Role of psychopathic personality traits on the micro-structure of free-operant responding: impacts on goal-directed but not stimulus-drive responses in extinction

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Declarations of interest: None.

Short title: Psychopathy and schedules.

Chen, X., Osborne, L.A., & Reed, P. (2020). Role of psychopathic personality traits on the micro-structure of free-operant responding: impacts on goal-directed but not stimulus-drive responses in extinction. Personality and Individual Differences. Doi: 10.1016/j.paid.2020.110055

Abstract

The current study explored effects of psychopathic personality traits on micro-structure of free-operant responding. Non-clinical participants were recruited, and responded on a multiple random-ratio (RR) random-interval (RI) schedule for points, prior to being placed into extinction. They completed the TriPM to measure psychopathic personality, and were divided into those scoring lower and higher on the sub-scales of the TriPM (meanness, boldness, disinhibition). Responding was higher on RR than RI schedules, with no difference between rates of bout-initiation, but higher rates of within-bout responding the RR schedule. Extinction reduced responding after an initial response burst. No personality traits impacted acquisition of overall free-operant responding, nor its microstructure. However, meanness retarded the course of extinction after promoting an initial response burst. The results suggest psychotics are more goal-directed, consistent with meanness being associated with aggression and low tolerance to frustration, potentiating frustrative non-reward effects.

Keywords: psychoticism; meanness; schedules of reinforcement; extinction; micro-structure; goal-directed responding.

1. Introduction

Psychopathy may be regarded as a continuous dimension of personality (Cleckley, 1941; Wilkowski & Robinson, 2008), but its effect on learned behaviour is unclear (Morgan et al., 2011). Schedule-controlled behaviour is taken to comprise both 'bout-initiation' and 'within-bout' responses. 'Bout-initiation' responses are controlled by rates of reinforcement (Shull, 2011), through contextual conditioning (Reed et al., 2018), and to be automatic or habitual (Reed, 2020). 'Within-bout' responses are controlled by the relationship of behaviour to the reinforcer (Killeen et al., 2002), and are conscious and goal-directed (Reed, 2020). The current study investigated the impact of psychopathy on the micro-structure of free-operant responding (Killeen et al., 2002; Shull, 2011) during acquisition and extinction to illuminate the effects of psychopathy on learned behaviour.

Psychopaths exhibit aggression, impulsivity, disinhibition, reward-value overestimation, unrealistic-goals (Hosking et al., 2017). These characteristics suggest there should be impacts on behaviour and decision-making, especially in weighing consequences of actions, such as might be expected in the control of free-operant instrumentally-conditioned behaviour (Balleine & Dickinson, 1998; Reed, 2001). Gendreau and Suboski (1971) noted no overall effect of psychopathy on classical conditioning, but suggested different learning mechanisms for those with lower- and higher-psychopathy levels. Those with higher-psychopathy have been suggested to display greater passive avoidance (withholding responding to avoid punishment), and are not modulated by punishment levels; interpreted as an emotional-learning impairment (Blair et al., 2004). Poor modulation of dominant responses also has implicated in psychopaths (Howland et al., 1993). However, there is little direct evidence about the impact of such traits or processes on instrumental leaning, and none regarding it microstructure.

These above considerations suggest that relationships between psychopathy and schedule-performance may not be straightforward. The suggestion of increased subjective-value for any given stimulus might imply increased operant responding; although, no such effect was observed by Bryan and Kapche (1967). However, as noted by Morgan et al. (2011), there are many dimensions to psychopathological-personality (e.g., meanness, boldness, disinhibition; Patrick, 2010), and not all traits may exhibit an effect on all conditioning tasks.

To examine these effects, psychopathological-traits were measured using the Triarchic Psychopathy Measure (TriPM; Patrick, 2010), and their relationship to free-operant behaviour controlled by random ratio (RR) and random interval (RI) schedules assessed (see Randell et al., 2009). Assessing the degree to which psychopathological-traits impact stimulus-driven and goal-directed responses can be accomplished by studying the micro-structure of this free-operant responding (Reed, 2020). Cornell et al. (1996; Glenn & Raine, 2009) suggested psychopaths are highly driven 'instrumentally' (are strongly directed to a valued goal), rather than being 'reactive'. This implies a greater sensitivity to goal-directed control, rather than stimulus-driven control (Hosking et al., 2017), suggesting an effect on 'within-bout', but not 'bout-initiation', responding.

Irrespective of the impact of psychopathic-traits on acquisition, psychopathy may also impact extinction. There are stronger theoretical reasons for suspecting this to be the case; failure to modulate dominant responses implies an impact of psychopathy on extinction (Howland et al., 1993). Increased resistance to extinction would also be predicted by the view that reactive aggression in psychopaths relates to an increased frustration (Blair, 2010), which can drive levels of extinction-responding (Gallup, 1965). However, given the heightened goal-directedness of psychopaths (Cornell et al., 1996), this may be more apparent in extinction of goal-directed within-bout responding, rather than stimulus-driven

bout-initiation responding (Hosking et al., 2017). Such an effect may also be especially apparent at times of increased frustration, such as at commencement of extinction (Amsel, 1992).

The present experiment evaluates the effects of psychoticism on human schedule performance in acquisition and extinction, in terms of overall levels of responding, and the micro-structure of that responding. While it was unclear whether there would be impacts of psychoticism during acquisition, it was hypothesised that psychoticism would be related to extinction, especially to within-bout responding during the early stages of extinction.

2. Method

2.1 Participants

75 volunteers (41 males, 34 females) were recruited at a Chinese University (mean age=18.69±.64 SD). Participants received no finical payment. There were no explicit inclusion/exclusion criteria. Participants were asked if they had a history of mental illnesses (depression, anxiety, autism spectrum disorder, schizophrenia), they were also prompted to report any other disorders, and/or any current psychoactive medications. None of the sample reported such a history. There have been no previous investigations of the effect of psychopathy on schedule performance, but investigations of schizotypy and schedule behaviour have found statistical significance ($p<.05$), with medium effect sizes, using a sample of 70-80 (Randell et al., 2009). G-Power suggests for 90% power, at $p<.05$, and medium effect sizes, a sample of 58 is needed. Ethical permission was given by the Ethics Committee of the University's Psychology Department, and all participants gave informed consent for their participation by signing a consent form.

2.2 Materials

Triarchic Psychopathy Measure (TriPM; Patrick, 2010) is a 58-item self-report measure, consisting of three sub-scales; meanness (19-items, maximum score = 57; α=.87), boldness (19-items, maximum score = 57; α=.80), and disinhibition (20-items, maximum score = 60; α=.80). Meanness is the tendency towards emotionally callous, unemphatic cruelty. Boldness is the tendency towards low stress-reactivity, social dominance, fearlessness, excitement seeking, and social dominance. Disinhibition reflects low motivation for pursuit or anger in the context of activation, leading to irresponsibility, impulsivity, poor planning, and anger.

2.3 Apparatus

The experimental task was presented on a standard desktop computer. Visual Basic (6.0) was used to programme the task. The programme first presented a RR-30 schedule, wherein points (reinforcers) were awarded for space bar responses (every response had a 1/30 probability of reinforcement). Second, a RI schedule delivered points following the first response after a specified amount of time. The RI schedule was yoked to the preceding RR schedule, so that each successive RI reinforcement was delivered after the elapse of time for the corresponding RR reinforcer. Each reinforcer consisted of 40 points being added to the participant's total, which started at 100 at the start of each schedule presentation (trial). Participants lost one point for each space bar response, regardless of whether the response was reinforced. This procedure was adopted as such a response-cost generates human schedule performance similar to that observed in nonhumans (Raia et al., 2000).

The task was presented on a white screen, with a stimulus box (8x3cm) in the centre upper portion of the screen, of a single colour (blue or pink). A new schedule was indicated by a change in colour. Underneath the stimulus box, the word "POINTS" (in Chinese) was

positioned, and the running total of the points accumulated during the current schedule exposure appeared in figures.

2.4 Procedure

After giving informed consent, participants were tested individually in a quiet room, which contained a desk and computer, with the monitor situated approximately 60cm from them. Participants gave written consent, and read the study information and instructions for the task. Participants commenced the task in their own time, and were required to fill in basic demographic details about themselves, and the questionnaire, before the experimental schedule task was presented. When they were ready, all participants were directed to the computer, and were presented with the following instructions on the computer screen:

"*When the task begins, use the space bar to score* ***as many points as possible****. There are eight games in total. The first game is identified with a large blue [pink] rectangle at the top of the screen. When the first game is over, the rectangle will change to blue [pink] to indicate the start of the next game. The rectangles alternate between blue and pink to indicate the changing games for the remainder of the task. Your goal in each game is to reach the* ***highest score possible****. You will see that the points reduce according to the way in which you play, but will rise again every so often, according to the pattern of space bar hits that you use. All you need to do is to find the best pattern of space bar hits to score* ***as highly as possible*** *in each game. It may be a good idea to respond quickly sometimes and slowly at other times, but you need to discover this for yourself!*"

The participants were then instructed to click a start button to continue with the experiment. Each participant experienced 8 different trials during which the responded to earn points on the schedules, as described above. Each schedule presentation (trial) was 4min long, and a RR schedule trial was always presented immediately prior to the yoked

RI schedule trial. There were four such presentations of the yoked RR–RI pairs (eight schedule presentations in total; 4 RR schedules, and 4 yoked-RI schedules). The procedure of yoking RI trials to preceding RR trials, described above, ensured that reinforcement in the RI schedule was delivered after a similar elapsed time that it had taken for the corresponding reinforcers to be awarded on the RR trial.

After the eight acquisition trials (4 RR and 4 RI trials), reinforcement was withdrawn. Without any gap in the experiment, and unsignalled to the participants, all participants then experienced a further 12, 2-min trails. There were 6 trials with each of the colours previously associated with the RR and RI schedules. During extinction, the colours signalling the different components were presented randomly, with the exception that only two trials of extinction of a particular schedule (the previous RR or RI schedules) could occur in a row. During this part of the study, responses continued to lose points from the participant's total, but no reinforcement was presented.

3. Results

3.1 Acquisition

The mean overall response rate (per min) for the sample, on the last trial of conditioning, for the RR schedule was 189.70$\pm$9.61) responses per min, and for the RI was 94.27$\pm$9.22) responses per min. A repeated-measures analysis of variance (ANOVA) revealed a significant effect of schedule, $F(1,74)=67.20$, $p<.001$, $\eta^2_p=.480$[95% CI:.308-.594], $H_1/D=.999$.

A log survivor method was adopted to determine the micro-structure of responding (Shull, 2011). This turns into logs the percentage of inter-response times (IRTs) emitted in particular time-bins compared to all IRTs not yet emitted. A double exponential equation can be fitted, where the equation fits the two distributions of IRTs (i.e. those prior to the 'break'

taken to represent response initiations; and those after the break, taken to represent within-bout responses. This equation takes the form: Ppred = a*exp(-bt)+(1-a)*e(-dt), where b and d represent the rates of within-bout and bout-initiation, respectively.

The sample-mean bout-initiation rate, on the last trial of conditioning for the RR schedule was 33.53±21.94 responses per min, and for the RI was 35.46±18.82) responses per min. This difference was not significant, $F<1$, $\eta^2_p=.005[.000-.079]$, $H_0/D=.878$. The sample-mean within-bout rate, on the last trial of conditioning for the RR schedule was 307.00±218.10 responses per min, and for the RI was 194.18±197.42 responses per min, which was significant, $F(1,174)=16.35$, $p<.001$, $\eta^2_p=.181[.048-.328]$, $H_1/D=.996$. This pattern of behaviour is consistent with previous examinations of schedule-controlled behaviour (Peele et al, 1984; Reed et al., 2018)

3.2 Extinction

To analyse the overall effect of extinction, rates of responding for the first and last extinction trials (for RR and RI schedules combined) was calculated as a percentage of that rate on the last session of conditioning. The first trial was analysed to determine whether an extinction burst (Skinner, 1938), often associated with frustration (Amsel, 1992), had occurred, and the last to see whether responding had reduced over the subsequent sessions of extinction. This procedure was conducted for the overall, bout-initiation, and within-bout rates of responding (which was tested using a paired t-test against 100%).

--- Figure 1 ---

Figure 1 presents the sample-mean percentages of baseline responding for the sample. On the first extinction session, responding was greater than 100% of baseline for overall rates, $t(74)=5.61$, $p<.001$, $d=.65$, bout-initiation rates, $t(74)=4.00$, $p<.001$, $d= 45$, and within-burst rates, $t(74)=3.03$, $p=.003$, $d=.65$. Indicating extinction bursts for all measures had

occurred (Skinner, 1938). For the last session, there was significant reduction from baseline for response-initiation, $t(74)=3.28$, $p=.002$, $d=.38$, but not for overall rates, $t(74)=1.28$, $p=.203$, $d=.16$, or within-bout rates, $t<1$, $d=.09$. However, all rates on the final session of extinction reduced from rates on the first extinction session: overall rates, $t(74)=8.53$, $p<.001$, $d=.99$; bout-initiation rates, $t(74)=4.34$, $p<.001$, $d=.50$; and within-burst rates, $t(74)=3.45$, $p=.001$, $d=.39$.

3.3 Psychopathology

--- Table 1 ---

To explore whether the psychopathological traits had any relationship to rates of responding, Pearson correlations between each of the psychopathological personality traits (TriPM) and rates of overall, bout-initiation, and within-bout responding, on the last block of training, are shown in Table 1. They reveal no relationship between any trait and any rate of responding during acquisition.

--- Figure 2 ---

Figure 2 shows Pearson correlations between psychopathological traits and each of the percentage extinction scores. There were small, positive correlations between meanness and within-bout rates during the first and last extinction sessions ($r=.283$, $r=.254$, respectively).

3.4 Meanness

Participants were split into two groups according to the mean meanness subscale score (15.24 ± 7.50): creating a lower-meanness group ($N=47$; mean$=10.74\pm3.17$); and a higher-meanness group ($N=28$; mean$=22.79\pm6.53$). Figure 3 shows the group-mean RR and RI rates of response on the last trial of training, the first trial of extinction, and last trial of

extinction, for the overall (top panel), bout-initiation (middle panel), and within-bout (lower-panel), response rates.

--- Figure 3 ---

Inspection of the overall rates of response (top panel) shows higher RR than RI rates for both groups. Responding increased on the first extinction session more pronouncedly for the RI schedule, and the decreased by the last session of training more pronouncedly for the RR schedule. A three-factor mixed-model ANOVA (meanness x schedule x trial) revealed significant main effects of schedule, $F(1,73)=133.44$, $p<.001$, $\eta^2_p=.646[.509-.730]$, $H_1/D=.999$, and trial, $F(2,146)=51.01$, $p<.001$, $\eta^2_p=.411[.287-.504]$, $H_1/D= 999$, but not meanness, $F<1$, $\eta^2_p=.001[.000-.001]$, $H_0/D=.999$. There was a significant schedule and trial interaction, $F(2,146)=37.13$, $p<.001$, $\eta^2_p=.337[.212-.436]$, $H_1/D= 999$, but not between schedule and meanness, $F<1$, $\eta^2_p=.012[.000-.101]$, $H_0/D=.999$, trial and meanness, $F<1$, $\eta^2_p=.003[.000-.032]$, $H_0/D=.999$, or all three factors, $F<1$, $\eta^2_p=.001[.000-.002]$, $H_0/D=.999$.

Inspection of the bout-initiation response rates (Figure 3 middle panel) shows similar rates of response on the two schedule at the end of training for both groups. Rates increased on the introduction of extinction for RR but not RI schedules, before reducing from these levels. There was little difference in terms of meanness. A three-factor ANOVA (meanness x schedule x trial) revealed significant main effects of trial, $F(2,176)=12.45$, $p<.001$, $\eta^2_p=.145[.050-.2441]73$, $H_1/D=.999$, and schedule, $F(1,73)=5.71$, $p=.019$, $\eta^2_p=.073[.008-.156]$, $H_1/D=.664$, but not meanness, $F<1$, $\eta^2_p=.002[.000-.066]$, $H_0/D= 999$. There was a significant interaction between schedule and trial, $F(2,146)=15.06$, $p<.001$, $\eta^2_p=.337[.212-.436]$, $H_1/D=.938$, but not between schedule and meanness, $F<1$, $\eta^2_p=.001[.000-.044]$, $H_0/D=.999$, trial and meanness, $F(2,146)=1.08$, $p>.30$, $\eta^2_p=.015[.000-.064]$, $H_0/D=.999$, or all three factors, $F<1$, $\eta^2_p=.004[.000-.036]$, $H_0/D=.999$.

Inspection of the within-bout response rates (Figure 3 bottom panel) shows that response rates were higher for the RR than the RI schedule. These rates increased more on both schedules on the introduction of extinction for the higher-meanness group, which also showed less extinction at the end of training than the lower meanness group. A three-factor ANOVA (meanness x schedule x trial) revealed significant main effects of trial, $F(2,176)=34.56$, $p<.001$, $\eta^2_p=.321[.197-.422]$, $H_1/D=.999$, and schedule, $F(1,73)=34.70$, $p<.001$, $\eta^2_p=.322[.154-.464]$, $H_1/D=.664$, but not of meanness, $F(1,73)=2.98$, $p=.089$, $\eta^2_p=.039[.000-.154]$, $H_0/D=.659$. There were significant interactions between schedule and trial, $F(2,146)=14.92$, $p<.001$, $\eta^2_p=.169[.067-2711]$, $H_1/D=.934$, schedule and meanness, $F(1,73)=3.84$, $p=.050$, $\eta^2_p=.050[.000-.171]$, $H_0/D=.531$, and trial and meanness, $F(2,146)=3.18$, $p=.045$, $\eta^2_p=.042[.000-.113]$, $H_0/D=.592$, but not all three factors, $F<1$, $\eta^2_p=.003[.000-.029]$, $H_0/D=.999$.

3.5 Boldness

The participants were split into two groups according to the mean boldness subscale score (26.79 ± 7.63): creating a lower-boldness group ($N=36$; mean$=20.92\pm4.81$); and a higher-boldness group ($N=39$; mean$=32.79\pm5.41$). Figure 4 shows the group-mean rates of response for the RR and RI schedules on the last trial of training, first trial of extinction, and last trial of extinction, for the lower and higher boldness groups, for the overall (top panel), bout-initiation (middle panel), and within-bout (lower-panel), response rates. Inspection of these data suggests that boldness had little effect on rates of responding, of any type, during conditioning or extinction.

--- Figure 4 ---

Inspection of the overall rates of response (top panel) shows a higher rate for the RR compared to the RI schedule. Responding increased on the first session of extinction, and

decreased by the last session of training, but more pronouncedly for the RR schedule. A three-factor ANOVA (boldness x schedule x trial) revealed significant main effects of schedule, $F(1,73)=147.11$, $p<.001$, $\eta^2_p=.668[.537-.747]$, $H_1/D=.999$, and trial, $F(2,146)=56.29$, $p<.001$, $\eta^2_p=.435[.313-.526]$, $H_1/D=.999$, but not of boldness, $F<1$, $\eta^2_p=.003[.000-.069]$, $H_0/D=.999$. There was a significant interaction between schedule and trial, $F(2,146)=40.50$, $p<.001$, $\eta^2_p=.369[.231-.455]$, $H_1/D=.999$, but not between schedule and boldness, $F<1$, $\eta^2_p=.010[.000-.096]$, $H_0/D=.855$, trial and boldness, $F<1$, $\eta^2_p=.006[.000-.042]$, $H_0/D=.983$, nor between all three factors, $F<1$, $\eta^2_p=.009[.000-.053]$, $H_0/D=.981$.

Inspection of the bout-initiation rates (Figure 4 middle panel) shows similar rates on the RR and RI schedules at the end of training. These increased on the introduction of the extinction session, before reducing from these levels, more pronouncedly for the RR schedule. There was little difference in terms of boldness. A three-factor ANOVA (boldness x schedule x trial) revealed significant main effects of trial, $F(2,176)=10.57$, $p<.001$, $\eta^2_p=.127[.038-.222]$, $H_1/D=.999$, and schedule, $F(1,73)=5.51$, $p=.022$, $\eta^2_p=.072[.002-.146]$, $H_1/D=.664$, but not of boldness, $F<1$, $\eta^2_p=.000[.000-.022]$, $H_0/D=.999$. There was a significant interaction between schedule and trial, $F(2,146)=15.88$, $p<.001$, $\eta^2_p=.179[.074-.280]$, $H_1/D=.955$, but not between schedule and boldness, $F<1$, $\eta^2_p=.000[.000-.001]$, $H_0/D=.999$, trial and boldness, $F(2,146)=1.77$, $p=.175$, $\eta^2_p=.023[.000-.082]$, $H_0/D=.968$, or all three factors, $F<1$, $\eta^2_p=.001[.000-.012]$, $H_0/D=.999$.

Inspection of the within-bout rates (Figure 4 bottom panel) shows that rates were higher for the RR than the RI schedule, increased on both schedules at the outset of extinction, then reduced. There was little effect of boldness. A three-factor ANOVA (boldness x schedule x trial) revealed significant main effects of trial, $F(2,176)=32.01$, $p<.001$, $\eta^2_p=.305[.182-.406]$, $H_1/D=.999$, and schedule, $F(1,73)=41.50$, $p<.001$, $\eta^2_p=.362[.191-.499]$, $H_1/D=.999$, but not of boldness, $F<1$, $\eta^2_p=.012[.000-.102]$, $H_0/D=.999$.

There was a significant interaction between schedule and trial, $F(2,146)=16.90$, $p<.001$, $\eta^2_p=.188$[.081-290], $H_1/D=.970$, but not between schedule and boldness, $F<1$, $\eta^2_p=.001$[.000-.033], $H_0/D=.999$, trial and boldness, $F<1$, $\eta^2_p=.005$[.000-.039], $H_0/D=.999$, or all three factors, $F<1$, $\eta^2_p=.004$[.000-.037], $H_0/D=.999$.

3.5 Disinhibition

To explore whether disinhibition impacts schedule-maintained responding, the participants were split into two groups according to the mean disinhibition subscale score (20.11±8.25): creating a lower-disinhibition group ($N=45$; mean=14.44±3.37); and a higher-disinhibition group ($N=30$; mean=28.60±5.67). Figure 5 shows the group-mean rates of response for the RR and RI schedules on the last trial of training, first trial of extinction, and last trial of extinction, for the lower and higher disinhibition groups, for the overall (top panel), bout-initiation (middle panel), and within-bout (lower-panel) rates. Inspection of these data suggests little impact of disinhibition on any form of responding during conditioning or extinction.

--- Figure 5 ---

Inspection of the overall rates of response (Figure 5 top panel) shows a higher rate for the RR compared to the RI schedule, which initially increased on the first session of extinction for both schedules, but more pronouncedly for the RI schedule, and the decreased by the last session of training, but more pronouncedly for the RR schedule. A three-factor ANOVA (disinhibition x schedule x trial) revealed significant main effects of schedule, $F(1,73)=137.91$, $p<.001$, $\eta^2_p=.635$[.519-.736], $H_1/D=.999$, and trial, $F(2,146)=51.07$, $p<.001$, $\eta^2_p=.412$[.288-.505], $H_1/D=.999$, but not of disinhibition, $F<1$, $\eta^2_p=.004$[.000-.077], $H_0/D=.881$. There was a significant interaction between schedule and trial, $F(2,146)=38.46$, $p<.001$, $\eta^2_p=.345$[.220-.444], $H_1/D=.999$, but not between schedule and disinhibition,

$F(1,73)=1.78$, $p=.187$, $\eta^2_p=.024[.000-.127]$, $H_0/D=.778$, trial and disinhibition, $F(2,146)=2.53$, p=.084, $\eta^2_p=.034[.000-.099]$, $H_0/D=$ 954, nor between all three factors, $F<1$, $\eta^2_p=.001[.000-.001]$, $H_0/D=.999$.

Inspection of the bout-initiation rates (Figure 5 middle panel) shows that rates were similar between the two schedules at the end of training, but initially increased on the introduction of the extinction session for the RR, but not the RI schedule, before reducing from these levels for both schedules. There was little difference in terms of disinhibition. A three-factor ANOVA (disinhibition x schedule x trial) revealed significant main effects of trial, $F(2,176)=10.08$, $p<.001$, $\eta^2_p=.121[.034-.217]$, $H_1/D=.629$, but not schedule, $F(1,73)=3.19$, $p=.056$, $\eta^2_p=.072[.0002-146.200]$, $H_0/D=.501$, or disinhibition, $F<1$, $\eta^2_p=.000[.000-.022]$, $H_0/D=.999$. There was a significant interaction between schedule and trial, $F(2,146)=15.94$, $p<.001$, $\eta^2_p=.179[.074-.280]$, $H_1/D=.994$, but not between schedule and disinhibition, $F(1,73)=1.56$, $p=.215$, $\eta^2_p=.000[.000-.001]$, $H_0/D=.797$, trial and disinhibition, $F(2,146)=1.87$, $p>.30$, $\eta^2_p=.023[.000-.082]$, $H_0/D=.967$, or all three factors, $F<1$, $\eta^2_p=.001[.000-.012]$, $H_0/D=.999$.

Inspection of the within-bout rates (Figure 5 bottom panel) shows that rates were higher for the RR than the RI schedule, but increased on the introduction of the extinction session. There was little effect of disinhibition on any of these rates. A three-factor ANOVA (disinhibition x schedule x trial) revealed significant main effects of trial, $F(2,176)=32.90$, $p<.001$, $\eta^2_p=.311[.189-.412]$, $H_1/D=.999$, and schedule, $F(1,73)=38.95$, $p<.001$, $\eta^2_p=.348[.177-.487]$, $H_1/D=.999$, but not of disinhibition, $F<1$, $\eta^2_p=.002[.000-.065]$, $H_0/D=.999$. There was a significant interaction between schedule and trial, $F(2,146)=15.56$, $p<.001$, $\eta^2_p=.188[.081-290]$, $H_1/D=.949$, but not between schedule and disinhibition, $F<1$, $\eta^2_p=.003[.000-.069]$, $H_0/D=.999$, trial and disinhibition, $F<1$, $\eta^2_p=.009[.000-.052]$, $H_0/D=.999$, or all three factors, $F<1$, $\eta^2_p=.005[.000-.038]$, $H_0/D=.999$.

4. Discussion

The aim of the current study was to document the effects of psychopathic personality traits on free-operant responding order to further understand the influences of personality on human instrumental learning. With respect to the effect of psychopathological traits of meanness, boldness, and disinhibition, as measured by the TriPM scale (Patrick, 2010), none of these traits strongly impacted acquisition of free-operant responding (see also Bryan & Kapche, 1967), nor did they show an impact on its microstructure. However, there was an effect of the trait of meanness on extinction (although not of boldness or disinhibition). Those with higher meanness scores showed retarded extinction, and a stronger within-bout response burst at the start of extinction.

That meanness was the only psychopathological trait to show an effect in extinction is consistent with views of the nature of this trait (Blair, 2010; Glenn & Raine, 2009). It is hypothesised that meanness it is related to aggression (Patrick, 2010), and is associated with low tolerance to frustration (Blair, 2010), which may potentiate frustrative non-reward effects (Amsel, 1992; Gallup, 1965). This would increase the potential to see frustration-induced effects on extinction for those with high levels of meanness (Amsel, 1992; Blair, 2010).

This effect of meanness was limited to within-bout rates of responding during extinction. The higher-meanness group initially showed an increase in within-bout responding in extinction, and maintained their rates of responding to a greater degree than the lower meanness group. This is in line with the above suggestion that higher meanness scorers are more susceptible to frustration (Blair, 2010), which may drive this response-burst effect during extinction (Amsel, 1992). That this effect was confined to the goal-directed within-bout responding, is consistent with suggestions that psychotic individuals are more

focused on instrumental goals (Glenn & Raine, 2009), and are not differentially sensitive to stimulus-driven responding (Hosking et al., 2017).

The overall acquisition data for the sample replicate previous demonstrations that human response rates are higher on an RR than on an RI schedule, with equated rates of reinforcement (Bradshaw & Reed, 2012; Chen & Reed, 2020). The micro-structure of this responding, as calculated using the survivor method (Shull, 2011), was also consistent with previous examinations of human responding; in that there was no difference between the rates of bout-initiation responding, but there was a higher rate of within-bout responding the RR compared to the RI schedule (Chen & Reed, 2020; Reed et al., 2018). The overall results from extinction demonstrate that responding declined over the extinction sessions, but that there was an initial response burst, which increased rate so that terminal rates were still not that much below baseline conditioning rates. The presence of an extinction burst is thought of as a typical phenomenon in conditioning (Domjan & Burkhard, 1982; Skinner, 1938), and certainly occurs in studies of clinical interventions (Lerman & Iwata, 1995; Lerman, Iwata, & Wallace, 1999), but has recently been questioned in studies using nonhumans (Lattal, Kuroda, & Cook, 2020). This phenomenon was very clear in the current data, so this effect requires further exploration with respect to its boundary conditions of occurrence.

As with all studies using model population to explore the effects of clinical traits on learning, there are limitations to the current study. There is a need to replicate these results using a greater range of schedules and measurement tools. Although using a nonclinical population avoids several confounds associated with the use of patients (Raine & Lencz, 1995; Randell et al., 2011), it does limit generality when considering a clinical population.

In summary, the data suggest that the different types of responding seen on such free-operant schedules could be sensitive to psychopathological traits. In particular, meanness was observed to reduce the level of extinction of goal-directed (within-bout) responses, in

line with previous theorising about its frustration and goal-directed nature. This suggests that this methodology may prove fruitful in further disentangling the nature of schedule-performance and human personality affects on learning.

Footnote

The reported studies were not pre-registered.

Materials, code, and data, are available on request.

All authors contribution to the study design, data collection, data analysis, manuscript and writing.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This research received no funding.

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aggression: An integrative analysis. *Personality and Social Psychology Review*, *12*, 3-21.

Table 1: Pearson correlations between each of the psychopathological traits and rates of overall, bout-initiation, and within-bout responding, on the last block of conditioning.

		Overall		Bout-initiation		Within-bout	
Trait	Mean (SD)	RR	RI	RR	RI	RR	RI
Meanness	(10.74 ± 3.17)	-.190	-.058	-.097	.074	.056	.123
Boldness	(26.79 ± 7.63)	.148	-.124	-.076	-.146	.037	.150
Disinhibition	(20.11 ± 8.25)	.054	.069	.031	.180	-.057	-.046

*p < .05; **p < .01; ***p < .001

Figure 1: Sample-mean responding during the first and last extinction session, as a percentage of baseline (last session of conditioning), for the overall response rates, bout-initiation rates, and within-bout rates. Error bars = 95$ confidence limits.

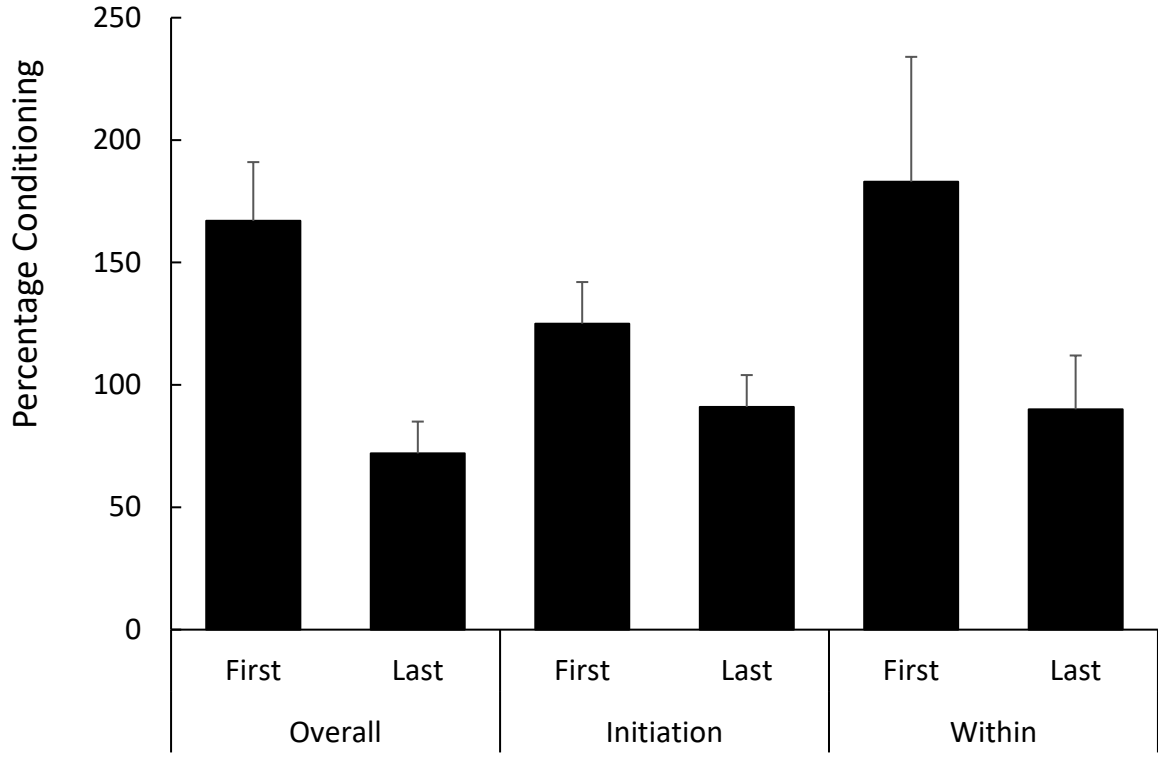

Figure 2: Pearson correlations between the three psychotic persoality traits and overall rates, bout-initaion rates, and within-bout rates, on the first and last sessions of extinction, for the sample.

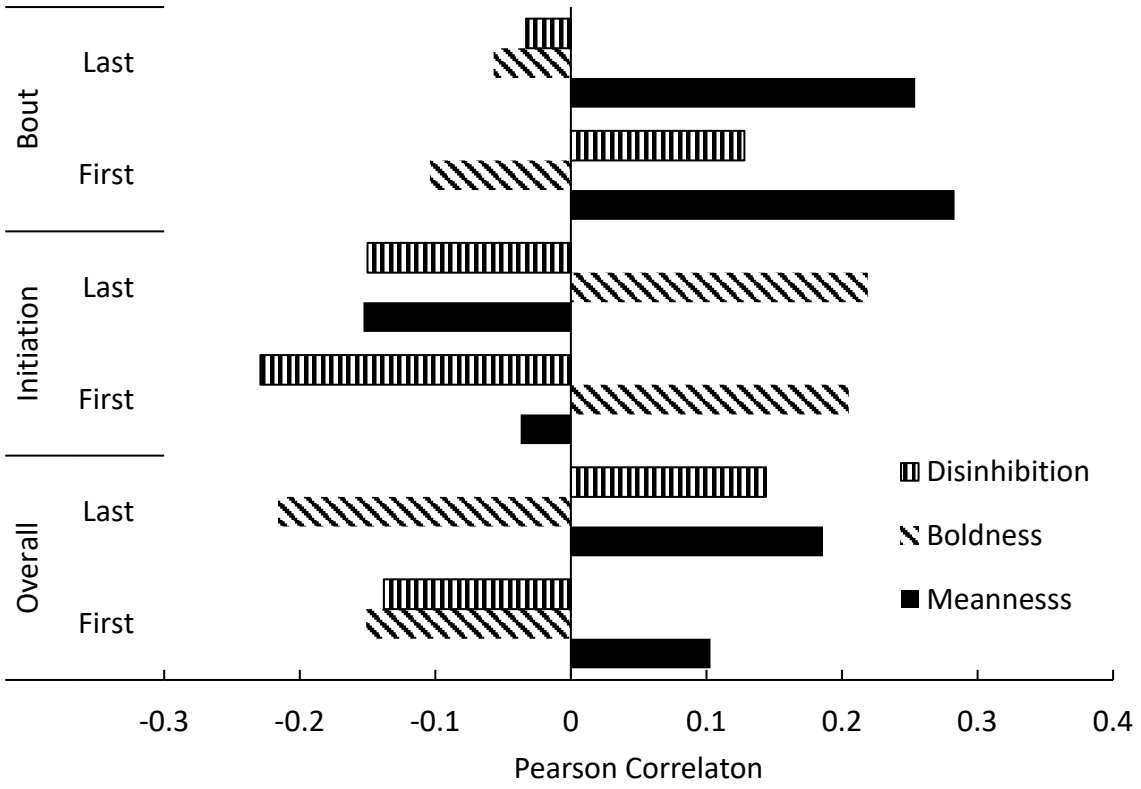

Figure 3: Group-mean rates of responding on the last session of acquisition, and first and last sessions of exaction, for the lower and higher meanness groups. Top panel = overall rates. Middle panel = bout-initiation rates. Bottom panel = within-bout rates. Error bars = 95% confidence limits.

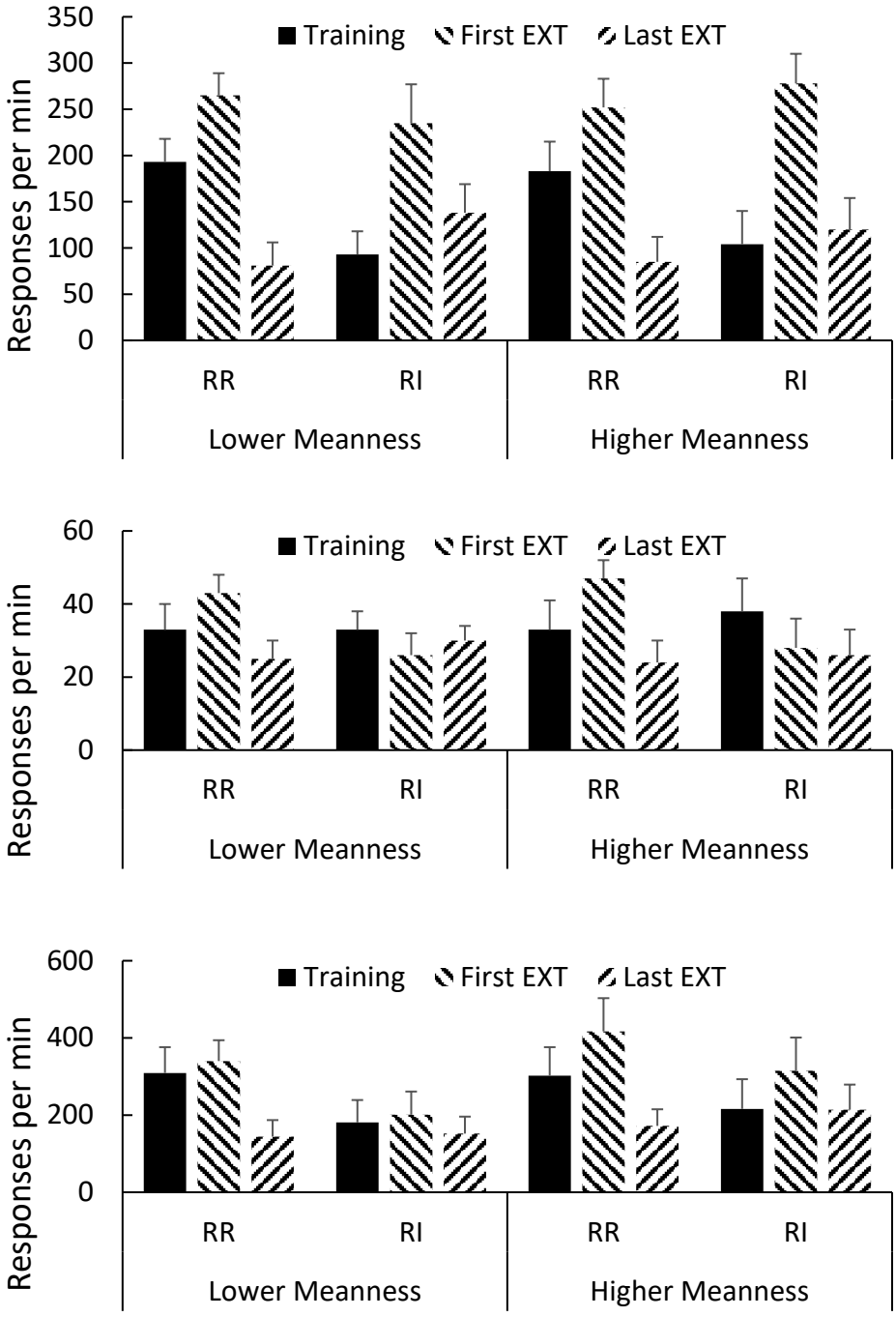

Figure 4: Group-mean rates of responding on the last session of acquisition, and first and last sessions of exaction, for the lower and higher boldness groups. Top panel = overall rates. Middle panel = bout-initiation rates. Bottom panel = within-bout rates. Error bars = 95% confidence limits.

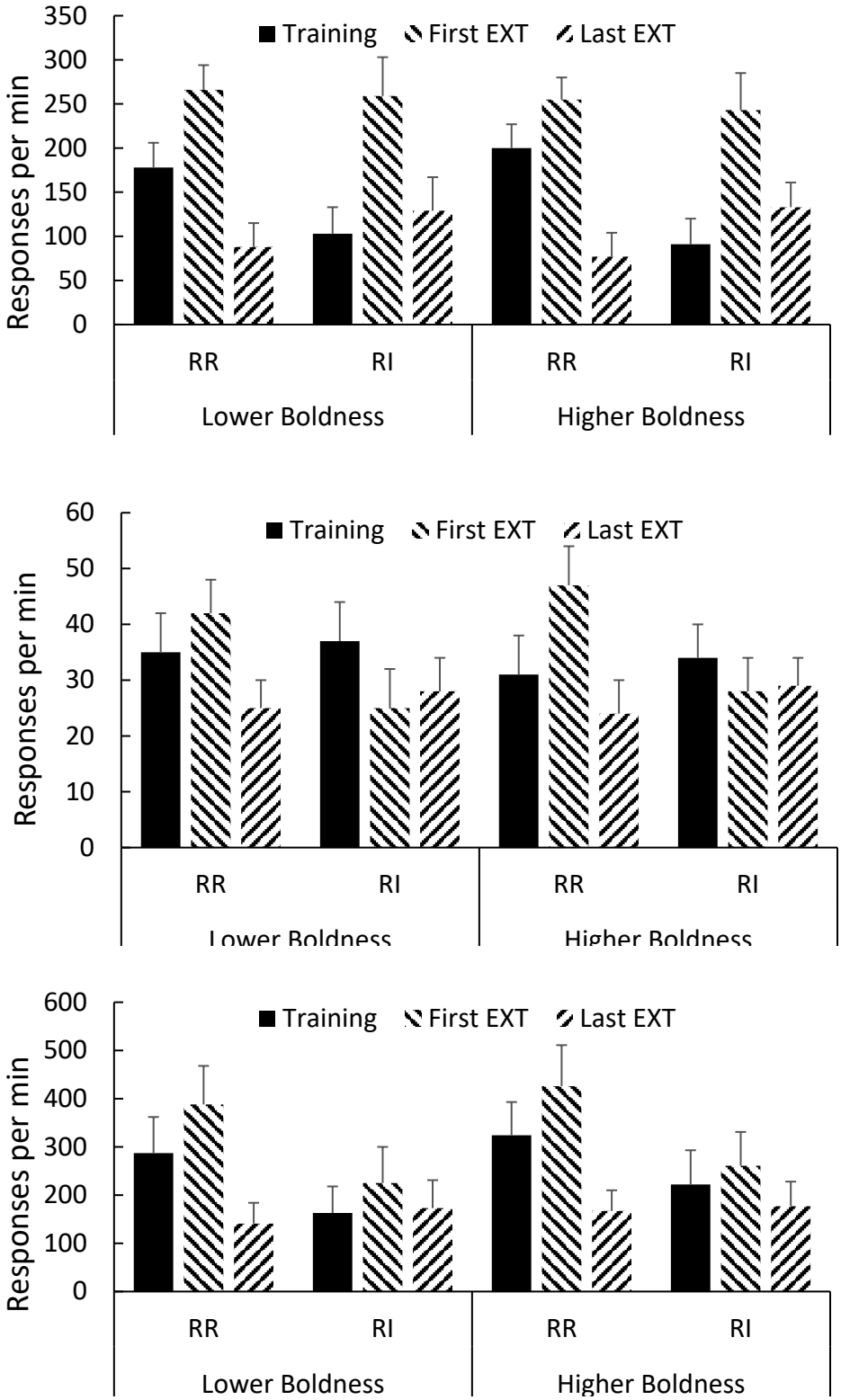

Figure 5: Group-mean rates of responding on the last session of acquisition, and first and last sessions of exaction, for the lower and higher disinhibition groups. Top panel = overall rates. Middle panel = bout-initiation rates. Bottom panel = within-bout rates. Error bars = 95% confidence limits.