Liu, L. et al.: Computational mechanisms underlying the impact of Pavlovian bias on instrumental learning in problematic social media users

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Supplementary Material

Table S1. Model comparison results

Model	PSMU group		HC group	
	Δ LOOIC	Model weight	Δ LOOIC	Model weight
Model 1	668.5	0	694.6	0
Model 2	338.2	0	431.3	0
Model 3	95.1	0	158.3	0
Model 4	16.2	0.02	78.4	0
Model 5	**0**	**0.98**	**0**	**1**

Table S2. Priors for parameters in Model 5

Parameter	Priors
Irreducible noise ξ	$\mu_{\xi'} \sim Normal(0,1)$ $\sigma_{\xi'} \sim Normal(0,0.2)$ $\xi' \sim Normal(\mu_{\xi'}, \sigma_{\xi'})$ $\xi = Probit^{-1}(\xi')$
Learning rate ε	$\mu_{\varepsilon'} \sim Normal(0,1)$ $\sigma_{\varepsilon'} \sim Normal(0,0.2)$ $\varepsilon' \sim Normal(\mu_{\varepsilon'}, \sigma_{\varepsilon'})$ $\varepsilon = Probit^{-1}(\varepsilon')$
Go bias b	$\mu_{b'} \sim Normal(0,10)$ $\sigma_{b'} \sim halfCauchy(0,1)$ $b \sim Normal(\mu_{b'}, \sigma_{b'})$
Reward sensitivity ρ_{rew}	$\mu_{\rho_{rew}'} \sim Normal(0,10)$ $\sigma_{\rho_{rew}'} \sim halfCauchy(0,1)$ $\rho_{rew} \sim Normal(\mu_{\rho_{rew}'}, \sigma_{\rho_{rew}'})$
Punishment sensitivity ρ_{pun}	$\mu_{\rho_{pun}'} \sim Normal(0,10)$ $\sigma_{\rho_{pun}'} \sim halfCauchy(0,1)$ $\rho_{pun} \sim Normal\left(\mu_{\rho_{pun}'}, \sigma_{\rho_{pun}'}\right)$
Pavlovian bias for reward π_{rew}	$\mu_{\pi_{rew}'} \sim Normal(0,1)$ $\sigma_{\pi_{rew}'} \sim Normal(0,0.2)$ $\pi_{rew}' \sim Normal(\mu_{\pi_{rew}'}, \sigma_{\pi_{rew}'})$ $\pi_{rew} = exp(\pi_{rew}')$
Pavlovian bias for punishment π_{pun}	$\mu_{\pi_{pun}'} \sim Normal(0,1)$ $\sigma_{\pi_{pun}'} \sim Normal(0,0.2)$ $\pi_{pun}' \sim Normal\left(\mu_{\pi_{pun}'}, \sigma_{\pi_{pun}'}\right)$ $\pi_{pun} = exp(\pi_{pun}')$

Table S3. Spearman's correlation between the PSMU severity and parameters from Model 5 in all participants

	Irreducible noise	Learning rate	Go bias	Reward sensitivity	Punishment sensitivity	Reward Pavlovian bias	Punishment Pavlovian bias
PSMU severity	ρ = -0.11 p = 0.40	ρ = 0.15 p = 0.23	ρ = 0.08 p = 0.51	**ρ = -0.66** **p < 0.001**	**ρ = -0.27** **p = 0.03**	ρ = 0.04 p = 0.78	ρ = 0.10 p = 0.41

Table S4. Spearman's correlation between the PSMU severity and accuracy of the four conditions in all participants

	Accuracy GW	Accuracy NGW	Accuracy GA	Accuracy NGA
PSMU severity	ρ = -0.11 p = 0.37	ρ = -0.23 p = 0.07	ρ = 0.02 p = 0.85	ρ = 0.05 p = 0.69

Table S5. Spearman's correlation between key parameters and self-reported and model-free measures

	Impulsivity (BIS-11)*	Behavioral Approach System*	Behavioral Inhibition System*
Learning rate	ρ = -0.15 p = 0.31	ρ = -0.26 p = 0.08	ρ = -0.16 p = 0.28
Reward sensitivity	**ρ = -0.30** **p = 0.04**	**ρ = 0.31** **p = 0.04**	ρ = -0.28 p = 0.06
Punishment sensitivity	ρ = -0.28 p = 0.06	ρ = -0.05 p = 0.76	ρ = 0.13 p = 0.40

* Self-reported questionnaire data are available for 46 participants.

Table S6. Spearman's correlation between the accuracy of the two incongruent conditions and key parameters and self-reported measures

	Learning rate	Reward sensitivity	Punishment sensitivity	Impulsivity (BIS-11)*	Behavioral Approach System*	Behavioral Inhibition System*
Accuracy NGW	$\boldsymbol{\rho = 0.26}$ $\boldsymbol{p = 0.04}$	ρ = 0.24 p = 0.05	ρ = -0.03 p = 0.81	ρ = 0.20 p = 0.18	ρ = -0.16 p = 0.28	ρ = -0.06 p = 0.70
Accuracy GA	$\boldsymbol{\rho = 0.43}$ $\boldsymbol{p < 0.001}$	ρ = -0.09 p = 0.48	ρ = 0.21 p = 0.07	ρ = -0.28 p = 0.06	ρ = -0.21 p = 0.15	ρ = -0.25 p = 0.10

* Self-reported questionnaire data are available for 46 participants.

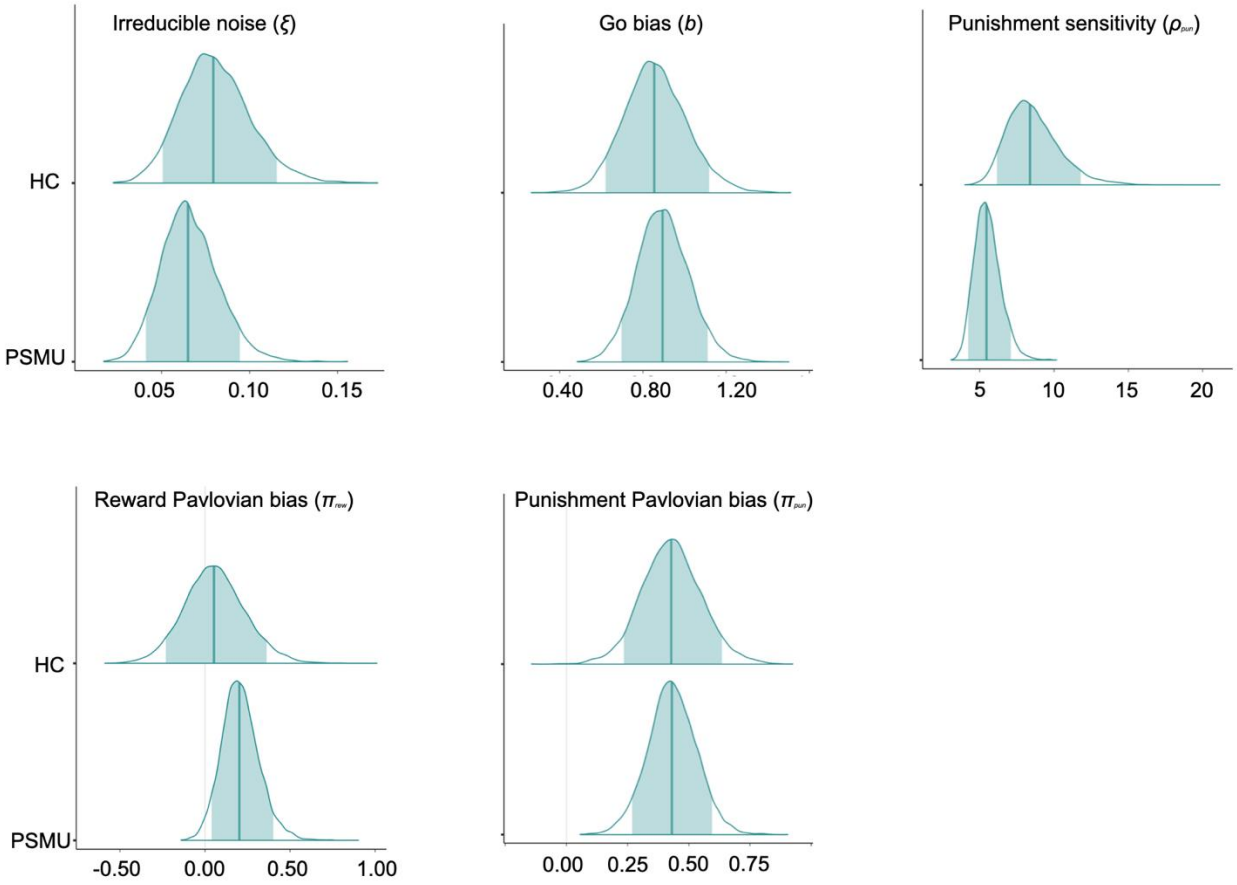

Fig. S1. Posterior distributions of irreducible noise ξ, punishment sensitivity ρ_{pun}: go bias b, reward Pavlovian bias π_{rew}, and punishment Pavlovian bias π_{pun} from Model 5.