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Abstract

Two eye movement experiments were conducted to investigate the effects of monetary reward and punishment-induced motivation on attentional control processes in individuals under different spatial cueing conditions. Experiment 1 employed a prosaccade/antisaccade paradigm, where participants performed simple prosaccades and antisaccades requiring inhibition of prepotent responses under conditions where endogenous cues provided mental preparation. The results revealed that, compared to the no-incentive condition, the reward condition yielded higher accuracy in the prosaccade task, while the punishment condition produced higher accuracy in the antisaccade task; peak saccadic velocity under both incentive conditions was higher than that under the no-incentive condition across both saccade tasks. Experiment 2 utilized a Go/No-go task to further explore the effects of reward and punishment on attentional control when exogenous peripheral cues were processed by the parafovea, thereby failing to provide adequate mental preparation. The results showed that saccadic latency for Go responses was shorter under the reward condition, accuracy for No-go responses was higher under the punishment condition, and peak saccadic velocity was higher under both conditions compared to the no-incentive condition. These findings indicate that both reward and punishment can facilitate individual attentional control, but their processing mechanisms are dissociable: reward can enhance approach behavior, while punishment can significantly promote inhibitory control behavior. Moreover, reward and punishment exhibit distinct modulatory patterns in attentional control processing—reward can activate the attentional control system earlier to more rapidly facilitate behavior initiation and execution, whereas punishment can promote inhibition of prepotent responses in goal-directed behavior by modulating attentional resources.

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Optimization and Dissociation of Reward and Punishment in Attentional Control: An Eye-Movement Study

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Abstract

Two eye-tracking experiments investigated how monetary reward and punishment—motivational factors—modulate attentional control under different spatial cueing conditions. Experiment 1 employed a pro/anti-saccade paradigm where participants performed simple prosaccades and antisaccades requiring inhibition of prepotent responses, with endogenous cues providing advance preparation. Results showed that reward increased accuracy on prosaccade trials compared to the no-incentive condition, whereas punishment increased accuracy on antisaccade trials. Peak saccade velocity was higher under both reward and punishment conditions than under no incentive for both tasks. Experiment 2 used a Go/No-go task to examine how reward and punishment affect attentional control when exogenous peripheral cues processed in the parafovea cannot provide adequate advance preparation. Reward shortened saccade latency on Go trials, while punishment increased accuracy on No-go trials. Peak saccade velocity was again higher under both motivational conditions than under no incentive. These findings indicate that both reward and punishment enhance attentional control, but their underlying processes are dissociable: reward improves approach behavior, whereas punishment specifically facilitates inhibitory control. Moreover, they operate through distinct modes—reward appears to activate attentional control systems earlier, thereby accelerating behavior initiation and execution, while punishment modulates attentional resources to promote inhibition of prepotent responses during goal-directed behavior.

Keywords: attentional control; reward; punishment; motivation; saccade

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Attentional control refers to the ability to suppress prepotent, habitual, or irrelevant responses and regulate appropriate behaviors to meet task demands and adapt to changing environments. It represents a core component of executive function (Diamond, 2013; Herrera, Speranza, Hampshire, & Bekinschtein, 2014). Research has consistently shown that clinical populations characterized by impulsivity, ADHD, OCD, and drug addiction exhibit weakened attentional control as a central feature (Aarts et al., 2015; Chambers, Garavan, & Bellgrove, 2009; Masui & Nomura, 2011; Pekny, Izawa, & Shadmehr, 2015). Consequently, optimizing attentional control is not only crucial for effective learning and environmental adaptation but also holds therapeutic potential for psychological disorders (Becker et al., 2013). In recent years, the relationship between motivational incentives and attention has garnered increasing attention in decision-making and cognitive control research. Numerous studies have examined reward' s modulatory role in executive control (Steenbergen, Band, & Hommel, 2012; Braem, Hickey, Duthoo, & Notebaert, 2014; Bucker, Silvis, Donk, & Theeuwes, 2015; Ji, Chen, Ding, & Wei, 2015). More recently, researchers have begun exploring how reward and punishment—two distinct motivational factors—differentially influence detection and control processes in cognitive regulation. However, such research remains scarce and findings inconsistent. The most consistent finding to date is that motivational incentives, particularly reward, modulate attentional control systems compared to neutral conditions (Kubanek, Snyder, & Abrams, 2015; Kilpelainen & Theeuwes, 2016).

Motivational systems play a critical role in evaluating situational threats and the appropriateness of behavioral tendencies (Zhang, Xuan, & Fu, 2012). Since reward and punishment regulate behavior by activating motivation, understanding their impact on attentional control requires clarifying how motivation influences inhibitory control. Gray' s (1987) Reinforcement Sensitivity Theory (RST) posits two motivational systems: the Behavioral Approach System (BAS), sensitive to reward and eliciting approach behavior, and the Behavioral Inhibition System (BIS), sensitive to punishment and eliciting inhibitory behavior (Gray, 1987; Pascalis, 2014; Heym, Kantini, Checkley, & Cassaday, 2015; Gu, Bai, & Wang, 2015). Recent research suggests that reward expectation, as a positive motivational factor, optimizes attentional resources and enhances top-down attentional control (Chelazzi, Perlato, Santandrea, & Libera, 2013; Ji et al., 2015). Pessoa' s Dual Competition Model proposes that motivation reallocates attentional resources available to executive functions to maximize potential rewards (Pessoa, 2009). Because attentional resources are limited, concurrent processes share these resources, meaning motivational reallocation affects not only reward-related processing but also co-occurring processes. In Padmala and Pessoa' s (2010) study using a stop-signal task, rewards were provided only for trials without stop signals, which impaired performance on stop-signal trials—participants allocated more attention to rewarded trials, leaving fewer resources for inhibitory control. The Dual Competition Model further suggests that reward enhances attentional control, influencing attentional orienting and reorienting in both exogenous (Engelmann & Pessoa, 2007) and endogenous tasks (Engelmann, Damaraju, Padmala, & Pessoa, 2009). Recent work shows that reward enhances cognitive control by improving signal monitoring, enabling more efficient resolution of control conflicts (Wang, Chen, Hu, & Yin, 2019). fMRI studies demonstrate that reward magnitude increases detection sensitivity and visual cortical activity (Eliana et al., 2014; Hauser, Iannaccone, Walitza, Brandeis, & Brem, 2015).

Despite this progress, research on punishment' s role in attentional control remains limited compared to reward (Spear, 2011; Schmitt, Ferdinand, & Kray, 2015). Although behavioral economics has long recognized that losses loom larger than gains (Tversky & Kahneman, 1992), few studies have examined how punishment influences attentional control, with inconsistent results. Since motivation comprises multiple components—including approach to reward, avoidance of loss, and escape from punishment—reward and punishment may operate through distinct processing modes. Some studies find symmetric effects, with both reward and punishment reducing error rates in inhibitory control (Masui et al., 2011; Gu et al., 2015). Others report that only punishment enhances inhibitory capacity (Jazbec et al., 2006). Additionally, reward and punishment appear to differentially modulate behavioral states and neural systems: reward expectation broadens attentional scope and promotes novelty seeking (Berridge, Robinson, & Aldridge, 2009), whereas punishment expectation narrows attention and engages neural circuits associated with avoidance (Ross, Lanyon, Viswanathan, Manoach, & Barton, 2011; Murty, LaBar, & Adcock, 2016).

These inconsistencies may stem from how attentional resources are allocated during motivational processing. Studies using different paradigms in primates and humans have explored how reward and punishment influence selective attention, but findings remain unclear and largely focused on reward cues. Peck et al. (2009) found that monkeys' saccades were more efficient when targets appeared at previously rewarded locations, suggesting reward modulates spatial attention independent of action valence. Ross et al. (2011) extended this to humans using pro/anti-saccade tasks, finding that both reward and punishment reduced reaction times, with reward showing stronger effects. Critically, they observed inhibition of return (IOR) effects at cued locations, but unlike monkeys, human reward effects were action-based rather than visual-selection-based, becoming more pronounced in resource-demanding anti-saccade tasks. Kilpelainen et al. (2016) used eye-tracking to examine visual search patterns in regions associated with monetary punishment, finding that punishment reduced saccade rate and increased latency, demonstrating flexible attentional allocation to avoid punishment. Wang et al. (2019) showed that reward enhances cognitive control by improving signal monitoring, but whether punishment operates similarly remains unexplored.

Thus, while punishment' s effects on cognitive control are poorly understood, they appear as important as reward' s. Critically, punishment may show distinct processing patterns when modulated by attentional resources. When both reward and punishment are present, with cognitive processes involving both top-down endogenous and bottom-up exogenous attention, how do these motivational expectations allocate executive attentional resources? Does punishment, like reward, modulate different stages of attentional control? Do reward and punishment produce different behavioral patterns when inhibitory processes demand substantial resources? Prior literature rarely addresses these questions. Moreover, successful inhibitory control requires both suppressing automatic responses and generating goal-directed actions. While reward and punishment affect inhibitory control, their specific impacts on these subprocesses remain unknown.

The present study used monetary reward and punishment in anti-saccade (Experiment 1) and saccadic Go/No-go tasks (Experiment 2) to investigate these issues. The anti-saccade paradigm effectively assesses inhibitory control, comprising prosaccades (simple, visually-guided approach behavior) and antisaccades (requiring strong effort to inhibit reflexive saccades and generate mirror-image saccades), allowing comprehensive analysis of inhibitory processing (Munoz & Everling, 2004; Dafoe, Armstrong, & Munoz, 2007). The saccadic Go/No-go task involves Go trials (approach behavior similar to prosaccades) and No-go trials (requiring saccade suppression without subsequent action generation), isolating the inhibition component (Machado & Rafal, 2000; Sommer & Wurtz, 2001). To enhance sensitivity and expectancy while minimizing individual differences in monetary valuation, we used point-based feedback convertible to monetary rewards.

Based on RST, the Dual Competition Model, and prior findings (Ross et al., 2011; Murty et al., 2016), we hypothesized that reward and punishment would optimize attentional resource allocation to target-relevant processing, improving performance relative to neutral conditions. However, they would activate distinct motivational systems, producing different modulatory effects on inhibitory control. When mixed motivational cues were presented, the systems would interact, yielding differential effects depending on attentional preparation state. Specifically, with adequate preparation from top-down cues, both incentives could optimize resource allocation and produce dissociable effects. With inadequate preparation and greater effort demands from bottom-up cues, resource allocation would become difficult. The approach tendency of reward would diminish with increased effort, while punishment—being more salient and easily aroused—would maintain its effect on avoidance behavior by capturing more attentional resources.

Experiment 1

Participants

Twenty-four undergraduate and graduate students participated. All were right-handed, had normal or corrected-to-normal vision (1.0), and no history of psychiatric or neurological disorders. Two trained raters administered the Hamilton Anxiety Scale; all participants scored below 6 (no anxiety symptoms). Two participants with excessively low saccade accuracy were excluded, leaving 22 valid participants (8 male, 14 female; mean age = 22.72 ± 2.97 years). Participants received monetary compensation proportional to points earned.

Design

A 2 (task: prosaccade vs. antisaccade) × 3 (valence: reward, punishment, neutral) within-subjects design was employed.

Procedure

Participants were tested individually. After familiarization, they were seated with their chin on a rest and instructed to minimize head movements. Instructions, reward schemes, and procedures were explained using PowerPoint. A five-point calibration was performed before the experiment began. The task comprised practice (24 trials) and formal testing (144 trials).

Each trial consisted of three phases (see Figure 1 [Figure 1: see original paper]): (1) Cue phase: A central cue (white or gray "+", "-", or "O", 1.5°×1.5°) indicated saccade type (white = prosaccade, gray = antisaccade) and motivational valence ("+" = reward, "-" = punishment, "O" = neutral), displayed for 1000 ms. (2) Response phase: A target stimulus (yellow dot, 0.7°×0.7°) appeared randomly at 5.7° left or right of center for 1000 ms. On prosaccade trials, participants looked toward the target; on antisaccade trials, they looked to the mirror location opposite the target. Successful saccades had to land within 130 pixels of the correct location within 500 ms (saccades of 500–700 ms were coded as errors but retained). (3) Feedback phase: Correct responses received green feedback ("+5" , "+0"); errors received red feedback ("-5" , "-0"), displayed for 1000 ms.

Apparatus

An SR Research EyeLink II head-mounted eye tracker (500 Hz sampling rate) recorded right-eye movements. Stimuli were presented on a Dell 19-inch CRT monitor (150 Hz refresh rate, 1024×768 resolution) at 75 cm viewing distance.

Results and Analysis

Invalid trials were excluded based on these criteria (Jazbec et al., 2006): (1) first saccade off-screen; (2) no eye movement record or target presentation during blink; (3) saccade amplitude <3°; (4) saccade duration <25 ms or >100 ms; (5) first-saccade latency 80 ms or 700 ms; (6) latencies of 500-700 ms coded as errors but retained. Overall, 7.66% of trials were excluded.

First-saccade accuracy (percentage of correct first saccades) reflects overall performance and is the most sensitive measure in saccade paradigms. Antisaccade accuracy specifically indexes inhibitory control capacity.

A 2 (task) × 3 (valence) repeated-measures ANOVA revealed significant main effects of task, $F(1, 21) = 97.00$, $p < 0.001$, $^2 = 0.82$, and valence, $F(2, 42) = 4.74$, $p = 0.014$, $^2 = 0.18$, and a significant interaction, $F(2, 42) = 3.27$, $p = 0.048$, $^2 = 0.14$. Simple effects analysis showed that for prosaccades, valence was significant, $F(2, 42) = 4.12$, $p = 0.023$: reward produced higher accuracy than neutral ($p = 0.006$), while punishment vs. neutral ($p = 0.995$) and reward vs. punishment ($p = 0.137$) did not differ. For antisaccades, valence was also significant, $F(2, 42) = 3.80$, $p = 0.031$: punishment produced higher accuracy than neutral ($p = 0.017$), while punishment vs. reward ($p = 0.108$)

and reward vs. neutral ($p = 0.321$) did not differ (see Figure 2 [Figure 2: see original paper]A).

First-saccade latency (time from target onset to first saccade) indexes execution speed for prosaccades and inhibitory efficiency for antisaccades (shorter latencies indicate more efficient control). The ANOVA showed a significant task main effect, $F(1, 21) = 70.35$, $p < 0.001$, $^2 = 0.79$, with prosaccade latencies shorter than antisaccade latencies. Neither the valence main effect, $F(2, 42) = 2.16$, $p = 0.128$, nor the interaction, $F(2, 42) = 1.27$, $p = 0.292$, was significant.

Peak saccade velocity (maximum velocity of the first saccade) provides a precise index of cognitive control processes mapped onto specific neural functions, reflecting attentional modulation of motor execution. Higher velocities indicate more efficient inhibitory control (Jazbec et al., 2006). The ANOVA revealed no task main effect, $F(1, 21) = 0.01$, $p = 0.941$, but a significant valence main effect, $F(2, 42) = 5.67$, $p = 0.007$, $^2 = 0.21$. Post-hoc tests showed that both reward and punishment produced higher peak velocities than neutral ($p = 0.015$ and $p = 0.006$, respectively), with no difference between reward and punishment ($p = 0.995$). The interaction was not significant, $F(2, 42) = 0.11$, $p = 0.898$ (see Figure 2 [Figure 2: see original paper]B).

Experiment 1 largely confirmed our hypotheses. In mixed motivational contexts, reward improved prosaccade accuracy, while punishment improved antisaccade accuracy. Peak velocity increased under both motivational conditions for both tasks, with no latency differences. These results demonstrate dissociable effects: reward facilitates approach behavior, whereas punishment enhances inhibitory control. Both incentives improved behavioral execution. According to RST, BAS activation by reward improved prosaccade performance, while BIS activation by punishment enhanced antisaccade performance. The absence of latency effects may reflect cautious strategies adopted when motivational cues were mixed, creating a trade-off. However, the peak velocity findings confirm that reward and punishment optimize and modulate attentional control. Notably, punishment specifically enhanced inhibitory control without reward showing a comparable effect, consistent with Kubanek et al. (2015), who found that reward promotes repetition while punishment promotes avoidance, with distinct processing dynamics.

However, because motivational and saccade cues in Experiment 1 were presented before target onset, these top-down endogenous cues provided adequate preparation. Would the dissociation persist when motivational cues appear independently and bottom-up exogenous cues guide attention? Would punishment’ s specific benefit for inhibitory control remain constant without adequate preparation? Experiment 2 addressed this using a monetary reward/punishment Go/No-go task.

Experiment 2

Participants

To control individual differences and follow up on Experiment 1, the same 22 valid participants were tested one week later to avoid fatigue effects.

Design

A single-factor (valence: reward, punishment, neutral) within-subjects design was used.

Procedure

Each trial comprised three phases (see Figure 3 [Figure 3: see original paper]): (1) Cue phase: A central cue (white “+” , “-” , or “O” , 1.5°×1.5°) indicated motivational valence, displayed for a variable duration (1250–1750 ms). (2) Response phase: A target stimulus (yellow or blue square, 0.7°×0.7°) appeared randomly at 5.7° left or right for 1000 ms. Color indicated response type (counterbalanced across participants): yellow signaled a Go trial (saccade to target), blue signaled a No-go trial (maintain central fixation). Participants first identified target color using peripheral vision before responding. (3) Feedback phase: Correct responses received green feedback (“+5” , “+0”); errors received red feedback (“-5” , “-0”), displayed for 1000 ms.

Participants completed 24 practice and 144 formal trials. Successful responses required fixation within 95 pixels of the correct location. Monetary compensation ranged from ¥5 to ¥20 based on points earned.

Apparatus

Identical to Experiment 1.

Results and Analysis

Exclusion criteria matched Experiment 1, removing 7.17% of trials.

Response accuracy was analyzed with one-way repeated-measures ANOVAs (see Figure 4 [Figure 4: see original paper]A). For Go trials, valence did not affect accuracy, $F(1, 42) = 0.72$, $p = 0.495$, $^2 = 0.03$. For No-go trials (indexing prepotent response inhibition), valence was significant, $F(2, 42) = 3.55$, $p = 0.038$, $^2 = 0.15$: punishment produced higher accuracy than neutral ($p = 0.035$), while punishment vs. reward ($p = 0.266$) and reward vs. neutral ($p = 0.072$) did not differ significantly.

Saccade latency and peak velocity were analyzed only for correct Go trials (No-go trials require no saccade). **Latency** showed a significant valence effect, $F(2, 42) = 5.87$, $p = 0.006$, $^2 = 0.22$: reward produced shorter latencies than punishment ($p = 0.008$), with no other differences (see Figure 4 [Figure 4: see original paper]B). **Peak velocity** also showed a significant valence effect, $F(2, 42) = 8.46$, $p = 0.001$, $^2 = 0.29$: both reward and punishment increased velocity relative to neutral ($p = 0.004$ and $p = 0.013$, respectively), with no difference between them ($p = 0.995$), replicating Experiment 1’ s prosaccade findings.

Experiment 2 confirmed our predictions: punishment enhanced No-go accuracy, while reward shortened Go latency. Go accuracy was near ceiling across conditions, but the latency effect demonstrates that reward facilitated action execution in exogenous attention-guided behavior requiring minimal resources. The No-go accuracy findings replicate Experiment 1’ s antisaccade results, and the peak velocity effects mirror Experiment 1’ s prosaccade pattern. These results demonstrate that monetary reward and punishment enhance Go and No-go performance, with dissociable effects on exogenous cue-guided attentional control: punishment more robustly optimizes inhibitory processing.

General Discussion

This study investigated how monetary reward and punishment modulate attentional control. Results show that both motivational incentives improve behavioral execution, with punishment specifically optimizing inhibitory control and reward more strongly facilitating approach behavior. Both experiments indicate that reward and punishment affect attentional resource allocation through dissociable processes: reward is detected early to promote action execution, while punishment more prominently facilitates prepotent response inhibition.

Dissociable Optimization by Reward and Punishment

Prosaccades represent exogenous, visually-guided approach behavior, whereas antisaccades are endogenous, requiring active inhibition of reflexive responses. Reward improved prosaccade accuracy, consistent with prior research (Jazbec et al., 2006; Geier & Luna, 2012) showing reward activates oculomotor circuitry supporting attentional control. Punishment improved antisaccade accuracy, demonstrating enhanced inhibitory control. These findings align with RST: BAS activation by reward facilitates approach, while BIS activation by punishment facilitates inhibition. Peak velocity increases under both conditions support the Three-Arousal Model (Arnett & Newman, 2000), which adds a Non-Specific Arousal System (NAS) that enhances behavioral speed and intensity when either BAS or BIS is activated. Thus, reward and punishment differentially modulate attentional control: reward promotes approach, punishment improves avoidance.

A key finding emerged when motivational cues conflicted with task demands (reward on antisaccade trials; punishment on prosaccade trials). Neither reward on antisaccades nor punishment on prosaccades improved performance significantly. According to RST, simultaneous BAS and BIS activation produces interactive inhibition (Corr, 2001). The Dual Competition Model suggests motivation reallocates resources to maximize reward, enhancing executive control

(Pessoa, 2009). Participants may have strategically reallocated resources to avoid approach behaviors during antisaccades and overcome inhibitory tendencies during prosaccades to maximize rewards. The peak velocity findings under mixed motivational conditions support this strategic modulation.

However, Experiment 1's cues preceded targets, providing top-down preparation. Would dissociation persist with independent motivational cues and bottom-up exogenous attention? Experiment 2 confirmed that punishment's specific benefit for inhibition remained robust even without adequate preparation.

Interactive Effects on Attentional Control

Attentional control involves both inhibiting prepotent responses and generating voluntary actions. Antisaccades comprise both inhibition and action generation; prosaccades and Go trials involve action generation; No-go trials involve only inhibition. Using both tasks allowed us to dissociate these subprocesses and examine how reward and punishment differentially affect them.

Experiment 1 showed punishment enhanced antisaccade accuracy (overall inhibition), while reward improved prosaccades (approach). Experiment 2 showed punishment enhanced No-go accuracy (inhibition), while reward shortened Go latency (action generation), with no reward effect on Go accuracy due to ceiling effects. These findings extend prior research (Hardin, Schroth, & Ernst, 2007; Padmala et al., 2010; Geier & Luna, 2012) by demonstrating distinct motivational modulation patterns: punishment primarily affects inhibitory processes, while reward primarily affects action execution.

Reward Facilitates Early Attentional Control Processing

Reward typically triggers approach behavior, which has evolutionary significance (Freeman & Aron, 2016). Experiment 1 showed reward improved prosaccade accuracy. Experiment 2 demonstrated that reward shortened Go latency, facilitating action execution in exogenous attention-guided behavior requiring minimal resources. Recent research using cue-target paradigms shows that reward accelerates saccade preparation, with deterministic rewards producing the shortest latencies (Wolf, Heuer, Schubö, & Schütz, 2017). This indicates reward signals are monitored early in attentional control, promoting goal-directed behavior faster than neutral conditions (Anderson, Laurent, & Yantis, 2011).

Punishment Facilitates Inhibitory Control Processing

Both experiments showed that while reward and punishment enhanced behavioral execution (increased peak velocity), punishment more robustly facilitated inhibitory control: antisaccade and No-go accuracy were significantly higher under punishment than reward or neutral conditions. This aligns with behavioral economics research showing losses have greater subjective impact than gains (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Tversky & Kahneman,

1992) and with Kubanek et al. (2015), who found stronger behavioral modulation by punishment than reward.

The loss-specific effect may reflect transient arousal enhancement that increases sensitivity to target selection and behavioral outcomes (Yechiam & Hochman, 2013). Kubanek et al. (2015) found that reward magnitude modulated choice behavior, whereas punishment magnitude did not. Our mixed-cue paradigm revealed that punishment consistently facilitated inhibitory control across both endogenous (Experiment 1) and exogenous (Experiment 2) attentional contexts, suggesting punishment' s effect is independent of cue type and reflects a specific mechanism for rapid behavioral switching in response to potential harm. This supports Yechiam and Hochman' s loss-attention arousal hypothesis, proposing that losses trigger rapid attentional arousal and behavioral change.

Notably, while neuroimaging studies have begun examining dissociable neural mechanisms of reward and punishment during decision-making, research on attentional processes remains dominated by reward. The few punishment studies are nascent. Eye-tracking offers advantages over EEG by avoiding artifacts from eye movements while enabling precise measurement of first-saccade latencies. Future research should combine eye-tracking with EEG or fMRI to investigate the neural mechanisms underlying these dissociable motivational effects on attentional control.

Conclusion

Using pro/anti-saccade and Go/No-go tasks, we examined how reward and punishment modulate attentional control. Both incentives enhanced behavioral execution, but operated through dissociable mechanisms: reward facilitated approach behavior, while punishment optimized inhibitory control. Punishment primarily affected prepotent response inhibition, whereas reward primarily affected action execution. Notably, punishment' s beneficial effect on inhibition remained stable across tasks. These findings support and extend RST, the Dual Competition Model, and attentional arousal theories, highlighting punishment' s critical role in inhibitory behavior. Future research should examine whether these effects vary across cultures and developmental stages, and should investigate the neural mechanisms using combined neuroimaging and eye-tracking methods.

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