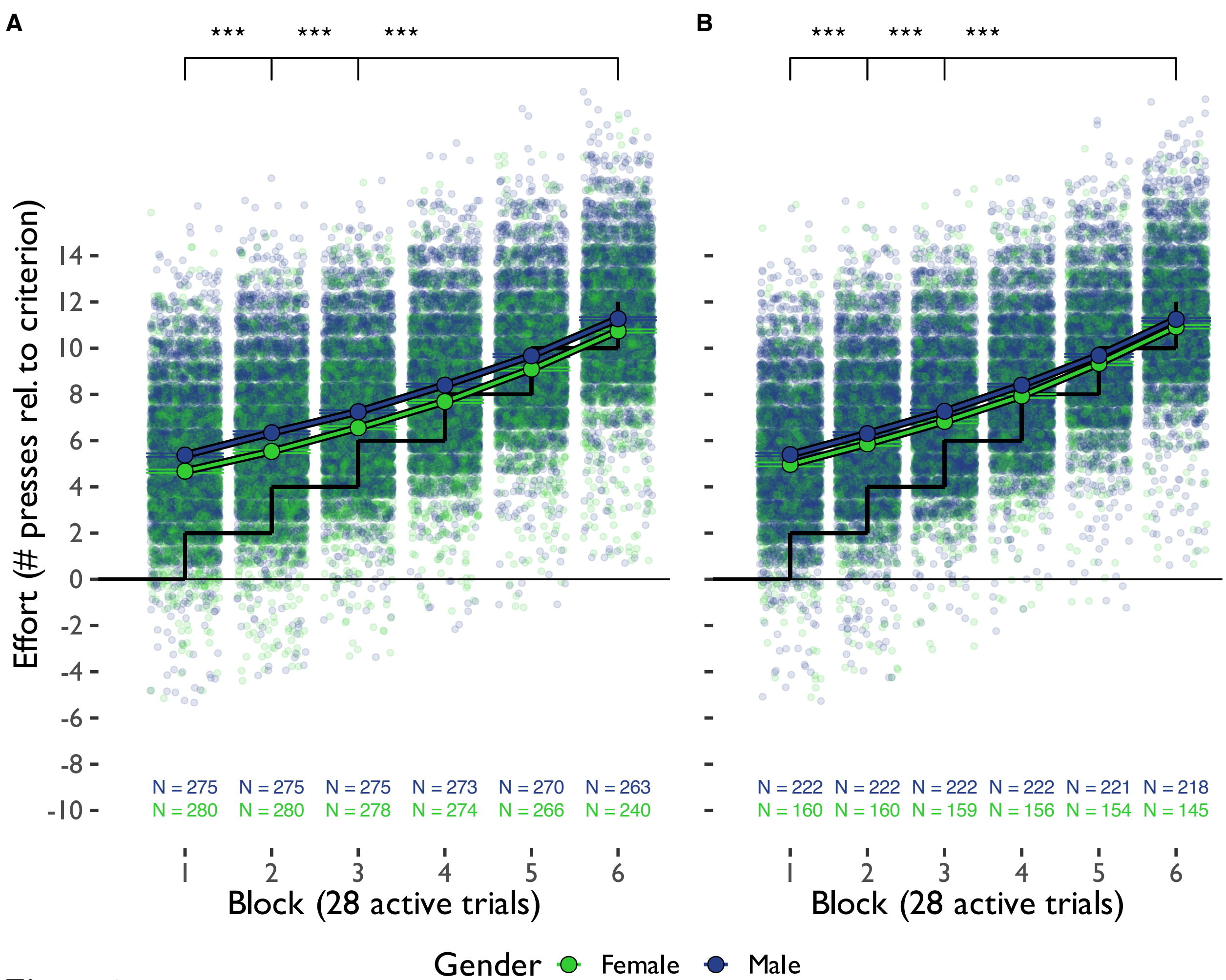
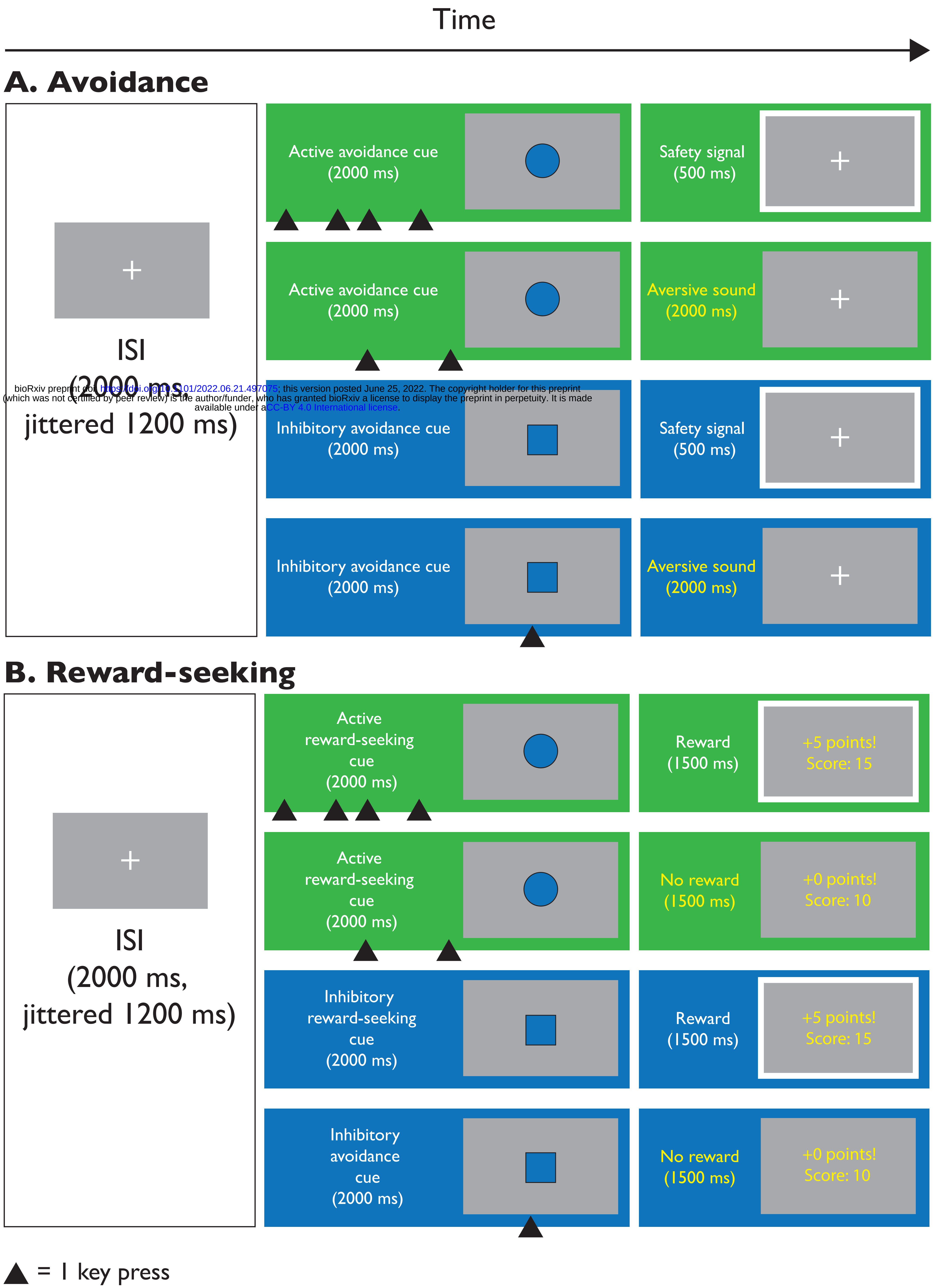
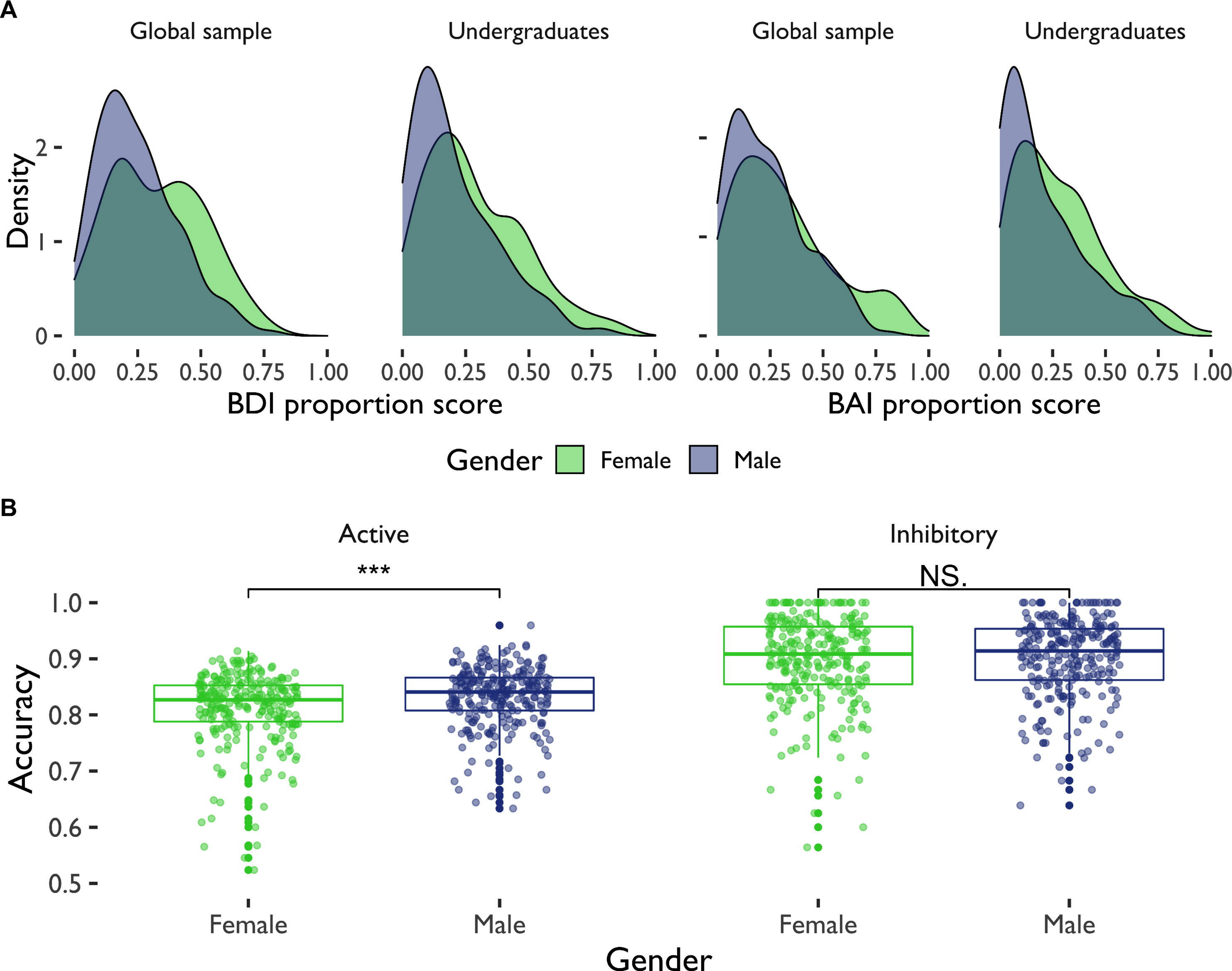
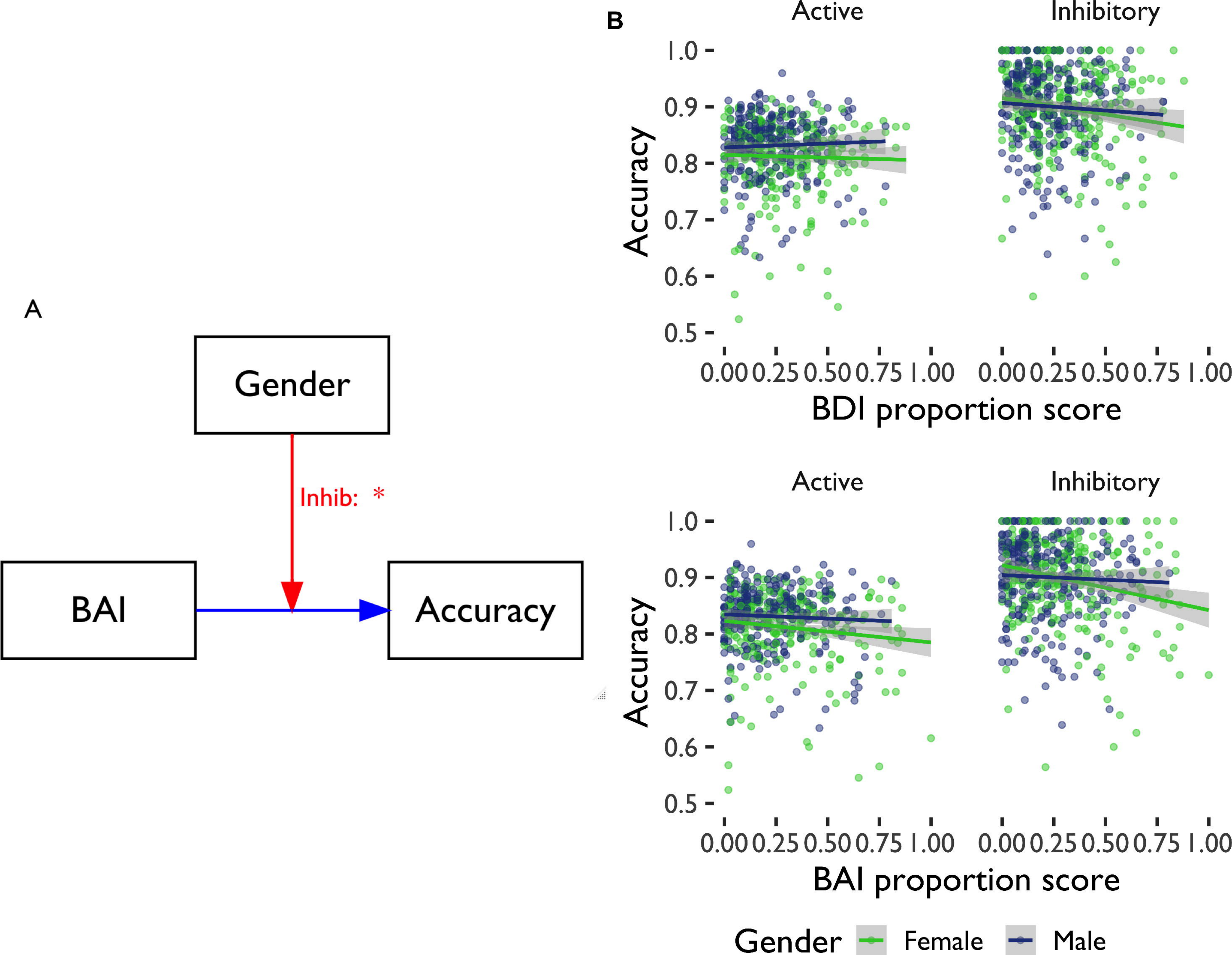


Figure 8

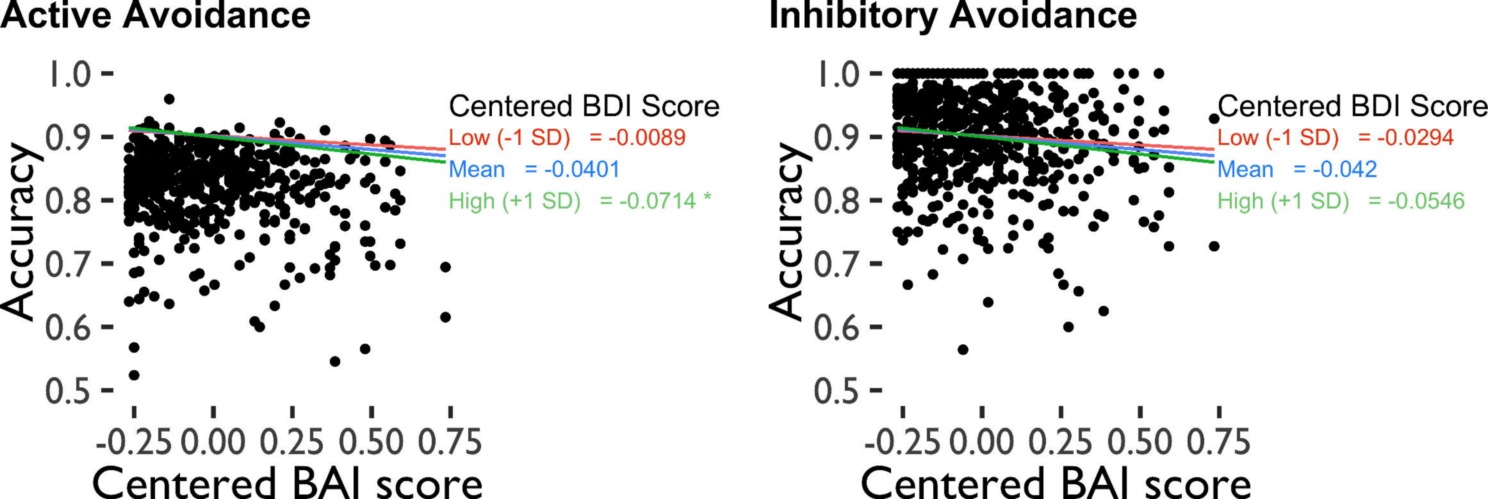
Effort deployment across active avoidance (A) and reward-seeking (B) trials relative to the criterion effort deployment required to avoid an aversive outcome or obtain reward (black line). Each point represents one trial. N values represent number of participants of each gender who completed the task during that block of trials.

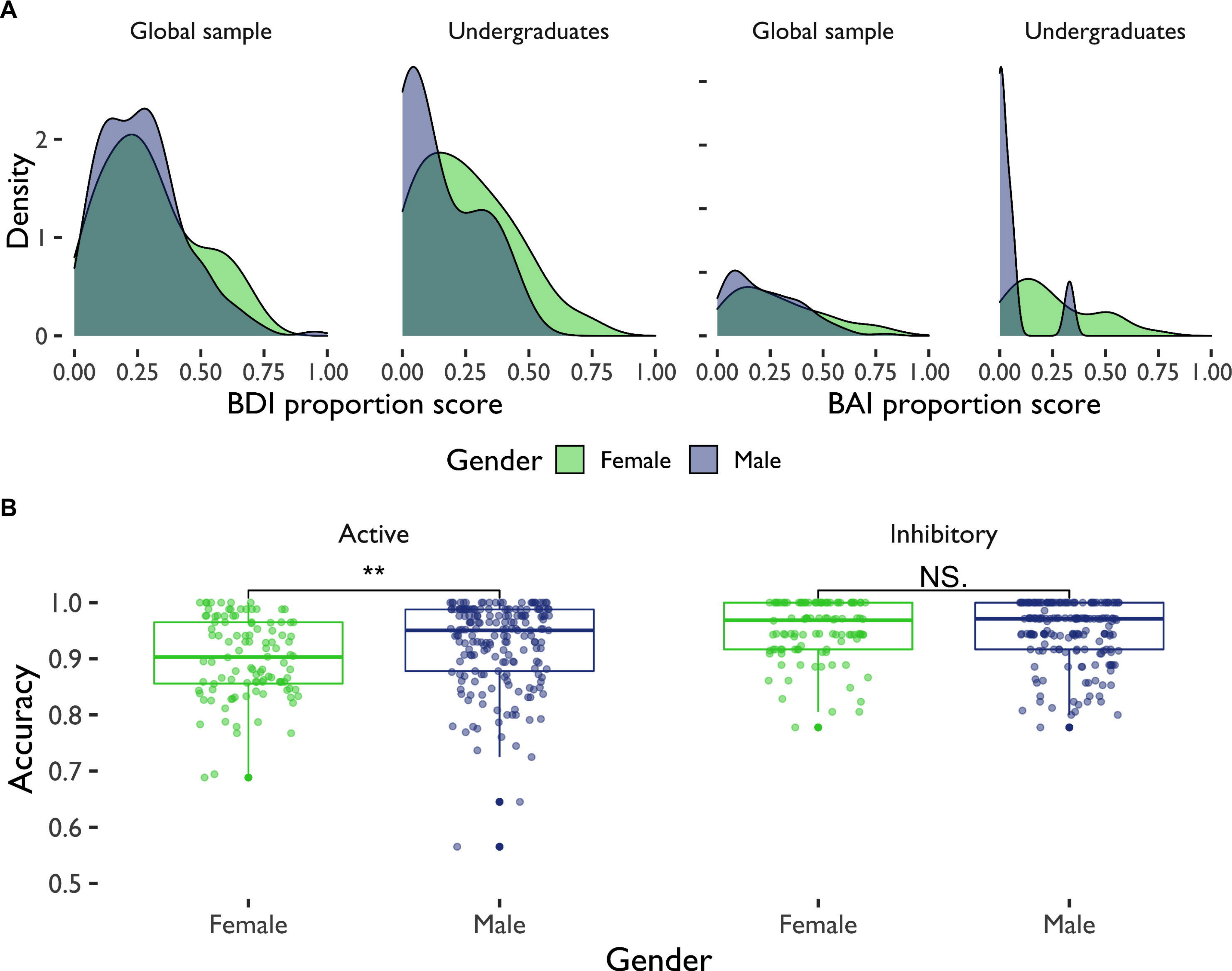

Time
A. Avoidance
ISI
(2000 ms,
jittered 1200 ms)
Active avoidance cue
(2000 ms)
Safety signal
(500 ms)
Active avoidance cue
(2000 ms)
Aversive sound
(2000 ms)
Inhibitory avoidance cue
(2000 ms)
Safety signal
(500 ms)
Inhibitory avoidance cue
(2000 ms)
Aversive sound
(2000 ms)
B. Reward-seeking
ISI
(2000 ms,
jittered 1200 ms)
Active
reward-seeking
cue
(2000 ms)
Reward
(1500 ms)
+5 points!
Score: 15
Active
reward-seeking
cue
(2000 ms)
No reward
(1500 ms)
+0 points!
Score: 10
Inhibitory
reward-seeking
cue
(2000 ms)
Reward
(1500 ms)
+5 points!
Score: 15
Inhibitory
avoidance
cue
(2000 ms)
No reward
(1500 ms)
+0 points!
Score: 10
= 1 key press

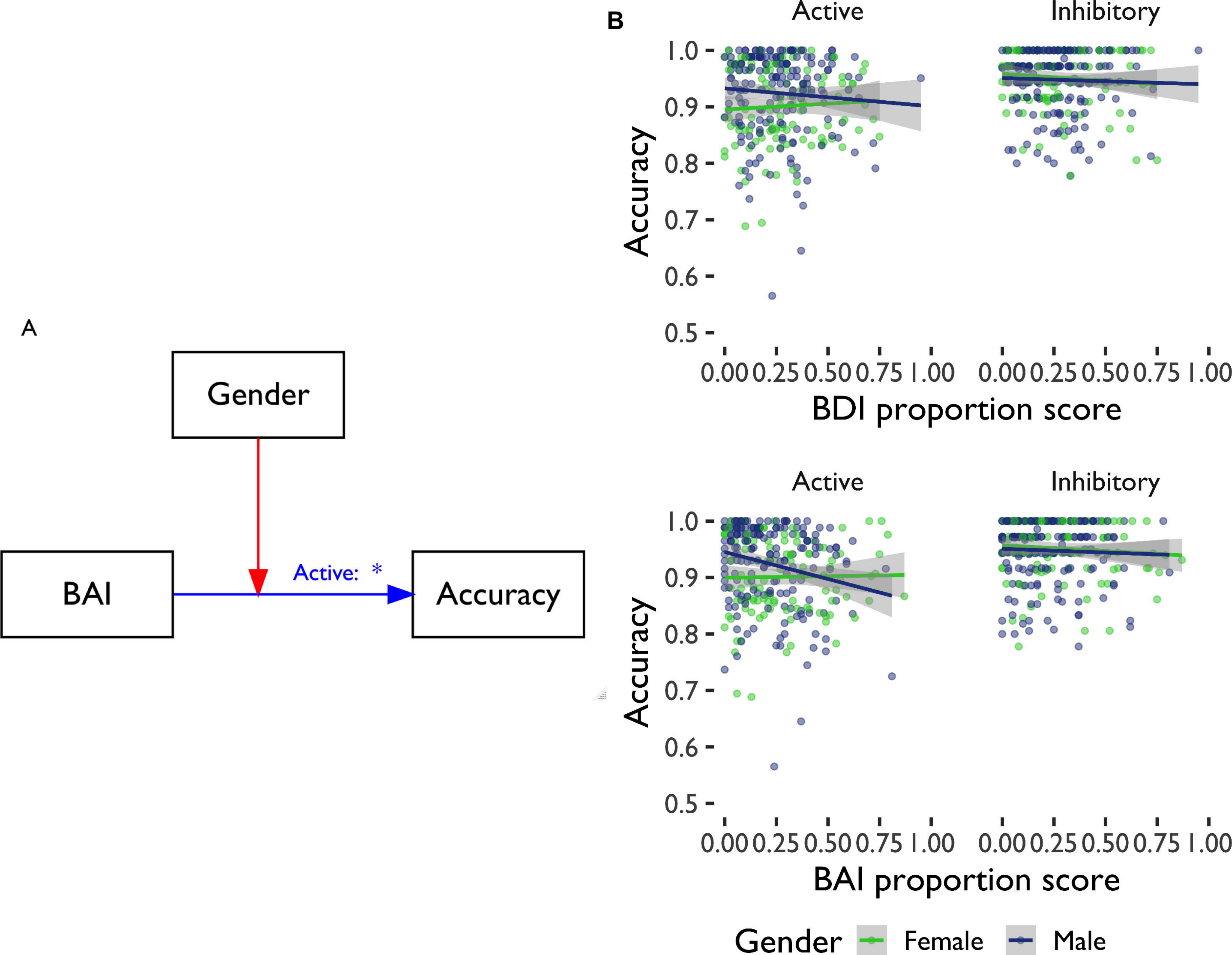

A
Global sample
Undergraduates
Global sample
Undergraduates
Density
0
1
2
0.00
0.25
0.50
0.75
1.00
BDI proportion score
BAI proportion score
Gender
Female
Male
B
Active
Inhibitory
***
NS.
Accuracy
1.0
0.9
0.8
0.7
0.6
0.5
Female
Male
Female
Male
Gender



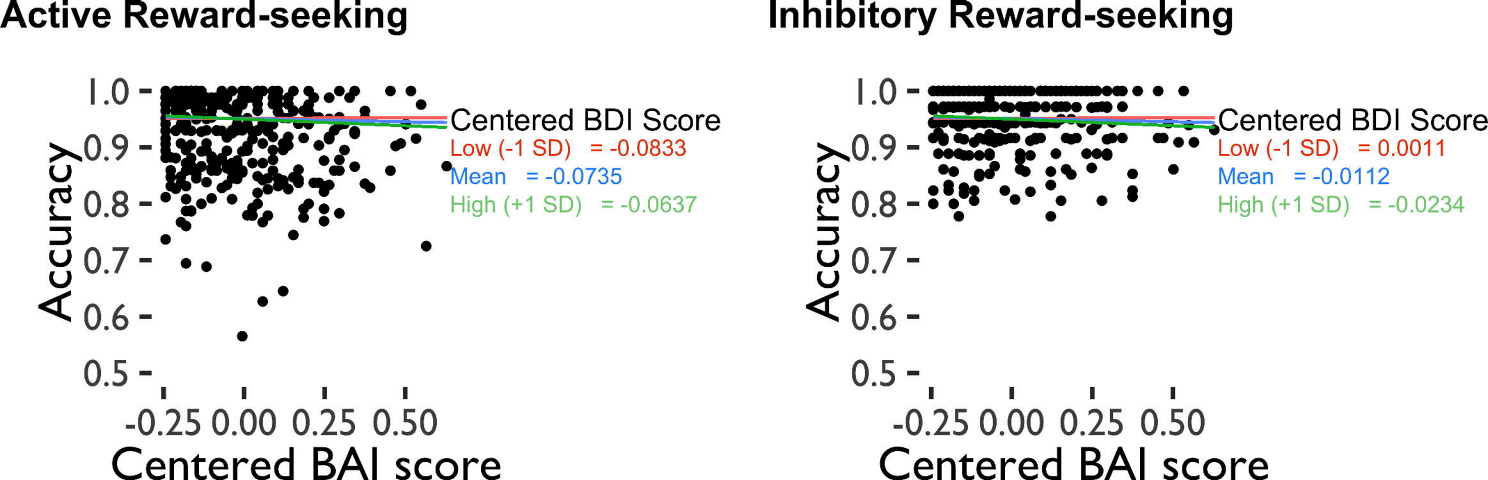
A
Gender
Inhib: *
BAI
Accuracy
B
Active
Inhibitory
Accuracy
1.0
0.9
0.8
0.7
0.6
0.5
0.00 0.25 0.50 0.75 1.00
BDI proportion score
BAI proportion score
Gender
Female
Male

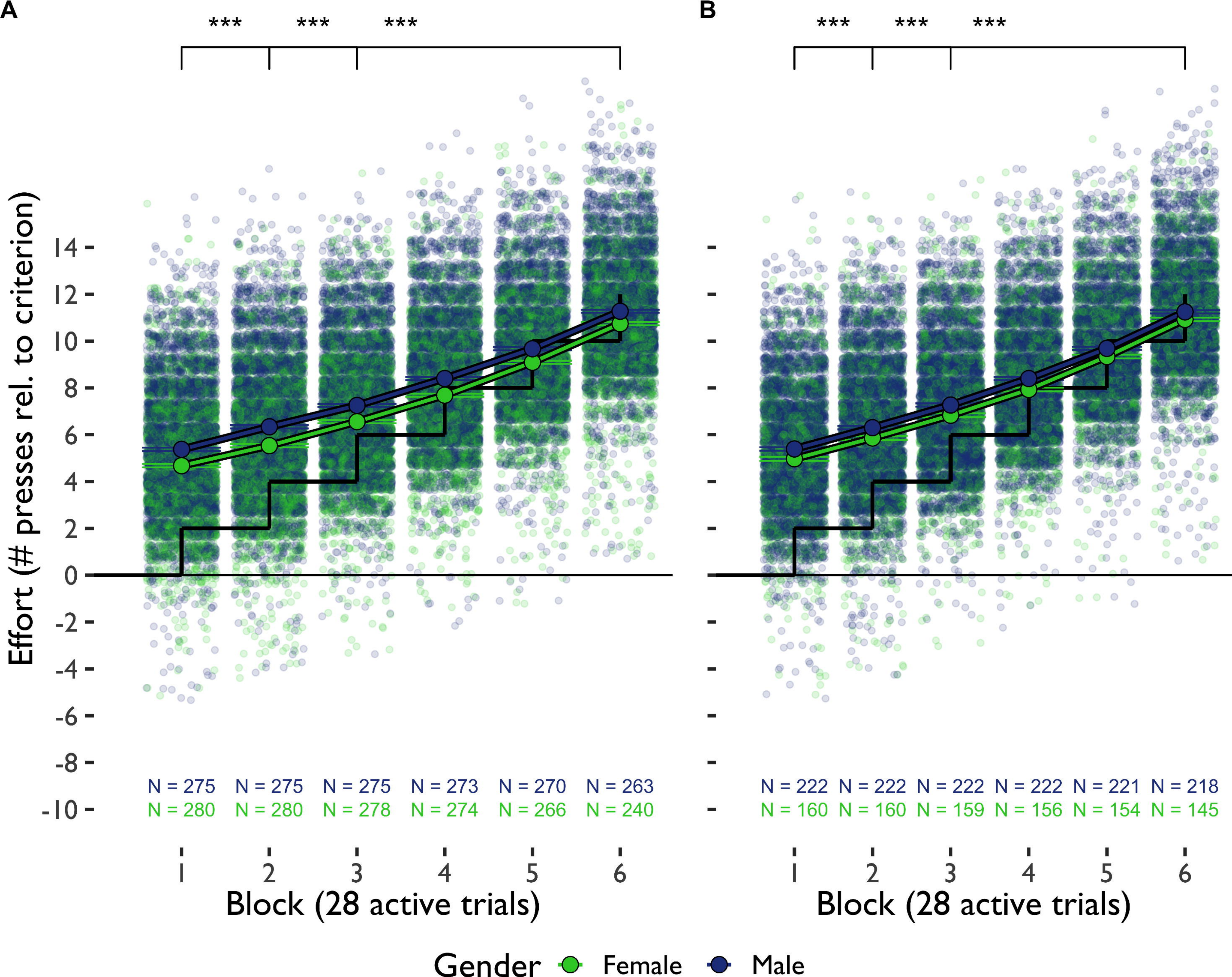

Active Avoidance
Inhibitory Avoidance
Accuracy
1.0
0.9
0.8
0.7
0.6
0.5
Centered BDI Score
Low (-1 SD) = -0.0089
Mean = -0.0401
High (+1 SD) = -0.0714 *
Low (-1 SD) = -0.0294
Mean = -0.042
High (+1 SD) = -0.0546
-0.25
0.00
0.25
0.50
0.75
Centered BAI score


A
Global sample
Undergraduates
Global sample
Undergraduates
Density
BDI proportion score
BAI proportion score
Gender
Female
Male
B
Active
Inhibitory
**
NS.
Accuracy
Female
Male
Female
Male
Gender



A
Gender
BAI
Active: *
Accuracy
B
Active
Inhibitory
Accuracy
1.0
0.9
0.8
0.7
0.6
0.5
0.00 0.25 0.50 0.75 1.00
BDI proportion score
Active
Inhibitory
Accuracy
BAI proportion score
Gender
Female
Male


Active Reward-seeking
Inhibitory Reward-seeking
Accuracy
1.0
0.9
0.8
0.7
0.6
0.5
-0.25
0.00
0.25
0.50
Centered BAI score
Centered BDI Score
Low (-1 SD) = -0.0833
Mean = -0.0735
High (+1 SD) = -0.0637
Centered BDI Score
Low (-1 SD) = 0.0011
Mean = -0.0112
High (+1 SD) = -0.0234



A
B
***
Effort (# presses rel. to criterion)
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
N = 275 N = 275 N = 275 N = 273 N = 270 N = 263
N = 280 N = 280 N = 278 N = 274 N = 266 N = 240
N = 222 N = 222 N = 222 N = 222 N = 221 N = 218
N = 160 N = 160 N = 159 N = 156 N = 154 N = 145
1 2 3 4 5 6
Block (28 active trials)
Gender
Female
Male