Extinction of outcome-specific PIT, instrumental outcome devaluation, and reward-related attentional capture are predicted by affect-driven impulsivity.

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Abstract

In two online experiments, we aimed to study the relationship between emotion dysregulation and persistence of incentive salience attributed to reward cues. Participants' Negative urgency (NU) was assessed before they completed a Value-Modulated Attentional Capture (VMAC) task measuring incentive salience as attentional sign-tracking. This consisted of two phases—rewarded and unrewarded—to evaluate the persistence of the VMAC effect. Subsequently, a Pavlovian-to-Instrumental Transfer (PIT) procedure was employed as another measure of incentive salience. In Experiment 1 both outcome-specific and general PIT effects were assessed, along with the impact of instrumental outcome devaluation (OD). Experiment 2 focused on the effect of Pavlovian extinction on specific PIT. Both outcome devaluation and extinction are indices of implicit emotion regulation. In Experiment 1, the OD index showed a significant positive correlation with specific PIT and a negative correlation with the NU score. In Experiment 2, the extinction index of specific PIT, linked to the level of explicit knowledge of the contingencies, correlated negatively with NU. The VMAC effect and its persistence showed correlations with NU, positive and negative, respectively (Experiment 1). No relationships were found between any measure of VMAC and OD or PIT effects in any of the experiments. These findings suggest that difficulties in emotion regulation are associated with increased attentional sign-tracking and can hinder action control and selection. These phenomena may be governed by distinct mechanisms, with the VMAC effect being more automatic and the specific PIT effect exhibiting varying degrees of goal-directed behavior depending on the effectiveness of implicit emotion regulation strategies.

Adaptive, flexible reward-seeking behavior depends on the integration of both cue-outcome (Pavlovian conditioning) and action-outcome (instrumental conditioning) knowledge, which interact in the Pavlovian-to-instrumental transfer (PIT) procedure (Estes, 1943). Emotion dysregulation, defined as a failure in the operation of processes, conscious or unconscious, aimed at modifying the trajectory of an emotion, can result in emotional responses that are excessive, inappropriate or insufficient (Etkin et al., 2015), potentially affecting both learning processes. Under certain conditions or in vulnerable individuals, emotion dysregulation may be linked to excessive *incentive salience* ('wanting') attributed to reward cues, triggering more intense motivation to pursue reward (Peciña & Berridge, 2013). In the present work we aim to investigate the relationship between emotion dysregulation and excessive incentive salience attributed to reward cues in both Pavlovian and instrumental contexts.

Incentive salience: Attentional sign-tracking in Pavlovian scenarios

Excessive incentive salience can make the cues attract attention by themselves, becoming desirable, triggering approach as well as reward-seeking responses, and thus acting as 'motivational magnets' (Berridge, 2001; Berridge & Robinson, 2003; Olney et al., 2018), even at the expense of missing or neglecting current goals (but see Derman et al., 2018, for an expectancy-mediated account of sign-tracking behavior as a measure of incentive salience in rodents sensitive to outcome devaluation).

Individual differences in the tendency to attribute incentive salience to reward cues have been linked to the *sign-tracking* (ST) phenomenon. When discrete and localizable stimuli are utilized in appetitive Pavlovian conditioning, ST (Hearst & Jenkins, 1974) is described according to the conditioned response exhibited by rats toward reward cues (Derman et al., 2018). For instance, a stimulus (such as the insertion of a lever) precedes the delivery of food in the magazine, becoming a predictor of food availability and triggering a conditioned response

(magazine entry) directed to the place where the food (the goal) will be found. For sign-trackers, however, the cue additionally acquires *incentive value*, directing behaviors to the CS itself (the lever) as if it were a food surrogate, such as sniffing and nibbling (Anselme et al., 2013). While ST could be beneficial in certain scenarios by, for example, increasing attention to cues signaling important outcomes such as food or water, it may be counterproductive when it shows inflexibility, resistance to extinction, or insensitivity to other changes in CS-US contingency (such as reversal learning) or the value of an outcome (outcome revaluation). As reviewed by Colaizzi et al. (2020), ST conditioned responses, in contrast to goal-tracking, show greater resistance to extinction, increased susceptibility to reinstatement, and persist even when they result in an adverse outcome or loss of reward. Although ST is well-established in animal models as a plausible index of excessive incentive salience (Anselme et al., 2013), its direct application to individual differences in human subjects remains unclear.

Evidence suggests that ST behavior may be estimated in humans. For instance, Garofalo and di Pellegrino (2015) measured eye gaze during a Pavlovian conditioning task (monetary reward) to categorize participants as either sign-trackers or, alternatively, goal-trackers. Similarly, attentional ST has been studied through the value-modulated attentional capture (VMAC) effect (Anderson et al., 2011; Le Pelley et al., 2015). VMAC is typically measured using the additional singleton task (Theeuwes, 1992), although there are several variants (see Colaizzi et al., 2020). In the experiments reported here, we focus on a paradigm similar to the tasks employed in animal models: the reward cues are both task-irrelevant and response-independent. Consequently, attentional capture in this context is thought to be driven by Pavlovian rather than instrumental conditioning (Le Pelley et al., 2015).

In this version of the task (please refer to the Procedure section for further details), participants are presented with a uniquely shaped target among other non-targets of a different shape, forming a circular search array. To earn points, participants must determine the

orientation (vertical or horizontal) of a line within the target while ignoring non-targets in the same stimulus array (e.g., Garre-Frutos et al. 2024; Watson et al., 2019). The optimal strategy is to ignore the distractors since attending to them would slow down the response earning fewer points. However, participants tend to focus on the distractors, especially when they signal an increase in reward magnitude (condition high). On average, correct responses are typically slower than those of the control conditions without a corresponding trade-off in accuracy. This pattern suggests that attentional capture is modulated by the incentive value of the 'high' cue, and for this reason, VMAC [1] is considered appropriate for studying incentive salience as attentional sign-tracking in a Pavlovian scenario.

Incentive salience in action control and selection: Pavlovian-to-instrumental transfer (PIT)

The examination of reward-seeking behavior in instrumental scenarios often involves using the PIT procedure (see Cartoni et al., 2016, Holmes et al., 2010, for reviews of animal studies; Mahlberg et al., 2021, for human studies; and Garbusow et al., 2022, for studies with a focus on human psychopathology), which may be considered a relatively pure assay of incentive salience (Peciña & Berridge, 2013). When it comes to investigating human learning, especially in the context of subclinical or clinical mental disorders, the use of the PIT procedure is a relatively recent field of research (Garbusow et al., 2022).

While there are several variants of the PIT task, the basic paradigm typically consists of three phases. In the initial two phases, participants undergo training in instrumental (R-O) and Pavlovian (S-O) conditioning (in any order), followed by a transfer test in the third phase. Following each of the two training phases, participants' explicit knowledge about the relevant associations may be assessed. Finally, on the transfer test, participants freely perform the

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[1] For the sake of brevity, we will use the term 'VMAC task' to refer to the visual search task designed to estimate the VMAC effect.

instrumental responses while the Pavlovian cues are occasionally presented at different times during the session. This phase is typically conducted in nominal extinction to prevent further learning; that is, participants are told that they are still earning outcomes, but these are not displayed on the screen (for a more detailed description, please refer to the Procedure section).

This paradigm (e.g., Hinojosa-Aguayo & González, 2020; Morris et al., 2015) may allow for estimating both outcome-specific and general PIT effects (see Table 1). Specific PIT is observed as a bias in choice behavior, where the presence of a Pavlovian cue selectively increases the rate of the particular response with which it shares the outcome. On the other hand, general PIT is evident when a stimulus previously paired with a third outcome, not presented during instrumental training, produces a non-selective invigorating effect on general responding compared to baseline.

Emotion dysregulation and the persistence of attentional sign-tracking and reward-seeking behavior

As previously mentioned, emotion dysregulation may lead to inappropriate emotional responses (Etkin et al., 2015). In this context, the persistence of attentional sign-tracking and reward-seeking behavior, even when the S-O contingency or the incentive value of the outcome is reduced, may serve as a proxy for maladaptive cue reactivity, suggesting an inability to integrate and update new information. It is important to note that both extinction and outcome devaluation have been recognized as forms of implicit emotion regulation (Braunstein et al., 2017)—strategies aimed at modifying one's emotional state, primarily driven by incidental model-free processes, which can be assessed through objective computerized behavioral tasks (Muela et al., 2023). In addition, emotion dysregulation as a trait can be measured using questionnaires. For instance, *Negative urgency*, a factor of the UPPS-P scale (see Methods section), captures emotional impulsiveness, favoring immediate solutions that provide short-term emotional relief. This reflects an inefficient strategy for long-term emotion regulation (King

et al., 2018) and is therefore considered a form of generalized emotion dysregulation (Jara-Rizzo et al., 2019).

The present work

Given the above, we aim to examine the relationships between (1) failures in implicit emotion regulation processes involving behavioral persistence, such as instrumental outcome devaluation (Experiment 1) and Pavlovian extinction (Experiment 2); (2) negative urgency, as an explicit measure of generalized emotion dysregulation; and (3) indices of incentive salience, measured through attentional sign-tracking (VMAC) and specific PIT. In both experiments, we also evaluated the persistence of the VMAC effect when the reward was omitted and its relationship with negative urgency.

Additionally, in Experiment 1, we aimed to replicate previous findings regarding the relationships between instrumental outcome devaluation, specific PIT, and negative urgency (Hinojosa-Aguayo & González, 2020, Exp. 1). In Experiment 2, a conceptual replication of Experiment 2 in Seabrooke et al., 2018 using our task, we sought to extend these findings by examining the effect of Pavlovian extinction on specific PIT and exploring any potential relationships with negative urgency.

Given previous results (Hinojosa-Aguayo & González, 2020, Exp. 1) in Experiment 1 we expected to find a positive relationship between the indices of specific PIT and instrumental outcome devaluation [2], as well as negative correlations between both of these and the negative urgency score. Regarding the VMAC task the predictions were less clear. We broadly followed the procedure used by Watson et al. (2019), with an acquisition phase followed by another in which reward (points) was omitted on all trials (akin to an extinction procedure), with only

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[2] Please note that the outcome devaluation phase occurred after the PIT phase. Therefore, the devaluation effect we intended to estimate here was on instrumental performance, not on PIT.

feedback on accuracy provided to participants. Previous studies, using a reward-only variant of the VMAC task and the total score on the short UPPS-S impulsivity scale, have found a positive correlation between the VMAC effect and impulsivity in participants with addiction-related and compulsive-obsessive behavior (Albertella et al., 2019a). This is consistent with the idea that the VAMC effect may be related to problems of behavior control, but it needs to be tested in a healthy sample. We expected to find a VMAC effect during the acquisition phase that was positively related to negative urgency score. However, we were unable to make a clear prediction regarding the effect of reward-omission. If observed, as an index of flexibility, we would expect to find significant positive relationships with indices of instrumental outcome devaluation and specific PIT, along with a significant negative relationship with the negative urgency score. For clarity, predictions regarding Experiment 2 will be presented later, following the discussion of Experiment 1. In both experiments, participants first completed the VMAC task. Twenty-four hours later, they were sent another link to the PIT task (see Procedure for details).

Experiment 1

Methods

Participants. Participants were recruited through advertisements made available to students and members of the wider community of the University of Granada. Due to the potential introduction of noise in the data in an online study, we increased the target sample size from 48 (sufficient for yielding differential sensitivity in a previous study performed in our laboratory; see Hinojosa-Aguayo & González, 2020, Exp. 1) to 60 participants. No specific *a priori* power analysis was conducted. The analyses only included participants who completed the sociodemographic questions, the UPPS-P, and the two experimental tasks (VMAC and PIT), and declared to be fluent in Spanish, have normal or corrected vision, and normal color perception. Additionally, only participants whose VMAC data met the inclusion criteria were considered in

the reported analyses. Of the 75 participants who chose to take part in the study, 14 did not complete the two tasks. From the remaining 61 participants, we filtered out those with accuracy lower than 70% in the VMAC task. The final sample consisted of 58 participants (15 males), 88% of whom were university students. Their average age was 22.0 years ($SD = 2.8$, range 18-29). At the end of the study, participants received compensation between 3 and 8 euros based on their performance on the VMAC task.

Materials

Spanish adaptation of the short version of the UPPS-P questionnaire (Cándido et al., 2012). This questionnaire contains 20 items, four for each factor considered in the five-factor model of impulsiveness (Whiteside & Lynam, 2001): negative and positive urgency, (lack of) premeditation, (lack of) perseverance, and sensation-seeking. We focused on negative and positive urgency factors which are of special interest as they are considered to be affect-driven impulsiveness factors, particularly negative urgency, which has been identified as a common transdiagnostic factor for addictive and other externalizing disorders characterized by emotion dysregulation (Quintero et al., 2020; see also Muela et al., 2023). Reliability estimations in our sample for negative and positive urgency subscales (Cronbach's alpha) in the present experiment were .91 and .84, respectively.

Value-modulated attentional capture (VMAC) task

The task was programmed in OpenSesame software (Mathôt et al., 2012) and hosted in JATOS (Lange et al., 2015). As the task was completed online, each participant estimated their distance from the screen using the virtual chinrest procedure devised by Li et al. (2020). In this procedure, the dimensions of the stimuli are adjusted based on the eccentricity of items in the search display. The experimental task was adapted from that used by Watson et al. (2019), with the exception that the reward-omission phase comprised 12 instead of 2 blocks, matching the

acquisition phase (see also Garre-Frutos et al., 2024). The first 24 trials served as practice trials similar to those used in the acquisition phase, except that the colors used for Low and High trials were different to those used in the main experimental task. Participants were instructed to respond as accurately and quickly as possible, as available points depended on their performance level. Additionally, they were informed that a bonus trial would occur when one of the circles appeared in a particular color (associated with the High condition). See below for further details. Instructions provided to participants for this task are available in the Appendix.

Following the practice trials, the acquisition phase began. A central fixation cross appeared on the screen before the search display was shown. Six shapes (2.3º x 2.3º visual angle) were evenly arranged to form an imaginary circle (10.1º). Five of these shapes were circles containing lines tilted 45º randomly to the right or left. The target was a grey diamond containing a line oriented randomly horizontally or vertically. On singleton Absent trials, all shapes were grey. On Low singleton trials, one of the circles was randomly colored (either blue or orange for some participants or green or pink for others, with random assignment), while the alternative color signaled the High singleton trials. The locations of the target and the distractors were random on each trial. Participants were tasked with determining the orientation of the line within the diamond (horizontal or vertical) as quickly and accurately as possible by pressing the 'V' or the 'H' keys, respectively. Therefore, the color of the distractors played no instrumental role in the task. Each block comprised 24 trials: 4 without singleton distractors (condition Absent), 10 corresponding to the Low condition, and 10 to the High condition. Participants earned 0.1 points for every millisecond that their response time (RT) was below 1,000 ms on the Absent and Low trials. On the High trials, the points were multiplied by 10. Responses with an RT longer than 1,000 ms were not rewarded, and errors led to a loss of points equivalent to what would otherwise have been earned. The search display remained until the participant responded, or for 2,000 ms, followed by feedback for 700 ms, indicating the number of points earned or lost for

correct or incorrect responses, respectively. The intertrial interval was 1,200 ms. After the

acquisition phase, the unrewarded phase began. Unlike Watson et al. (2019), the length of this

phase was equal to the acquisition phase, with 12 blocks of 24 trials each. Otherwise, the task

remained the same — to determine the orientation of the line within the diamond. However, no

points were awarded based on performance, and participants were informed of this aspect of the

procedure. Only feedback on accuracy was provided.

PIT Task

Initial level of hunger and outcome pleasantness rating. Before starting the PIT task,

hunger and pleasantness were assessed using a 7-point Likert-type response scale ranging from 0

(not at all) or 7 (extremely).

Pavlovian to instrumental transfer (PIT) task. For the present study (see Table 1), we

slightly modified the computerized task used in Experiment 1 of Hinojosa-Aguayo and González

(2020), which was an adaptation of those employed by Morris et al. (2015) and Quail et al.

(2017). The task was programmed using the online experimental platform "Labvanced"

(https://www.labvanced.com). Instructions provided to participants for this task are available in

the Appendix.

Table 1

Experiment 1. Experimental design of the PIT effect and instrumental outcome devaluation test
(following Hinojosa-Aguayo & González, 2020 after Morris et al., 2015).

Instrumental training	Pavlovian training	Transfer test	Outcome devaluation	Devaluation test
R1 - O1	S1 - O1	S1: R1 (Same) vs. R2 (Diff)		

R2 - O2	S2 - O2	S2: R1 (Diff) vs. R2 (Same)	Devaluation (O1 or O2)	R1 vs. R2
	S3 - O3	S3: R1, R2 (CS+)		
	S4 – no outcome	S4: R1, R2 (CS-)		

Note: PIT = Pavlovian-to-instrumental transfer; R = response; O = outcome; S = stimulus; CS+ = excitor CS; CS- = inhibitor CS.

Instrumental training. Participants were instructed to collect as many free food snacks as they could from a virtual vending machine. To do so, they were required to tilt the machine to the right and to the left using the "up" and "down" arrow keys of the keyboard (R1 or R2, randomized across participants) using the index finger of their dominant hand. The outcomes (Os) were images of three snacks (M&M's chocolates, crisps, and a popular chocolate cookie in Spain) that were randomly assigned to O1, O2, and O3. During the instrumental phase, participants performed R1 and R2 to obtain O1 and O2. They completed six blocks of trials on which they freely performed the two responses, with reinforcement following a random ratio schedule (the number of consecutive responses required to obtain the outcome varied randomly between 5 and 10). The image of the outcome appeared on the screen for 1 s. Once three outcomes were obtained, participants were asked to identify which key they should press to obtain a particular outcome whose image was displayed on the screen. They were given feedback, "Correct" or "Incorrect," which remained for 1 s. This procedure, inquiring about the R-O assignment, was repeated 6 times. The instrumental phase concluded when the participants correctly answered the 6 questions consecutively for a given block.

Pavlovian training. During this phase, participants observed passively as the vending machine was intermittently lit with one of four colors: blue, green, red, and yellow. They were

informed that each color signaled whether the machine was currently empty or filled with one of three snacks that could fall freely without the need for tilting the machine. Two colors (S1 and S2) signaled that the instrumental outcomes (O1 and O2, respectively) could freely fall from the machine; a third color (S3) signaled the free availability of a third outcome (O3) that was not present during the instrumental phase but shared motivational value with the stimuli used during this phase; and finally, a fourth color (S4) signaled that the machine was empty. The assignment of the four colors to S1, S2, S3, and S4 was randomized for each participant. There were 4 blocks of 4 trials each. On each trial, an uncolored image of the vending machine was displayed on the screen. Subsequently, the machine was lit with one of the four colors for 3 s, and the image of an outcome appeared during the last two seconds of this period before returning to the uncolored image. The intertrial interval varied between 1 and 3 s. The order of the four colors in each block was randomized. After each block of trials, the image of the vending machine illuminated with one of the four colors appeared, and participants were given a multiple-choice question. They were asked to identify which of the four possible outcomes corresponded to that color, in random order, after which feedback was given for 1 s. After completing the four acquisition blocks, they were presented with a further set of similar questions asking about the four S-O associations without feedback. A score of explicit S-O knowledge was calculated based on the percentage of correct responses.

Pavlovian to instrumental transfer (PIT). Participants had to tilt the vending machine to obtain the snacks, freely performing R1 and R2, but were advised that the outcomes would not appear on the screen this time (nominal extinction). Participants completed six blocks of four trials, with an ITI varying between 8 and 16 s. The vending machine appeared in the original, uncolored version during this interval, with the final 6 s constituting the preCS period. During each trial, the vending machine was lit with one of the four colors (in random order) for 6 s (the CS period) before returning to the uncolored version. To assess outcome-specific PIT, R1 was

labeled as the *Same* response when performed during the S1 CS-period, and as *Different* when performed during the S2 CS-period. Conversely, R2 was labeled using the opposite assignment. To evaluate general PIT, R1 and R2 were collectively treated as "responses" and their total numbers were summed when performed during the S3 and S4 CSs-periods, and when computing the average number of responses during the preCS period.

Outcome devaluation. One of the two instrumental outcomes (O1 or O2) was randomly chosen and devalued by presenting a gif image in which two cockroaches run over the snack for approximately 10 s. Subsequently, participants completed the outcome devaluation test (lasting 120 s) in which they freely performed R1 and R2 in extinction. The participants then re-evaluated the pleasantness levels of the three outcomes, as well as their level of hunger.

Procedure

The protocols of the experiments reported here were approved by the Ethics Committee on Human Research of the University of Granada (approval number 3022/CEIH/2022). Both studies were advertised to students and members of the wider community of the University. Those who agreed to participate first completed a survey programmed in Limesurvey (https://www.limesurvey.org), which included the informed consent form, sociodemographic questions, the questionnaires[3], and the link to the VMAC task. Once participants completed this part of the study, they were sent another link to the PIT task 24 hours later and were given 48 hours to complete this task. This time delay was implemented to prevent participants from performing the two tasks consecutively and to mitigate potential carry-over effects such as tiredness or disengagement from the second task, which might negatively affect performance.

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[3] As part of a wider study, participants were presented with two other questionnaires. However, only the urgency subscales of the short Spanish version of the UPPS-P were relevant to the present studies and the data for the rest are omitted. The questionnaires were the Spanish adaptation of the Emotion Regulation Questionnaire (ERQ); and the Spanish Version of the Shortened Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ-20).

After finishing the PIT task, participants were finally contacted to action the payment of the incentive according to their performance on the VMAC task.

Results and Discussion

Statistical Analyses

Repeated-measures (RM) analyses of variance (ANOVAs) were conducted to determine main effects and interactions. Greenhouse-Geisser correction was applied when the sphericity assumption was violated, and effect sizes were estimated using η^2_p. Student's *t*-test for paired measures (one-tailed when having a priori directional hypotheses) was used in the case of pairwise mean differences, using Cohen's *d* as a measure of the effect size. Holm's correction was applied when using multiple post hoc comparisons. Pearson's correlation coefficients, with 95% confidence intervals (CI), were computed to assess the degree of relationship between measures and were directional (one-tailed) when derived from *a priori* hypotheses. To find evidence in favor of the null hypothesis when observing non-significant differences in the main hypotheses of each study, Bayes Factor (BF) was estimated using Jeffreys-Zellner-Siow (JZS) prior (Rouder et al., 2009) following the conventional interpretation of JZS values proposed by Wagenmakers et al. (2011). In addition, the recommendations by Schönbrodt et al. (2017) concerning the incorporation of prior knowledge when selecting the value of the Cauchy prior were used. Considering the observed effect sizes in our previous research (Hinojosa-Aguayo & González, 2020), which may be considered large, we decided to set the Cauchy prior to $r = \sqrt{2}$. In the case of Bayesian correlations, the value of the stretched beta prior width was set to 0.5 following the suggestions by Quintana & Williams (2018). All statistical analyses were carried out using the open-source software JASP 0.18.1 (JASP Team, 2023).
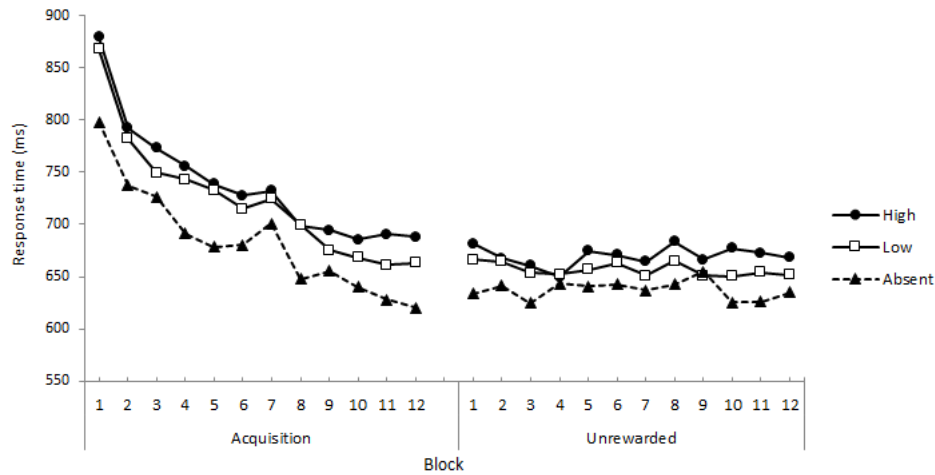
VMAC task

Following the exclusion criteria outlined by Garre-Frutos et al. (2024), the data from the first two trials of each block were removed, as well as trials where no response was recorded. Additionally, we filtered the data by only including responses with RTs less than 1800 and greater than 150 (discarding less than 1% of responses in both phases). For RT analyses, we excluded incorrect responses (rewarded phase: 5.75%, unrewarded phase: 5.14%).

VMAC Acquisition. RTs for correct responses were submitted to an RM-ANOVA, with stimulus (Absent, Low, High) and block (1 to 12), as within-subject factors, yielding significant main effects of Stimulus, $F(1.86, 106.14) = 50.83$, $p < .001$, $\eta_p^2 = .471$, and Block, $F(3.42, 195.04) = 37.85$, $p < .001$, $\eta_p^2 = .399$. The interaction between these variables was not significant, $F < 1$. Post hoc comparisons using Holm's correction revealed that the three experimental conditions differed from each other (marginal means: Absent = 683.77, Low = 723.98, High = 737.98; SE = 14.50), largest $p = .011$. Regarding blocks, a steady decrease in RT from the 1st block to the 7th (included) was observed. No further significant decreases were found from blocks 8 to 12. Therefore, the VMAC effect was evident, reaching an asymptotic value around the 8th block (Figure 1).

Unrewarded VMAC phase. Similarly, RTs for correct responses were submitted to an RM-ANOVA with Stimulus and Block as within-subject factors, which yielded a significant main effect of Stimulus, $F(1.97, 112.63) = 23.65$, $p < .001$, $\eta_p^2 = .293$ (marginal means: Absent = 637.36, Low = 656.61, High = 669.78; SE = 13.80). Post hoc comparisons using Holm's corrections confirmed that the three conditions differed from each other, largest $p = .006$. No other main effect or interaction was significant, $F_s < 1$. This pattern of results suggests that the VMAC effect was still evident during the unrewarded phase (Figure 1).

Figure 1. Experiment 1 VMAC task: Average correct response times by stimulus and block during the Acquisition and the Unrewarded phases

Comparison between the Acquisition and Unrewarded phases of the VMAC task. As

significant differences were not observed between the last four blocks of acquisition and the first

four unrewarded blocks, we considered it worth comparing the RTs for each phase averaged over

those four blocks (Figure 2). The RM-ANOVA with stimulus (Absent, Low, High) and phase

(acquisition, unrewarded), yielded a significant main effect of Stimulus, $F(1.98, 113.09) = 31.44$,

$p < .001$, $\eta_p^2 = .355$, Phase, $F(1, 57) = 4.03$, $p = .049$, $\eta_p^2 = .066$, and, critically, a Stimulus x

Phase interaction, $F(1.88, 107.24) = 4.17$, $p = .020$, $\eta_p^2 = .068$. Regarding the main effect of

stimulus, the three stimuli differed from each other after applying Holm-Bonferroni correction,

largest $p = .009$, with response times being slower on High trials than the Low trials, and

responses on the latter being slower than on Absent trials.

However, differences in RT were not related to accuracy in any of the phases. An RM-

ANOVA conducted on the accuracy data with stimulus and block (four) as the within-subject

factors revealed no significant main effects or interactions in the acquisition phase, largest

$F(2.82, 160.61) = 2.47$, $p = .07$ for blocks, or in the unrewarded phase, largest $F < 1$. (Accuracy

means for each stimulus during the last four blocks of acquisition: Absent = 0.95, Low = 0.95,

High = 0.94; $SE = 0.007$; during the first four blocks of the unrewarded phase: Absent = 0.93,

Low = 0.94, High = 0.95; $SE = 0.008$).

Figure 2. Experiment 1. Average RT by Stimulus during the last four blocks of acquisition and the first four blocks of the unrewarded phase. Error bars represent SEM with the corrections applied using JASP based on Morey (2008).
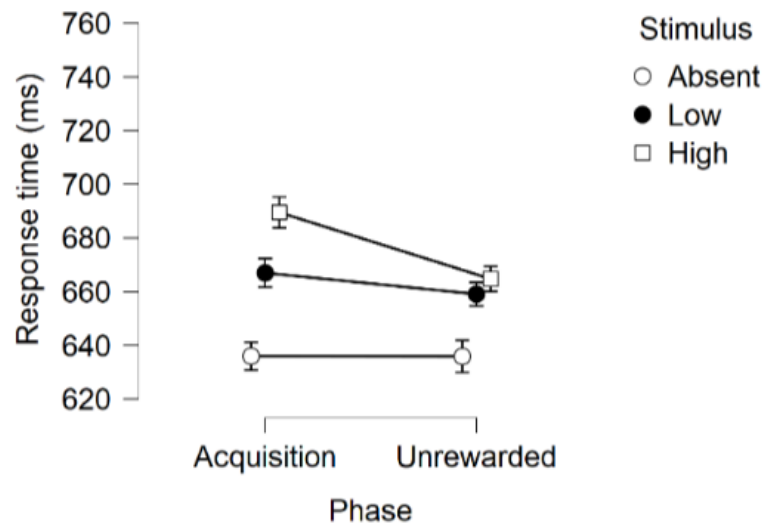
To explore the critical stimulus by phase interaction in RTs, a post hoc analysis was conducted using the Holm-Bonferroni correction for multiple comparisons. We focused on the putative decrease in response time from the acquisition to the unrewarded phase for each stimulus, predicted if the attentional effect (increase in RT) produced by the High stimulus was indeed due to Pavlovian conditioning The decrease was significant for the High stimulus (mean difference of 24.76 ms, $SE = 7.42$) $p = .007$, but not for the Low stimulus, $p = 1.000$ or Absent, $p = 1.000$, for which the mean differences were 7.90 and 0.08 ms, respectively.

To compute an extinction index for the High stimulus (EXT High) to be used in relation to PIT and impulsivity measures in subsequent analyses, the difference in RT between the average of the last four blocks of acquisition (High_acq) and the first four blocks of the unrewarded phase (High_ext) was calculated for each participant. The higher the EXT High index, the more effective the unrewarded manipulation in decreasing RTs for stimulus High. As previously mentioned, we reasoned that those individuals with a lower EXT High index should show

smaller outcome devaluation and specific PIT effects, as well as higher negative urgency (NU) scores. These analyses are presented at the end of this section after the analyses of the PIT task results.

PIT task

Initial level of hunger and pleasantness. The average initial level of hunger was $M = 3.17$, $SD = 1.69$. An RM-ANOVA on the pleasantness scores for the three outcomes did not yield a significant effect, $F(1.87, 106.47) = 1.93$, $p = .153$ (O1: $M = 3.8$, $SD = 2.0$; O2: $M = 3.6$, $SD = 2.1$; $M = 3.2$, $SD = 2.1$).

Instrumental training. As expected, there were no significant differences in the number of R1 and R2 responses performed (R1: $M = 118.02$, $SD = 68.78$; R2: $M = 114.36$, $SD = 58.12$; $t(57) < 1$, $p = .497$; $BF_{10} = 0.179$), or the number of O1 and O2 outcomes gained (O1: $M = 9.38$, $SD = 2.19$; O2: $M = 9.34$, $SD = 2.33$; $t(57) < 1$, $p = .947$; $BF_{10} = 0.144$). All participants answered the explicit R-O knowledge questions correctly before finishing this phase and proceeding to the next.

Pavlovian training. At the end of this phase, 51 (87.93%) participants answered all the final S-O questions correctly, five (8.62%) showed an accuracy of 75%, and two (3.45%) had an accuracy of 50%.

Outcome specific PIT. The average number of R1 and R2 responses made during the preCS periods was considered as the baseline rate. Total numbers of *Same* and *Diff* responses were averaged over trials and differential CS-preCS scores for each condition were compared using a one-tailed paired *t*-test that revealed significant differences between conditions, $t(57) = 5.72$, $p < .001$, $d = 0.75$ (*Same*: $M = 5.00$, $SD = 9.26$; *Diff*: $M = -5.71$, $SD = 6.72$). A one-sample *t*-test with a test value of 0 showed that both scores differed significantly from baseline (*Same*, $t(57) = 4.18$, $p < .001$, $d = 0.54$; *Diff*: $t(57) = - 6.47$, $p < .001$, $d = - 0.85$). This pattern of results

confirms that a specific PIT effect was observed, replicating previous results with a similar task (Hinojosa-Aguayo & González, 2020, Exp. 1).

General transfer PIT. Differential CS-preCS scores for each condition (CS+ or S3, and CS- or S4) were computed by subtracting the average preCS number of responses from the average number of responses in the presence of each CS (collectively considering responses R1 and R2 in both cases). The difference between the differential scores for the CS+ and the CS- was significant, one-tailed, $t(57) = 6.89$, $p < .001$, $d = 0.90$ (CS+: $M = -0.54$, $SD = 3.82$; CS -: $M = -6.38$, $SD = 5.94$). However, only the CS- produced a change in responding compared to baseline, specifically a decrease, $t(57) = -8.19$, $p < .001$, $d = -1.07$. In the case of the CS + there was no significant change, $t(57) = -1.08$, $p = .284$; $BF_{10} = 0.250$. This finding might be taken to indicate that S4 served as a conditioned inhibitor, decreasing the response rate when the color signaled that the vending machine was empty during the Pavlovian phase. This result again replicates previous findings when using a very similar task (Hinojosa-Aguayo & González, 2020), suggesting that S4 prompts an inhibitory PIT effect, either general or specific, without a corresponding excitatory general PIT effect for S3. While the absence of an outcome may be a very salient event in this context, participants may have understood that S3 was not linked to R1 and R2 in a significant way (they never experienced an instrumental relationship between R1 and R2 and O3) and thus they did not modify their level of responding in its presence. Therefore, we did not find evidence of a general PIT effect for S3.

Outcome devaluation effect on instrumental performance. The total number of non-devalued (the response whose outcome was not devalued, *Non-Dev*) and devalued (the response whose outcome was devalued, *Dev*) responses were compared using one-tailed paired samples *t*-test that revealed a significant difference between the two measures, $t(57) = 2.99$, $p = .002$, $d = 0.39$, that is, and outcome devaluation effect (*Non-Dev*: $M = 354.41$, $SD = 122.92$; *Dev*: $M = 261.08$, $SD = 137.73$). The change in outcome pleasantness scores was also analyzed by

computing the difference between the scores given at the start of the experiment and those given after the devaluation procedure. In the case of the devalued outcome, there was a significant decrease (one-tailed), $t(57) = 5.93$, $p < .001$, $d = 0.78$, (*Pre*: $M = 3.5$, $SD = 2.1$; *Post*: $M = 2.1$, $SD = 1.8$), but no change was detected in the case of the non-devalued outcome, $t(57) = - 0.105$, $p = .542$; $BF_{+0} = 0.133$ (*Pre*: $M = 3.9$, $SD = 2.0$; *Post*: $M = 3.9$, $SD = 2.1$). Therefore, the devaluation procedure was effective in lowering the pleasantness score of the devalued outcome.

Relationship between specific PIT and instrumental outcome devaluation measures. To estimate the degree of relationship between these measures, we computed three differential indices (Table 2 summarizes the correlational analyses performed in this and the following experiment). In the case of the instrumental outcome devaluation effect, we subtracted the total number of 'devalued responses' from the total number of 'non-devalued' responses (DEV); for the outcome-specific PIT, the average number of 'Different' responses was subtracted from the average number of 'Same' responses (specific PIT). As hypothesized, a significant across-task positive correlation between the specific PIT and DEV indices was found (one-tailed), $r = .320$, $p = .007$, 95% CI: [.109, 1.000]. This result replicates findings reported previously (Hinojosa-Aguayo & González, 2020, Exp. 1), suggesting that the observed specific PIT effect in this experiment is related to the instrumental outcome devaluation effect which has been proposed as a mark of goal-directed control.

Table 2

Table 2. Summary of correlations found in Experiments 1 and 2 among measures of instrumental outcome devaluation (Dev), specific PIT, extinction of PIT (EXT PIT), VMAC (EXT High, High_acq, High_ext) and negative urgency (NU).

Experiment 1

DEV – specific PIT $\qquad$ $r = .320, p = .007, 95\% \text{ CI: } [.109, 1.000]$

DEV – NU $\qquad$ $r = -.333, p = .005, 95\% \text{ CI: } [-.123, -1.000]$

specific PIT – NU $\qquad$ *n.s.*

EXT High – NU $\qquad$ $r = -.233, p = .039, 95\% \text{ CI: } [-.016, -1.000]$

EXT High – DEV $\qquad$ *n.s.*

EXT High – specific PIT $\qquad$ *n.s.*

Experiment 2

EXT PIT–R-O knowledge $\qquad$ *n.s.*

EXT PIT– S-O knowledge $\qquad$ $r = .382, p = .004, 95\% \text{ CI: } [.132, .586]$

EXT PIT–Ext knowledge $\qquad$ $r_s = .300, p = .025, 95\% \text{ CI: } [-.016, -1.000]$

EXT PIT–Transfer knowledge $\qquad$ $r = .422, p = .001, 95\% \text{ CI: } [.179, .617]$

EXT PIT–NU $\qquad$ $r = -.282, p = .017, 95\% \text{ CI: } [-.064, -1.000]$

EXT PIT-High_acq $\qquad$ *n.s.*

EXT PIT- High_ext $\qquad$ *n.s.*

NU–High_acq $\qquad$ $r = .384, p = .003, 95\% \text{ CI: } [.135, .588]$

NU–High_ext $\qquad$ $r = .453, p < .001, 95\% \text{ CI: } [.215, .639]$

Note: DEV = instrumental outcome devaluation index (difference between the average total number of responses for the Non-Dev response and the Dev response); NU = negative urgency score; EXT High = extinction index for stimulus High (High_acq – High_ext); High_acq: average RT for correct responses across the last four blocks of the acquisition phase for stimulus High; High_ext = average RT for correct responses across the first four blocks of the extinction phase for stimulus High.

Relationship between negative urgency, instrumental outcome devaluation and specific

PIT. Also confirming our expectations, the DEV index was negatively correlated (one-tailed)

with the Negative Urgency (NU) score, $r = -.333, p = .005, 95\% \text{ CI: } [- 0.123, - 1.000]$. Contrary

to previous findings, the correlation with positive urgency was found to be negative and

significant (two-tailed), $r = -.271$, $p = .039$, 95% CI: [- 0.014, - 0.495], while no negative significant relationship between specific PIT index and NU score was found, $r = -.032$, $p = .404$, $BF_{+0} = 0.137$ (one-tailed).

Given that the outcome devaluation effect has traditionally served as an indicator of model-based or goal-directed processes, the specific PIT effect observed in our studies might be rooted in this type of process. When considering individual differences, it appears that the NU score plays a role in influencing this connection. Specifically, individuals with higher NU scores, indicative of emotion dysregulation, may exhibit reduced tendencies to engage in goal-directed flexible behavior. This could manifest as difficulties in effectively integrating the current incentive value of instrumental outcomes with previously acquired instrumental knowledge (i.e., R-O), that is, in implicit emotion regulation. Experiment 2 may provide further insights into this issue by examining the impact (or absence thereof) of another implicit emotion regulation process on PIT: Pavlovian extinction.

Relationships between specific PIT, DEV, NU, and VMAC measures

An innovative aspect of the present work was the introduction of an attentional sign-tracking measure (Albertella et al., 2020): the VMAC effect. We predicted that persistence in the VMAC effect, expressed as a lower extinction index for stimulus High (EXT High), would be related to failures in outcome devaluation and measures of impulsivity, particularly negative urgency. To test these possibilities, one-tailed Pearson correlations were estimated for the relevant variables. As hypothesized, the EXT High index was negatively correlated with NU, $r = -.233$, $p = .039$, CI: [- 0.016, -1.000]; while the correlation with the same index calculated for stimulus Low did not reach significance (two-tailed), $r = -.044$, $p = .741$, $BF_{10} = .173$. However, contrary to our expectations, no significant positive correlation between EXT High and either the DEV or specific PIT indices were found, highest (one-tailed), $r = .039$, $p = .770$, for DEV, $BF_{+0} = .209$.

This pattern of results suggests that changes in the VMAC effect due to the omission of the reward (attentional flexibility) may be impaired in participants with higher self-reported NU scores. Additionally, these findings also point to the possibility that specific PIT and VMAC effects are not necessarily associated processes — at least using our tasks. Rather, these effects may reflect different aspects of incentive salience. For instance, persistence of VMAC might be linked to earlier processing of stimulus prioritization and failure in attentional disengagement, whereas PIT could be the result of a subsequent process of response selection. Both processes appear to be related to impulsivity/compulsivity in certain individuals (Albertella et al., 2019a). Moreover, while the VMAC effect (and its persistence) may still serve as a measure of attentional sign-tracking or incentive salience in our task, specific PIT appears to represent a model-based mode of action selection, reflecting a goal-directed control process as evidenced by the observed link with the effect of outcome devaluation. Participants with better emotion regulation, and consequently lower affect-driven impulsivity, would be expected to show a more flexible process of action selection. This idea will be taken up in more detail in the General Discussion.

Experiment 2

The key differences between the designs of Experiment 2 and Experiment 1 are outlined in Table 3. In the present study, our focus was on examining the effect of extinguishing a Pavlovian cue prior to the transfer test on specific PIT by comparing this with a non-extinguished cue. Given that a failure in Pavlovian extinction is considered another form of implicit emotion dysregulation—and for this reason both experiments are thought to be complementary—our predictions were similar to those considered for the effects of instrumental outcome devaluation in Experiment 1. Therefore, we anticipated observing an effect of extinction (EXT) on specific PIT, replicating the findings reported by Seabrooke et al. (2018, Exp. 2) using our task. We expected to observe positive correlations between the effect of extinction on specific PIT and (if

found again) the extinction of VMAC. Additionally, we expected to find negative correlations between NU score and indices of the extinction of both specific PIT and VMAC effects.

Methods

Participants. Of the 76 participants who agreed to take part in the study, 19 did not complete the two tasks and were thus excluded from the analyses. Of the remaining 57 participants, we filtered out those with a response accuracy below 70% in the VMAC task. The final sample consisted of 56 participants (14 males) with an average age of 22.5 years ($SD = 4.1$, range 18-42), 83.93% of whom had completed university studies. The advertisement procedure and incentives for participation were the same as in the previous study.

Materials. The initial level of hunger and pleasantness assessment (in this case for only two outcomes), the questionnaire battery, and the VMAC task were the same as those employed in Experiment 1. Cronbach's alpha value for the NU subscale of the UPPS-P was .85 (.68 for positive urgency). The PIT task was modified as follows.

PIT task

In this study, we followed and adapted the design used by Seabrooke et al. (2018, Exp. 2), which appears in Table 3. Instructions provided to participants for this task can be found in the Appendix.

Instrumental training. The procedure was the same as that used in Experiment 1.

Pavlovian acquisition. Other features not mentioned in this section were identical to those in Experiment 1. In this case, six instead of four colors acted as Pavlovian cues (brown and grey were added to the previous colors) and were randomly assigned to cues A-F. Participants initially received 6 blocks of 6 trials, one for each S-O assignment, presented in a random sequence. Each block concluded with a question about one outcome-cue relationship along with feedback.

Following the completion of the 6 blocks, participants were prompted to recall the six S-O

associations, presented successively in random order without feedback. This block of questions

was repeated once for all participants, and up to four times for those who failed after this point.

Table 3

Experiment 2. Experimental design for the outcome-specific PIT extinction task (adapted
from Seabrooke et al., 2018)

Instrumental Training	Pavlovian acquisition	Pavlovian extinction	Transfer test
	A – O1		
	B – O1	B – Ø	
			AD: R1 vs. R2
R1 – O1	C – O2	D – Ø	
			BC: R1 vs. R2
R2– O2	D – O2		
		E – O1	
	E – O1		
		F – O2	
	F – O2		

Note: PIT = Pavlovian-to-instrumental transfer. R = response: O = outcome; A and C =
non-extinguished cues; B and D = extinguished cues; E and F = fillers.

Pavlovian extinction. This took place immediately after the previous phase. The fillers

(stimuli E and F) continued to be associated with outcomes O1 and O2 while stimuli B and D

signaled that the vending machine was empty (no outcome). Stimuli A and C were not presented

during this phase. Participants received 6 blocks of 4 trials each, presented in random order, after

which they were asked about the six S-O associations, and feedback was provided for 1 s.

Transfer test. During this phase, conducted under nominal extinction conditions, the

images of two vending machines appeared at the top and bottom of the screen in their original

(uncolored) versions. Participants were informed that the position of the machines on the screen played no role in the task. However, they were instructed to pay attention to the colors of the two machines because, as they learned in the previous phase, the color provided information about the potential likelihood of a specific outcome falling when tilting the machine. When participants chose a response, both machines tilted in the same direction. This phase consisted of 24 trials with the compounds (12 for AD and 12 for BC) presented in a random order. The position of the cues (top or bottom) was counterbalanced for each compound. Other parameters, including the duration of the ITI, the baseline period (preCS in Exp. 1), and the compounds (single CSs in Exp. 1) were identical to those used in the previous study.

Explicit knowledge. Before finishing the experiment, participants were asked several questions in the following order.

S-O knowledge. "*Considering what you have learned previously in the last place, when the vending machine was lit in this color* [the image of the vending machine lit in a particular color was shown] *that meant that…",* and three alternatives were given: 'O1 (name of the snack that served as O1) was more likely to follow'; 'O2 (name of the snack that served as O2) was more likely to follow'; 'the machine was empty'. This was repeated for the six colors in random order.

Extinction. Upon the presentation of the image of the vending machine lit with a particular color, participants were asked to respond to the following question: *During the previous phase of the experiment, did the information about the availability of the outcomes provided by this color change?* [the response options were 'Yes' and 'No']. Again, this was repeated for the six colors, in random order.

R-O knowledge. Participants were asked the following question: "*Which key did you need to press to tilt the vending machine* [which appeared uncolored] *to obtain the following*

outcome? [the image of one of the snacks serving as O1 or O2 was shown]. *Please press the key to answer the question".* This question was asked for O1 and O2, in random order.

Transfer knowledge. The screen displayed the image of one of the two machine compounds, either AD or BC, and participants had to answer the following question: "*During the last phase of the experiment, no snacks were presented on the screen. However, when these two vending machines appeared, which snack did you expect to fall when you pressed the key …* [one of two keys, serving as either R1 or R2 was mentioned]?" The following three response options were available: 'O1' [name of the snack], 'O2' [name of the snack], 'None'. This was repeated for each compound and response combination (four questions), in random order.

Strategy used during the transfer test. Finally, the participants responded to an open question intended to ascertain whether (and if so how) they used the colors of the vending machines to choose between instrumental responses taking into account their current predictive value after the extinction phase. *There are no correct or incorrect answers to the next question, just try to be as honest as you can when responding.* "*Please, could you briefly describe the strategy, if any, that you have followed during the last phase of the experiment?* Participants typed their responses using the keyboard without space or time restrictions.

Procedure. The recruitment, materials, and procedures were identical to those used in Experiment 1 with the exceptions described above. Likewise, all phases were completed online by the participants.

Results and Discussion

VMAC task

As in the previous experiment, the data from the first two trials of each block were excluded, as well as trials for which no responses were recorded. We filtered the data by including responses with RTs less than 1800 and greater than 150 (discarding less than 1% of responses in both

phases). For RT analyses, incorrect responses were excluded (rewarded phase: 5.17%, unrewarded phase: 5.11%).

VMAC Acquisition. Response times for correct responses that met the inclusion criteria were submitted to an RM-ANOVA, with Stimulus (Absent, Low, High) and Block (1 to 12) as within-subject factors, yielding significant main effects of Stimulus, $F(1.97, 108.16) = 33.90$, $p < .001$, $\eta_p^2 = .381$, and Block, $F(4.41, 242.96) = 22.73$, $p < .001$, $\eta_p^2 = .292$). The interaction between these variables was not significant, $F(8.02, 441.49) = 1.25$. Regarding the main effect of Stimulus, post hoc comparisons using Holm's correction revealed that the three conditions differed from each other, (marginal means: Absent 657.28, Low 688.59, High 708.68; SE = 15.30), largest $p = .002$. Regarding blocks, as in Experiment 1, a steady decrease in RTs was observed from the 1st block until the 7th (inclusive), and no significant changes were found between Blocks 8 to 12 (Figure 3).

Unrewarded VMAC phase. A similar analysis to that described previously yielded a significant main effect of Stimulus, $F(1.77, 95.63) = 24.58$, $p < .001$, $\eta_p^2 = .313$ (marginal means: Absent = 617.07, Low = 638.21, High = 647.69; SE = 13.35). Post-hoc comparisons using Holm's corrections revealed that the three conditions differed from each other, largest $p = .036$. No other main effect or interaction was significant, largest $F(8.04, 434.33) = 1.32$ $p = .231$ (Figure 3).

Figure 3. Experiment 2 VMAC task: Average correct response times by stimulus and block during the Acquisition and the Unrewarded phases.
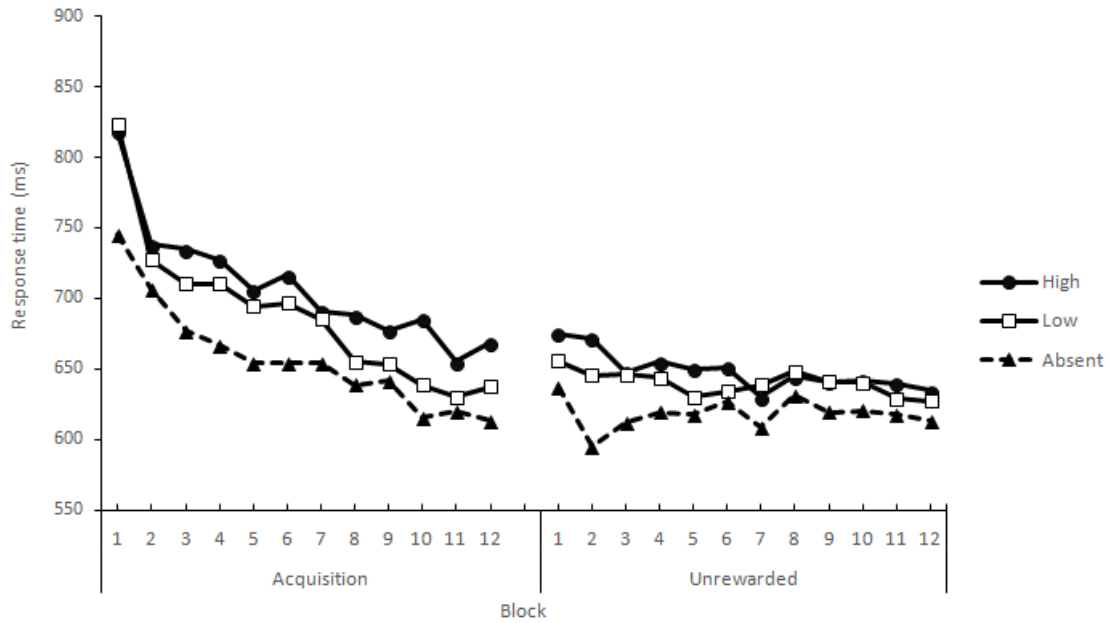
Comparison between Acquisition and Unrewarded phases. As in the previous experiment,

since no significant differences were detected between the last four blocks of acquisition or the

first four blocks of the unrewarded phase, RTs were averaged across blocks, and the means

submitted to an RM-ANOVA with Stimulus (Absent, Low, High) and Phase (Acquisition,

Extinction) as within-subject factors. This analysis revealed a significant main effect of

Stimulus, $F(1.97, 108.177) = 40.64$, $p < .001$, $\eta_p^2 = .425$ (marginal means, Absent = 619.35, Low

= 643.88, High = 666.83; SE = 13.82); while the main effect of Phase was not significant, $F < 1$.

The Stimulus x Phase interaction, $F(1.51, 82.84) = 1.68$, $p = .198$, did not reach significance,

indicating that omission of the reward did not modify the VMAC effect.

Finally, as in the previous experiments, the differences found in RTs did not correspond to

differences in accuracy. Two separate RM-ANOVAs conducted on the data from last four blocks

of acquisition and the first four blocks of the unrewarded phase revealed no main effects or

interactions; acquisition phase, largest $F(1.83, 100.48) = 2.20$, $p = .120$ (Absent 0.96, Low 0.95,

High 0.95, SE = 0.007), unrewarded phase, $F(1.58, 86.89) = 1.24$, $p = .289$ (Absent 0.93, Low,

0.95, High 0.95; SE = 0.008).

PIT task

Initial level of hunger and pleasantness. The average initial level of hunger was $M = 3.2$, $SD = 1.8$. A paired *t*-test conducted on the pleasantness scores for the two outcomes serving as O1 and O2 revealed no significant differences between them, $t(55) = 1.41$, $p = .164$, $BF_{10} = 0.372$ (O1: $M = 4.1$, $SD = 2.1$; O2: $M = 3.7$, $SD = 1.9$).

Instrumental training. There were no significant differences between the number of responses performed as R1 or R2 (R1: $M = 107.30$, $SD = 52.92$; R2: $M = 110.64$, $SD = 45.34$; $t(55) < 1$, $p = .624$; $BF_{10} = 0.164$) or the number of outcomes gained, O1 or O2 (O1: $M = 8.96$, $SD = 2.36$; O2: $M = 9.30$, $SD = 2.44$; $t(55) < 1$, $p = .593$; $BF_{10} = 0.167$). All participants answered the explicit R-O knowledge correctly before finishing this phase, as this was a requirement for proceeding to the next phase.

Pavlovian acquisition. The percentage accuracy on the S-O questions during this phase was 93.15% after the first block of questions and 94.64% after the second. Six participants needed a third block, and four of them needed a final 4th block.

Pavlovian extinction. Regarding the final explicit questions after the Pavlovian phase, the average percentage accuracy was 93.60%.

Transfer test. For each compound, AD and BC, the average number of R1 and R2 responses for each CS was recorded. For each compound, the response whose outcome-related cue had not undergone extinction was then labeled "Non-extinguished (NonExt)," whilst the alternative response was labeled "Extinguished (Ext)." The average number of responses for both categories was then calculated across the compounds (Figure 4). A paired *t*-test (one-tailed) showed that the number of NonExt responses was higher than that of Ext responses, $t(55) = 4.11$, $p < .001$, $d = 0.55$ (NonExt: $M = 16.28$, $SD = 6.99$; Ext: $M = 10.26$, $SD = 6.06$). Moreover, the average number of NonExt responses was significantly higher than the average number of

responses performed during the pre-compound periods (two-tailed) $t(55) = 2.83$, $p = .006$, $d = 0.38$, while the average number of Ext responses was significantly lower, $t(55) = - 4.29$, $p < .001$, $d = - 0.57$ (pre-compound number of responses: $M = 13.78$, $SD = 2.74$). These results confirm that specific PIT was affected by the extinction of Pavlovian cues. Along with the effect of instrumental outcome devaluation observed in Experiment 1, these results are compatible with the idea that the mechanism underlying the specific PIT effect exhibited by participants in our studies may be controlled by a propositional, goal-directed process (see e.g. Seabrooke et al. 2018).

Figure 4. Experiment 2. PIT test for the AD and BC compounds after Pavlovian extinction. Average number of responses performed during the three 6-s periods: pre-compound (preCSs), Non-Extinguished CS (NonExt: A & C), and Extinguished (Ext B & D). Error bars represent SEM with the corrections applied using JASP based on Morey (2008).
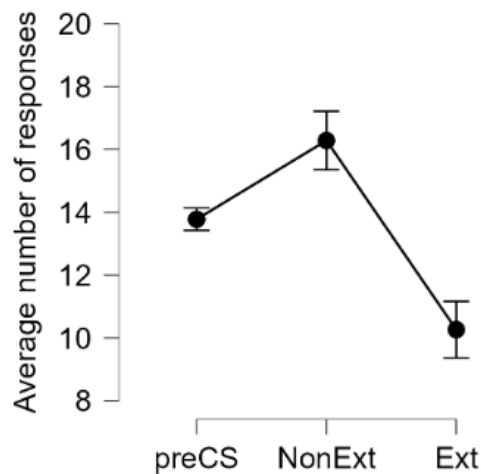
Explicit knowledge after the transfer test. There was some variability among participants with respect to the level of explicit knowledge of the different assessments reported at the end of the experiment. The average level of accuracy regarding knowledge of the final S-O associations (current Pavlovian knowledge including information acquired during the Pavlovian extinction

phase) was 85.42%; the average accuracy when detecting that the predictive value of a particular

color, or Pavlovian cue, had changed (or not) was 88.39 % (extinction knowledge); while

knowledge of the R-O assignation during the instrumental phase (instrumental knowledge) was

slightly lower at 79.46%. Finally, average accuracy related to the question about the response to

be performed during the transfer test taking into account the current predictive value of the

Pavlovian cue and the corresponding response with which it shared the outcome (transfer

knowledge) was the lowest at 53.12 %. This latter figure suggests that, on average, most

participants may have been choosing between R1 and R2 randomly, and that this test appeared to

be extremely difficult. However, according to the open question about the strategy used, 21 out

of 56 participants accurately reported having chosen the response for which the delivery of the

outcome was signaled by the non-extinguished cue, producing a general extinction effect when

comparing the overall means.

Relationship between explicit knowledge and transfer test performance. An index of

performance on the transfer test taking into account the effect of extinction of the Pavlovian cues

(EXT) was calculated by subtracting the average number of Ext responses from that of the

NonExt responses for each participant. The higher the index, the larger the effect of extinction on

specific PIT and therefore, the better the performance on the test. We reasoned that the level of

performance on the transfer test may depend on the accuracy of explicit knowledge exhibited by

participants, particularly regarding the predictive S-O and R-O relationships, and the integration

of this information at the time of decision making during the transfer test. Confirming these

expectations, the EXT index was significantly and positively correlated with the measures taken

at the end of the transfer test on S-O knowledge, $r = .382$, $p = .004$, 95% CI: [0.132, 0.586],

extinction knowledge (learning that during the experiment a particular Pavlovian cue had

changed its predictive value or not), Spearman's $rho = .300$, $p = .025$, 95% CI: [0.040, 0.522],

and the transfer knowledge (to determine which response was related to the outcome that was

still present, as signaled by the non-extinguished cue), $r = .422$, $p = .001$, 95% CI: [0.179,

0.617]. However, performance on the transfer test appeared to be unrelated to R-O instrumental

knowledge, $r = .234$, $p = .082$, 95% CI: [- 0.031, 0.468]. This might be unsurprising, given that

participants received extra training if they failed the R-O questions, thus reducing variability

among participants.

Relationship between the effect of extinction of the Pavlovian cues on PIT and measures of

impulsiveness. The EXT index was significantly and negatively correlated with negative urgency

(NU), one-tailed $r = - .282$, $p = .017$, 95% CI: [-1.000, - 0.064], as predicted (Figure 5). An

exploratory analysis found no significant relationship with positive urgency, two-tailed $r = -$

.219, $p = .105$, $BF_{10} = 0.602$.

Figure 5. Experiment 2. Pearson correlation scatter plot between EXT index (PIT task) and

NU score. Linear regression (continuous line) with its confidence interval (dotted lines).
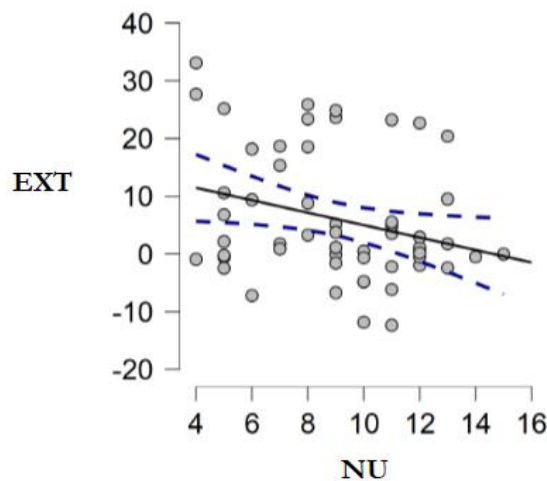
Relationship between VMAC effects and both specific PIT and negative urgency. Despite

the failure to observe extinction of the VMAC effect when removing the reward in the present

experiment, we reasoned that those participants with higher RTs for stimulus High during the

final part of the acquisition and/or the first blocks of the unrewarded phases could be considered

to exhibit more attentional sign-tracking. Therefore, we used High_acq and High_ext indices[4] and calculated correlations with the key elements of the specific PIT effect and NU score. Since this was not an *a priori* prediction, the analyses were two-tailed. Both indices (High_acq and High_ext) showed significant positive correlations with NU $r = .384$, $p = .003$, CI: [0.135, 0.588], and $r = .453$, $p < .001$, CI: [0.215, 0.639], respectively. No significant correlations were observed between VMAC indices and the index of the effect of Pavlovian extinction (EXT) on specific PIT, largest $r = - .112$, $p = .411$, $BF_{10} = 0.232$.

This pattern of results adds evidence to the proposal that emotion dysregulation as a trait is positively related to attentional sign-tracking and its persistence.

General Discussion

One of the primary goals of this research was to explore the relationship between emotion dysregulation—specifically negative urgency as a trait and failures in implicit emotion regulation processes (outcome devaluation and extinction)—and the extent to which individuals attribute incentive salience to reward cues. Incentive salience was assessed using tasks designed to evaluate (1) value-modulated attentional sign-tracking (VMAC) and (2) reward-cue influence on action control and selection (PIT). In both cases, indicators of difficulties in updating behavior were measured by the persistence of behavior following changes in outcome value (Experiment 1) and cue-outcome contingency (Experiment 2) in the PIT task, as well as extinction in both experiments in the VMAC task. To our knowledge, no previous study has examined the relationship between these various measures in relation to emotion dysregulation. Below, we discuss findings related to several specific objectives aimed at achieving this overarching goal.

Attentional sign-tracking

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[4] Please note that 'High_acq' and 'High_ext' response times refer to the average RT of the last four blocks of the acquisition phase and the first four blocks of the unrewarded phase, respectively. These were the components of the 'EXT High' index in Experiment 1.

The VMAC effect, a proxy for attentional sign-tracking, was consistently observed during the acquisition phase in both of our experiments, confirming that a cue for reward captured attention even when participants were explicitly instructed to ignore it and the cue itself had no instrumental role in the task. The analysis of the impact of reward omission during the second phase yielded a mixed pattern of results.

First, considering the entire unrewarded phase in both experiments, the VMAC effect was sustained throughout the blocks, suggesting that the effect persisted even when the cue was no longer predictive of an increase in reward (or even a reward at all). Our pattern of results adds to previous evidence indicating the persistence of the effect even when the prospect of reward is eliminated (Garre-Frutos et al., 2024; Watson et al., 2019), signaling that VMAC is an automatic process rather than the result of an explicit strategy directed toward an informative stimulus. This is consistent with the VMAC task being viewed as a tool for estimating individual differences in the propensity to exhibit the attentional sign-tracking pattern, which has been linked to a susceptibility to impulse control issues such as addictive-like behaviors, compulsive behaviors, impulsivity, and risky decision-making (Anderson, 2021; Colaizzi et al., 2020).

However, closer inspection of the data comparing equal-length intervals of both phases (average final four blocks of the rewarded and average first four blocks of the unrewarded phase) showed a decrease in RT in the case of stimulus High (but not for the others) in Experiment 1, indicative of a potential reduction of attentional sign-tracking between phases. Moreover, the extinction index was negatively correlated with negative urgency, suggesting that the persistence of VMAC after the omission of the reward might be more pronounced in participants with higher NU scores. Although this pattern was not found in Experiment 2, the two average four-block RT calculated for stimulus High at the end (High_acq) and start (High_ext) of each phase, while not statistically different this time, maintained significant positive correlations with NU. This again points to subtle individual differences in attentional sign-tracking and its persistence depending

on this emotion dysregulation trait. Participants with higher NU scores showed longer RTs in the presence of the High stimulus in significant intervals of the two phases. We acknowledge that our results provide only limited and rather arbitrary evidence (the study was not preregistered, and these measures were selected using a somewhat exploratory search).

Nonetheless, considering that, as in the studies of Watson et al. (2019) and Garre-Frutos et al. (2024), our participants were not specifically selected based on their NU scores or the presence of a given behavioral disorder, our findings point to the relevance of measuring individual differences in emotion dysregulation in so-called healthy participants, allowing preclinical approaches to the issue. More research is needed to pursue this potential connection between attentional sign-tracking and affect-driven impulsivity in the general population.

The adverse impact of emotion dysregulation on cue reactivity and action control and selection are expected to be stronger in clinical or subclinical samples. Failures in the extinction of a cue-reward association may lead to generalized incentive salience of cues when salience should be attenuated. For instance, participants with different levels of craving and gambling severity show impaired extinction, but not acquisition, of conditioned responses to erotic and gambling-related cues depending on their NU scores, which also predicted higher craving scores (Quintero et al., 2020; for related results involving positive urgency, see Muela et al., 2023).

It is important to note that investigation in the general population, as well as those including participants with subclinical or clinical disorders, may benefit from increasing the reliability of the VMAC measure, as measures with poor reliability are not sensitive in detecting individual differences. This improvement is needed to establish a link between individual differences in emotion dysregulation and behavioral disorders (for specific suggestions, see Garre-Frutos et al., 2024). Alternatively, the use of other measures showing superior reliability, such as those based on eye tracking, and the increase of sample sizes and the number of trials in behavioral tasks, are warranted to maximize statistical power, reliability, and reproducibility

(Kim et al. 2025). Increasing reliability (and thus validity) will favor the use of experimental tasks beyond those relying on self-reported measures of emotion dysregulation based on declarative knowledge. For instance, future studies could aim to provide further evidence of the validity of VMAC as a measure of attentional sign-tracking, for example by examining its association with other theoretically related measures. Note that although there are several studies showing that VMAC is related to self-report measures of impulsivity, depression symptoms and other psychopathological conditions (see Anderson, 2021), it is sometimes difficult to find associations between experimental tasks that purport to measure the same construct (Hedge et al., 2018; Nebe et al., 2024). Finding more evidence for validity will allow us to explore the role of incidental emotion regulation processes whose outcomes may lie outside of conscious recollection.

Reward-seeking behavior (PIT)

No significant relationships were observed between VMAC and PIT measures in either experiment. This pattern of results suggests that, at least with the tasks and measures employed in our study, specific PIT and attentional sign-tracking — considered measures of incentive salience — are not necessarily related, being differentially affected by emotion dysregulation, promoting attentional sign-tracking and impairing specific PIT.

The key results regarding specific PIT include its significant positive correlation with the instrumental outcome devaluation effect (Exp. 1) and the success in finding an effect of Pavlovian extinction (Exp. 2) on specific PIT. These results replicate those reported previously (Hinojosa-Aguayo & González, 2020, Exp. 1; Seabrooke et al., 2018, Exp. 2), and suggest that specific PIT may potentially be a goal-directed process, sensitive to changes in outcome-value and cue-outcome contingency. Both instrumental outcome devaluation and Pavlovian extinction have been proposed as instances of implicit emotion regulation processes (Etkin et al., 2015), which act in a rather automatic way before the emotion itself is fully appraised. The observation

that both effects were significant and negatively correlated with NU is consistent with this framework and further suggests that the extent to which specific PIT may rely on goal-directed control depends on individual differences in emotion dysregulation, particularly affect-driven impulsivity, even in a healthy sample. Thus, specific PIT might be more or less automatic depending on the success of incidental emotion regulation.

This possibility may fit well with dual-process models of associative learning in which, for instance, the PIT learning phenomenon may reflect the formation of an automatic associative S-O-R link mechanism, as well as higher order propositional reasoning processes. The automatic process will be dominant under circumstances when reasoning is less likely, such as when using complex designs in which the number of Pavlovian and instrumental contingencies is high or there are reversal instructions and multiple outcomes associated with each response (e.g., de Wit et al., 2013; Seabrooke et al., 2019). Likewise, emotion dysregulation would be expected to deplete cognitive resources and foster automatic rather than goal-directed control processes. A more extreme consideration is encouraged by pure propositional theories of human PIT. According to these theories, specific PIT involves controlled goal-directed actions based on the explicit knowledge of Pavlovian and instrumental contingencies (for a detailed account, see, for example, Mahlberg et al., 2021). Specific PIT is thought to be the consequence of a controlled decision-making process whereby participants infer which outcome is more available, as signaled by the cues, and thus which instrumental response is more likely to be reinforced on a given trial (Seabrooke et al., 2018). Evaluation of the theoretical accounts of the PIT effect falls beyond the scope of the present work. However, some of our results are consistent with the idea that the effect in humans reflects the operation of goal-directed control, which is related to explicit knowledge of contingencies involving the outcome, at least in participants with lower emotion dysregulation scores. Similarly, using essentially the same task, we previously found an

effect of outcome devaluation on specific PIT that depended on the negative urgency score (Hinojosa-Aguayo & González, 2020, Exp. 2).

Our findings indicating that a propensity for poorly regulated negative emotions may impair outcome devaluation, that is, goal-directed control, align with prior research demonstrating the impact of negative emotions on reward-seeking behavior. Notably, studies on acute stress induction in humans have revealed detrimental effects on goal-directed control of instrumental choice, leading to impaired instrumental outcome devaluation and a shift towards habitual behavior (e.g., Schwabe & Wolf, 2009). Similarly, negative emotional appraisal appears to selectively hinder the retrieval of an expected instrumental outcome value from working memory, a phenomenon observed even when accounting for factors such as task disengagement, ineffective devaluation treatment, or poor explicit knowledge of the response-outcome association (Pritchard et al., 2018).

Emotion regulation processes help us to focus on long-term interests over immediate emotional needs, and their failures therefore impact the control of action selection. Indeed, participants with high NU scores have been reported to prefer immediate solutions when experiencing negative emotions due to the cognitive cost of dealing with impulse control or the difficulty of using effortful and long-term emotion regulation. Instead, they employ non-adaptive emotion regulation strategies in the pursuit of short-term emotional relief or avoidance of negative emotional states. Reliance on these types of strategies can be damaging in the long term, resulting in both internalizing and externalizing disorders (King et al., 2018).

Limitations

As with other studies focusing on individual differences, we mainly rely on correlational methodology, and the results should be interpreted with this in mind. Our studies were not formally preregistered; however, their main goals were theoretically driven. Several of these

were attempts to replicate findings from our previous research (Hinojosa-Aguayo & González, 2020) and from other laboratories (Morris et al., 2015; Quail et al., 2017; Seabrooke et al., 2018; Watson et al. 2019). These replications included the detection of the behavioral effects of specific PIT, instrumental outcome devaluation, and the effects of Pavlovian extinction on the specific PIT and VMAC effects, thus contributing to the generalizability of those results. Although we did not conduct an *a priori* sample size estimation, we endeavored to increase sample sizes compared to those used in previous published studies whenever possible.

The studies were conducted online for convenience following the Covid-19 pandemic (for other related experimental studies conducted online, see also Garre-Frutos et al., 2024; Le Pelley et al., 2022; Watson et al., 2020). Overall, we observed results very similar to those of studies conducted in laboratory settings in the case of PIT and instrumental outcome devaluation effects. Concerning the VMAC task, we generally found results identical to those of previous studies during the acquisition phase but observed more varied results in the unrewarded phase. One notable advantage of using online recruitment was the increased heterogeneity of our samples, which included members of the university community beyond students of Psychology, thereby enhancing generalizability.

Participants consistently completed the VMAC task before the PIT task. Therefore, we did not control for any potential order effect. This choice was guided by the rationale that the VMAC task was longer and more attentionally demanding than the PIT task. However, it is unlikely that the first task had a considerable effect on the second, as they were conducted at least 24 hours apart.

We primarily followed extinction procedures used in previous research in which no points were available during the unrewarded phase. This method may be rather insensitive, and the persistence observed in VMAC could result from the task's inability to effectively engage the extinction process. Additionally, feedback on performance might have sustained behavior during

the unrewarded phase. Future investigations should consider these points. For instance, employing more sensitive extinction procedures (e.g., eliminating the extra points for stimulus High during the second phase) or using more salient manipulations like reversal learning (Albertella et al., 2019b), where persistence despite reversal has been linked to risky patterns of alcohol use.

Conclusions

Taken together, our results highlight the impact of individual differences in emotion dysregulation, specifically negative urgency (an affect-driven impulsivity factor), on processes involving the attribution of incentive salience to reward cues, as well as on action control and selection. Regarding incentive salience measured as attentional sign-tracking, individuals with higher levels of negative urgency also showed higher RTs for the stimulus signaling an increase in reward and demonstrated greater persistence of the VMAC effect during the unrewarded phase. This occurred even if participants were explicitly instructed to disregard the stimulus during acquisition and when the prospect of reward was eliminated during the second phase of training. This pattern of results suggests that attentional sign-tracking may be an automatic process rather than the product of an explicit strategy of controlled attention toward the stimulus as an informative cue. Negative urgency was also related to lower levels of instrumental outcome devaluation and Pavlovian extinction (both considered forms of implicit emotion regulation) in the PIT task. Moreover, no relationships were found between specific PIT (or its extinction) and attentional sign-tracking, suggesting that these phenomena are governed by different mechanisms. Unlike VMAC, the PIT effects observed in our experiments appear to be goal-directed and sensitive to changes in outcome value and cue-outcome contingency, at least in individuals with lower affect-driven impulsivity. In the case of Pavlovian extinction, the effect was linked to the extent of explicit knowledge involving the relevant contingencies, further emphasizing the controlled nature of this phenomenon in our task.

Declarations

Conflicts of interest/Competing interests: The authors report no competing interests to declare.

Ethics approval: This study was performed in line with the principles of the Declaration of Helsinki. The protocols of the experiments reported here were approved by the Ethics Committee on Human Research of the University of Granada (date: October 28th, 2022; approval number 3022/CEIH/2022).

Consent to participate: Participants who agreed to take part in the studies first completed an online survey which included the informed consent form.

Consent for publication: The informed consent included a provision detailing the use of the gathered data (pseudonymized) for statistical analyses, with potential dissemination of results through publication and/or presentation at scientific meetings.

Open Practices Statement

Materials and datasets analyzed during the current study are available from the corresponding author upon request. None of the experiments was preregistered.

Authors' contributions: Study conceptualization: FG, GH; Experiment programming IHA, FGF; Data acquisition and analysis: FG, IHA, FGF; Writing - Original draft: FG, GH; Writing - Review and Editing: FG, GH, FGF; Funding acquisition: FG.

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Figure captions:

Figure 1. Experiment 1 VMAC task: Average correct response times by stimulus and block during the Acquisition and the Unrewarded phases.

Figure 2. Experiment 1. Average RT by Stimulus during the last four blocks of acquisition and the first four blocks of the unrewarded phase. Error bars represent SEM with the corrections applied using JASP based on Morey (2008).

Figure 3. Experiment 2 VMAC task: Average correct response times by stimulus and block during the Acquisition and the Unrewarded phases.

Figure 4. Experiment 2. PIT test for the AD and BC compounds after Pavlovian extinction. Average number of responses performed during the three 6-s periods: pre-compound (preCSs), Non-Extinguished CS (NonExt: A & C), and Extinguished (Ext B & D). Error bars represent SEM with the corrections applied using JASP based on Morey (2008).

Figure 5. Experiment 2. Pearson correlation scatter plot between EXT index (PIT task) and NU score. Linear regression (continuous line) with its confidence interval (dotted lines).

Appendix

VMAC task instructions translated to English

Welcome to the experiment.
Before starting, it is necessary that you concentrate and avoid any kind of distraction since it is important to control the noise that may be produced by the context in which each person performs the task. Also, remember that depending on your performance you will be able to earn real money. Any kind of distraction will affect you negatively. Therefore, we ask you to perform the experiment in a place with a good internet connection, as isolated as possible, and dim lighting. In addition, please turn off, block, or keep your cell phone out of reach during the experiment.
Press S if you have followed the instructions.
  [Instructions to calibrate participant's distance from the screen using the virtual chinrest procedure devised by Li et al. (2020)]

VMAC. Acquisition

You are about to perform a visual search task. In this task we will introduce you to a configuration like this one throughout the experiment:
                         [configuration is shown]
Press the space bar to continue.

You will encounter different stimuli with two possible shapes: Diamonds or Circles. Your task is to respond to the orientation of the line within the diamond while trying to ignore the other shapes. In turn, the line within the diamonds may have two orientations: Vertical or Horizontal. If the orientation of the line inside the diamond is vertical press H. If the orientation of the line inside the diamond is horizontal press V. Before starting the experiment, we are going to perform a few practice trials to familiarize yourself with the task. Remember:

Press H if the orientation of the line inside the diamond is vertical.
Press V if the orientation of the line inside the diamond is horizontal.

In case you want to read the instructions again, press the R key. On the other hand, if you want to start practicing, press the space bar.
[practice trials completed]

You have completed the practice phase Very good! Now that you are familiar with the task, let's get started with the actual experiment.
Press the space bar to continue.

From now on, throughout the task you will be able to earn different amounts of points depending on your performance. Answering correctly will lead you to earn points, but

mistakes will cause you to lose the same number of points you would have earned. In addition, answering faster can make you earn (if you get it right) or lose (if you miss) more points. Also, if you answer too slowly, you will not earn points.
Press the space bar to continue.

Finally, do you remember that sometimes one of the circles could appear in another color? From now on, the color of the circle will determine the number of points you earn.

If a circle appears in color [Color High], you can earn 10 times more points in that trial. On the other hand, if it appears in color [Color Low], you will not earn extra points: Press the space bar to continue.

Now you are about to start the experiment.
Remember:
Press H if the orientation of the line inside the diamond is vertical.
Press V if the orientation of the line inside the diamond is horizontal.
In case you want to read the instructions again, press the R key, if you want to start the experiment, press the space bar.

VMAC. Extinction

You have done very well!
You will continue with the task but, from now on, you will no longer earn points.
Therefore, the color in which some stimuli may appear is completely irrelevant.
If you have read and understood this, press S to continue with the experiment.

Pavlovian-to-instrumental task: Instructions

Experiment 1. Instructions translated to English.

Instrumental training:

You are part of a group trying to obtain products to celebrate birthdays for underprivileged children. Any food that can be obtained will be greatly useful. There's a rumor that free snacks can be obtained from a vending machine. Press the 'up arrow' and 'down arrow' keys of the keyboard to move the machine left and right. Use only the index finger of your dominant hand. Shake the machine until a product falls out. You have to learn which snack falls when you use the' up arrow' and which when you use the 'down arrow' keys. Occasionally, a question will appear to test your knowledge about this relationship.

Pavlovian training:

Your group has discovered that the machines light up and provide information, indicating if the machine is too full of a product, making it fall more easily, or if the machine is empty. You must solely observe and pay attention to learn how each color relates to each possible outcome. Again, occasionally, what you have learned will be assessed through a question. Use the keyboard [numbers 1, 2, 3, or 4] to give the correct answer.
[1, 2, and 3 means that the machine is plenty of either O1, O2, or O3; 4 means that the machine is empty at that moment]

Transfer test:

Now your group and you are going to show the knowledge you have acquired. The purpose of this phase is to optimize the procedure of acquisition of snacks before you go out on the streets.

Remember that you can obtain food by shaking the machine from side to side using the 'up arrow' and 'down arrow' keys, just as you learned in the first phase. Again, use only the index finger of your dominant hand. Depending on which key you press, you will get one product or another. However, in this phase, the images of the snacks will not appear on the screen, although your task remains to gather as much food as you can, as efficiently as possible.

Furthermore, keep in mind that the machines will occasionally light up with different colors. These colors will indicate which products are more likely to fall at that particular moment, as you learned in the second phase.

In conclusion, press the "up arrow" and "down arrow" keys throughout the task to obtain food, as you did in the first phase. Similarly, take into account the colors that appear occasionally to know which foods would be more likely to fall, according to what you have learned in the second phase. Try to gather as much food as you can so that underprivileged children can celebrate the best birthdays of their lives.
Press the spacebar to continue.

Outcome devaluation phase:

Congratulations, you've passed the test and you're out on the streets with your group trying to get products for underprivileged children. You're in an area with quite a few vending machines, so it seems like a good spot. However, one of you has discovered that the machines are infected! Disgusting bugs have invaded some of the packages of one of the food items. When you shake the machine, one of the products that falls out will have to be shared with these new tenants. It's not all the packages of that food, but half of them. Below, you can see a sample of the condition half of the packages of that infected product are in. Take a good look at the image for the amount of time provided.

[the gif image of the outcome and cockroaches is shown]

This is a problem because, on one hand, you need to get as much food as you can, and on the other hand, half of the packages of the food item shown to you are infected with insects. Remember that you can get food by shaking the machine to the left or to the right using the 'up arrow' and 'down arrow', just as you learned in the first phase. Once again, use only the index finger of your dominant hand.

Depending on which key you press, you'll get one product or another. However, in this phase, images won't appear on the screen, although your task remains to gather as much food as you can, as efficiently as possible. Go ahead, hit the space bar to continue and get products for the underprivileged children.

Experiment 2. Instructions translated to English.

Instrumental training:

You are part of a group trying to obtain products to celebrate birthdays for underprivileged children. Any food that can be obtained will be greatly useful. There's a rumor that free snacks can be obtained from a vending machine. Press the 'up arrow' and 'down arrow' keys of the keyboard to move the machine left and right. Use only the index finger of your dominant hand. Shake the machine until a product falls out. You have to learn which snack falls when you use the' up arrow' and which when you use the 'down arrow' keys. Occasionally, a question will appear to test your knowledge about this relationship.
Press the spacebar to continue.

Pavlovian training:

Your group has discovered that the machines light up and provide information, indicating if the machine is too full of a product, making it fall more easily, or if the machine is empty. You must solely observe and pay attention to learn how each color relates to each possible outcome. Again, occasionally, what you have learned will be assessed through a question. Use the keyboard [numbers 1, 2, or 3] to give the correct answer.
[1 and 2 means that the machine is plenty of either O1 or O2; 3 means that the machine is empty at that moment]

Transfer test:

Now your group and you are going to show the knowledge you have acquired. The purpose of this phase is to optimize the acquisition of snacks, and for this, we have gathered two machines, which will allow you to gain more products.
Remember that you can obtain food by shaking the machine from side to side using the 'up arrow' and 'down arrow' keys, just as you learned in the first phase. Again, use only the index finger of your dominant hand. Depending on which key you press, you will get one product or another. However, in this phase, the images of the snacks will not appear on the screen, although your task remains to gather as much food as you can, as efficiently as possible.

Furthermore, keep in mind that the machines will occasionally light up with different colors. These colors will indicate which products are more likely to fall at that particular moment, as you learned in the second phase. The location of each machine—top or bottom—does not provide any relevant information.

In conclusion, press the "up arrow" and "down arrow" keys throughout the task to obtain food, as you did in the first phase. Similarly, take into account the colors that appear occasionally to know which foods would be more likely to fall, according to what you have learned in the second phase. Try to gather as much food as you can so that underprivileged children can celebrate the best birthdays of their lives.
Press the spacebar to continue.