**Supplemental Material**

**Study 2 Subsample Used in Imaging Analyses**

Within the subsample of youth included in Study 2, differences across latent profiles were largely maintained (see Supplemental Table S1). First, the HC profile was not significantly different from the ELS profile on the Alcohol Problems subscale of the AUDIT (*t*(95)=1.45, *p*=0.16). Second, the SU/RB profile continued to have qualitatively higher scores on the rule breaking subscale of the CBCL compared to all other profiles, but the differences were no longer significant compared to the ADHD profile (*t*(75)=1.43, *p*=0.16) and the ELS profile (*t*(52)=1.99, *p*=.052). Additionally, while the ADHD profile continued to have qualitatively higher scores on the attention problems subscale of the CBCL compared to all other profiles, the difference was not significant compared to the SU/RB profile (*t*(75)=1.74, *p*=0.09). Individuals in the SU/RB profile did not have significant elevations on the physical abuse (t(75)=0.71, p=0.48) or total CTQ (t(75)=1.89, p=0.06) relative to the ADHD profile although these scores were higher in the SU/RB profile compared to the ADHD profile. Individuals in the ELS profile did not have significant elevations on the CUDIT Cannabis Use subscale (t(61)=1.64, p=0.11) compared to the ADHD profile although they continued to have higher scores on the overall CUDIT (t(61)=2.05, p<.05). Regarding ethnicity, 6.9% of youth identified as Hispanic/Latino. Regarding race, approximately 1.1% of youth identified as American Indian/Alaska Native; 0.6% as Asian; 0% as Native Hawaiian/Other Pacific Islander; 10.9% as Black/African-American; and 79.3% as White. Approximately 6.9% reported identifying as more than one race, and 1.1% did not report race. For full clinical data on this subsample, see Supplemental Table S1. Supplemental Figure S1 shows average raw scores or *t*-scores (as applicable) on LPA indicator variables in the Study 2 subsample.

**Passive Avoidance (PA) Task**

Figure S2 provides a schematic of the PA Task used in the current study. Panel A represents a reward trial and panel B represents a punishment trial. Panel C represents a no-response trial (the sequence of events when a participant elects not to respond to a shape).

**Study 2 Passive Avoidance (PA) Task Main Effects**

Table S2 provides ANOVA results for the main effect of feedback type.

**AUDIT/CUDIT Analysis**

A previous study with an overlapping sample found that Alcohol Use Disorder symptom severity was inversely associated with striatal responsiveness to reward vs. punishment (Aloi et al., 2020).  Therefore, we sought to replicate this finding within the sample for the current study.

First, AUDIT and CUDIT scores were Rankit transformed and standardized to reduce skewness and kurtosis.  We ran a Multivariate Analysis of Covariance (MANCOVA); our dependent variables were the reward vs. punishment contrast values within each of the four striatal ROIs (right and left nucleus accumbens, right and left caudate); our independent variables were Rankit-transformed, standardized AUDIT and CUDIT scores as well as the AUDIT-by-CUDIT interaction.

There was a significant main effect of AUDIT scores on reward vs. punishment responsiveness within the striatal ROIs (F(4,167)=4.26, p=.003).  This was primarily driven by an inverse relationship between AUDIT scores and reward vs. punishment differences within the right nucleus accumbens (B=-.066, p=.006) and left caudate (B=-.045, p=.002).  Within left nucleus accumbens (B=-.041, p=.092) and right caudate (B=-.027, p=.064), the relationship between AUDIT scores and reward vs. punishment differences approached significance.

**Analysis Controlling for IQ, Age, Sex, and Race**

We repeated our analysis controlling for IQ, age, sex, and race (coded as a binary variable, white or non-white). There was a significant profile by feedback interaction [F(3,166)=4.495, p=.005] within our striatal ROIs, driven by reduced differential reward-punishment striatal responsiveness within the SU/RB profile within left nucleus accumbens, right nucleus accumbens, and left caudate. For our whole-brain analysis, we found a profile-by-feedback interaction within regions of posterior cingulate cortex, precuneus, and middle frontal gyrus overlapping with the main analysis. For details, see Supplemental Table S3.

**Analysis Excluding Participants Prescribed Psychotropic Medication**

We repeated our analysis excluding participants who were prescribed psychotropic medication (antidepressants, antipsychotics, stimulants). There was a significant profile by feedback interaction (F(3,129)=4.09, p=.008) within our striatal ROIs, driven by reduced differential reward-punishment striatal responsiveness within the SU/RB profile within left and right caudate. For our whole-brain analysis, we found a profile-by-feedback interaction within regions of posterior cingulate cortex and precuneus overlapping with the main analysis. For details, see Supplemental Table S4.

**Choosing an Optimal Profile Solution & Analysis Using a Three-Profile Solution**

Choosing an optimal profile solution necessarily involves weighing both fit statistics and theoretical considerations. We chose the 4-profile solution because it showed the lowest BIC, had high entropy and a significant bootstrapped p-value, and mapped most closely onto the indicator variables. This approach is in line with best-practice recommendations for using LPA in psychological and social sciences research, made by Spurk and colleagues (2020). However, the 3-profile solution also shows favorable fit statistics.

To that end, we repeated our analysis using a three-profile solution to our LPA using the exact same indicator variables from the AUDIT, CUDIT, CBCL, and CTQ. AIC, BIC, and Entropy values are shown in Table 2 of the main manuscript. Demographic information and clinical variables for the three profiles are shown in Table S5. Most youths (N=125) were classified as members of Profile 1 (Healthy Comparison, “HC”); 55 youths were classified as members of Profile 2 (Substance Use/Rule Breaking, “SU/RB”); and 86 youths were classified as members of Profile 3 (Other Psychopathology). The HC Profile had significantly lower scores on all subscales of the AUDIT, CUDIT, CBCL, and CTQ relative to the SU/RB and Other Psychopathology Profiles (*t*s>2.20, *p*s<.05). The SU/RB profile had higher scores on the AUDIT, CUDIT, and Rule-Breaking subscale of the CBCL relative to the Other Psychopathology Profile (*t*s>2.21, *p*s<.05). There were no differences between the other CBCL subscales and CTQ subscales between the SU/RB Profile and the Other Psychopathology Profile. In short, the first two Profiles (HC and SU/RB) very closely reflected the HC and SU/RB profiles from the main analysis. However, the third profile (Other Psychopathology), did not necessarily reflect a specific profile from the main analysis. See Table S5 for further information.

 Regarding our region of interest analysis with the fMRI data, we found a significant profile-by-feedback interaction effect across all striatal ROIs (F(2,170)=7.89, *p*<.05). Specifically, there was reduced BOLD responsiveness on the Reward – Punishment Contrast within left/right caudate and nucleus accumbens within the SU/RB Profile relative to the other Profiles (*F*s>3.60, *p*s<.05). This replicated the results of our main analysis.

 For our whole-brain analysis, we found a significant profile-by-feedback interaction effect within dorsolateral prefrontal cortex (dlPFC), precuneus, and posterior cingulate cortex (PCC). These interactions were driven primarily by reduced responsiveness to reward relative to punishment within the SU/RB profile compared to the other profiles (*F*s=10.22-18.23, *p*s<.05) and replicated the results of our main analysis, with the exception of several additional clusters that remained significant after controlling for multiple comparisons in comparing the three profiles. See Table S6 for further information.

References

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Spurk, D., Hirschi, A., Wang, M., Valero, D., & Kauffeld, S. (2020). Latent profile analysis: A

review and “how to” guide of its application within vocational behavior research. *Journal of Vocational Behavior*, *120*, 103445. doi: 10.1016/j.jvb.2020.103445

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| **Table S1. Demographic information and clinical variables for Study 2 subsample (N=174)** |
|  | HC (N=77) | SUD (N=34) | ADHD (N=43) | ELS (N=20) | F/*χ*2 |
| % Male | 54.5% | 61.8% | 67.4% | 50.0% | 2.66 |
| Ethnicity |  |  |  |  | 5.03 |
| Hispanic/Latino | 3.9% | 14.7% | 4.7% | 10% |  |
| Race |  |  |  |  | 14.06 |
| Native American/Alaska Native | 0% | 2.9% | 2.3% | 0% |  |
| Asian | 1.3% | 0% | 9% | 0% |  |
| Native Hawaiian/Other Pacific Islander | 0% | 0% | 0% | 0% |  |
| Black/African-American | 7.8% | 11.8% | 9.3% | 25% |  |
| White | 84.4% | 73.5% | 79.1% | 70% |  |
| More than one race | 3.9% | 11.8% | 9.3% | 5% |  |
| Age (SD) | 15.9 (1.68) | 16.7 (0.99) | 16.2 (1.41) | 15.9 (1.51) | 2.28 |
| IQ | 105.9 (13.06)a | 98.8 (10.28)b | 101.2 (11.89)a | 99.2 (12.37)b | 3.75\* |
| AUDIT Consumption | 0.2 (0.47)a | 3.8 (3.06)b | 1.1 (2.08)c | 1.5 (2.04)c | 29.98\*^ |
| AUDIT Problems  | 0.1 (0.56)a | 2.5 (3.26)b | 0.4 (1.44)a | 0.5 (1.28)a | 16.34\* |
| AUDIT Dependence  | 0.0 (0)a | 1.7 (2.92)b | 0.2 (0.65)c | 0.1 (0.31)c | 13.03\*^ |
| CUDIT Consumption  | 0.1 (0.44)a | 6.1 (1.23)b | 1.2 (1.86)c | 2.1 (2.47)c | 148.14\*^ |
| CUDIT Problems  | 0.0 (0.1)a | 3.3 (2.28)b | 0.2 (0.70)c | 0.5 (1.19)c | 72.80\*^ |
| CUDIT Dependence  | 0.0 (0.2)a | 5.2 (2.09)b | 0.4 (0.69)c | 0.7 (1.38)c | 194.45\*^ |
| CUDIT Psych Features | 0.2 (0.83)a | 4.7 (2.36)b | 1.0 (1.74)c | 2.1 (2.57)c | 55.86\*^ |
| AUDIT Total | 0.4 (0.87)a | 8.0 (8.10)b | 1.7 (3.87)c | 2.0 (2.79)c | 26.68\*^ |
| CUDIT Total | 0.4 (1.25)a | 19.3 (5.56)b | 2.8 (3.90)c | 5.4 (5.98)d | 202.32\* |
| CBCL Aggression | 51.7 (3.45)a | 68.7 (10.61)b | 71.0 (9.95)b | 65.0 (12.92)b | 65.54\*^ |
| CBCL Rule Breaking | 52.9 (5.02)a | 76.0 (9.13)b | 73.3 (7.35)b | 70.6 (10.37)b | 119.41\* |
| CBCL Attention Prob | 51.6 (7.34)a | 65.6 (10.50)b | 69.3 (8.15)b | 62.5 (7.59)b | 50.44\* |
| CBCL Externalizing  | 44.3 (9.97)a | 72.4 (8.22)b | 72.5 (6.83)b | 67.2 (11.41)b | 91.43\* |
| CTQ EA | 6.2 (2.14)a | 9.7 (4.75)b | 7.5 (2.41)b | 15.7 (4.41)c | 50.57\* |
| CTQ PA | 5.5 (1.09)a | 6.7 (3.21)b | 6.3 (2.04)b | 12.1 (4.37)c | 39.95\*^ |
| CTQ SA | 5.0 (0)a | 6.7 (4.92)b | 6.4 (4.71)c | 11.9 (7.19)d | 15.70\*^ |
| CTQ EN | 6.1 (1.69)a | 9.7 (4.84)b | 8.8 (3.86)b | 16.1 (3.82)c | 48.59\*^ |
| CTQ PN | 5.5 (0.93)a | 7.5 (3.80)b | 6.2 (2.15)b | 10.9 (3.86)c | 27.19\* |
| CTQ Total | 28.3 (4.11)a | 40.3 (14.37)b | 35.3 (8.88)b | 66.6 (12.58)c | 126.68\* |
| % ADHD | 6.5% | 64.7% | 74.4% | 55.0% | 67.63\* |
| % CD | 2.6% | 67.6% | 67.4% | 60.0% | 73.63\*^ |
| % GAD | 5.2% | 38.2% | 25.6% | 55.0% | 30.48\*^ |
| % MDD | 5.2% | 26.5% | 7.0% | 30.0% | 16.46\*^ |
| % PTSD | 0.0% | 14.7% | 11.6% | 45.0% | 33.84\*^ |
| Number of Commission Errors | 15.7 (10.88) | 18.9 (11.50) | 18.3 (12.10) | 19.1 (13.96) |  |
| Number of Omission Errors | 10.7 (10.49) | 13.4 (9.12) | 11.5 (8.17) | 11.7 (10.05) |  |
| \* indicates significant differences at *p*<.05, ^ indicates where all post-hoc between-groups comparisons from Study 1 replicated in the subsample for Study 2. ADHD=Attention Deficit Hyperactivity Disorder Profile, AUDIT=Alcohol Use Disorders Identification Test, CBCL=Child Behavior Checklist, CBCL Attention Prob=CBCL Attention Problems, CD=Conduct Disorder, CTQ=Childhood Trauma Questionnaire, CUDIT=Cannabis Use Disorders Identification Test, CUDIT Psych=Cannabis Psychological Features, EA=Emotional Abuse, ELS=Early Life Stress Profile, EN=Emotional Neglect, GAD=Generalized Anxiety Disorder, HC=Healthy Comparison Profile, MDD=Major Depressive Disorder, PA=Physical Abuse, PN=Physical Neglect, PTSD=Posttraumatic Stress Disorder, SA=Sexual Abuse, SD=Standard Deviation, SU/RB=Substance Use/Rule-Breaking Profile. |

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| **Table S2. Brain regions demonstrating significant responses to Feedback Type (N=174)** |
| Coordinates of Peak Activationb |
| Regiona | Hemisphere | BA | x | y | z | *F* | Partial η2 | Voxels |
| Reward>Punishment |
| Dorsomedial Prefrontal Cortex/Anterior Cingulate Cortex | R/L | 6/8 | -1 | 11 | 59 | 30.25 | .151 | 291 |
| Anterior Insular Cortex/Inferior Frontal Gyrus | L | 47 | -37 | 20 | -1 | 33.42 | .164 | 204 |
| Caudate | R/L | - | -10 | 5 | -1 | 45.77 | .212 | 145 |
| Anterior Insular Cortex/Inferior Frontal Gyrus | R | 13 | 29 | 17 | -7 | 31.62 | .157 | 120 |
| Superior Temporal Gyrus | R | 38 | 50 | 11 | -25 | 35.58 | .173 | 73 |
| Cingulate Gyrus | R | - | 20 | -13 | 29 | 27.63 | .140 | 55 |
| Middle Temporal Gyrus | R | 21 | 53 | -28 | -4 | 27.88 | .141 | 46 |
| Anterior Cingulate Cortex | L | 32 | -16 | 32 | 14 | 27.64 | .140 | 44 |
| Inferior Parietal Lobule | R | 40 | 56 | -43 | 26 | 23.07 | .119 | 38 |
| Inferior Parietal Lobule | L | 40 | -55 | -46 | 29 | 24.04 | .124 | 37 |
| Caudate | R | - | 32 | -34 | 2 | 36.83 | .178 | 35 |
| Superior Temporal Gyrus | L | 22 | -46 | -25 | -1 | 25.16 | .129 | 32 |
| Cingulate Gyrus | R | 24/32 | 17 | 11 | 23 | 21.80 | .114 | 23 |
| Posterior Cingulate Cortex | L | 30 | -16 | -61 | 8 | 15.50 | .084 | 19 |
| Superior Frontal Gyrus | L | 9/10 | -13 | 56 | 20 | 18.74 | .099 | 19 |

Note: a According to the Talairach Daemon Atlas (<http://www.nitrc.org/projects/tal-daemon/>), b Based on
the Tournoux & Talairach standard brain template, BA= Brodmann’s Area

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| **Table S3. Brain regions demonstrating significant Profile-by-Feedback interactions covarying for IQ, age, sex, and race** |
| Coordinates of Peak Activationb |
| Regiona | Hemisphere | BA | x | y | z | *F* | Partial η2 | Voxels |
| Profile-by-Feedback |
| Posterior Cingulate Cortex/Precuneus | R/L | 31 | -4 | -34 | 38 | 9.06 | 0.141 | 40 |
| Posterior Cingulate Cortex | R/L | 23 | -1 | -28 | 26 | 9.42 | 0.145 | 30 |
| Middle Frontal Gyrus | L | 10 | -31 | 47 | 23 | 9.91 | 0.152 | 28 |

Note: a According to the Talairach Daemon Atlas (<http://www.nitrc.org/projects/tal-daemon/>), b Based on
the Tournoux & Talairach standard brain template, BA= Brodmann’s Area

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| **Table S4. Brain regions demonstrating significant Profile-by-Feedback interactions excluding participants prescribed psychotropic medications** |
| Coordinates of Peak Activationb |
| Regiona | Hemisphere | BA | x | y | z | *F* | Partial η2 | Voxels |
| Profile-by-Feedback |
| Posterior Cingulate Cortex/Precuneus | R/L | 31 | -1 | -31 | 38 | 8.16 | 0.159 | 33 |
| Posterior Cingulate Cortex | R/L | 23 | -1 | -28 | 26 | 9.36 | 0.179 | 36 |

Note: a According to the Talairach Daemon Atlas (<http://www.nitrc.org/projects/tal-daemon/>), b Based on
the Tournoux & Talairach standard, BA = Brodmann’s Area

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| **Table S5. Demographic Information and Clinical Variables with Three Profiles (N=266)** |
|  | HC (N=125) | SU/RB (N=55) | ADHD (N=86) | F/chi-square |
| Age (SD) | 15.8 (1.66) | 16.7 (0.93) | 16.0 (1.38) | 8.121 |
| % Male | 56.0% | 60.0% | 60.5% | 0.50 |
| IQ | 105.9 (13.30) | 97.6 (9.85) | 99.5 (11.61) | 11.742 |
| AUDIT Consumption | 0.2 (0.75) | 4.5 (3.19) | 1.3 (2.17) | 85.303 |
| AUDIT Problems  | 0.1 (0.64) | 3.2 (3.33) | 0.5 (1.44) | 58.193 |
| AUDIT Dependence  | 0.0 (0) | 2.2 (3.15) | 0.2 (0.58) | 43.833 |
| CUDIT Consumption  | 0.1 (0.44) | 6.1 (1.25) | 1.5 (2.04) | 380.443 |
| CUDIT Problems  | 0.0 (0.09) | 3.5 (2.25) | 0.2 (0.69) | 205.253 |
| CUDIT Dependence  | 0.0 (0.16) | 5.2 (2.12) | 0.4 (0.95) | 418.183 |
| CUDIT Psych Features | 0.3 (0.96) | 4.7 (2.31) | 1.4 (2.04) | 125.203 |
| AUDIT Total | 0.4 (1.30) | 9.9 (8.54) | 1.9 (3.70) | 83.973 |
| CUDIT Total | 0.4 (1.38) | 19.5 (5.48) | 3.5 (4.41) | 512.133 |
| CBCL Aggression | 52.2 (4.45) | 68.7 (10.79) | 71.1 (11.08) | 147.344 |
| CBCL Rule Breaking | 53.1 (5.07) | 76.8 (9.10) | 73.7 (7.25) | 346.433 |
| CBCL Attention Prob | 52.6 (7.21) | 65.3 (10.06) | 68.31 (8.51) | 103.824 |
| CBCL Externalizing  | 44.7 (10.53) | 72.7 (7.98) | 72.4 (7.67) | 303.944 |
| CTQ EA | 6.4 (2.24) | 9.8 (4.80) | 11.0 (5.24) | 35.644 |
| CTQ PA | 5.67 (1.78) | 7.5 (3.69) | 8.3 (4.07) | 18.874 |
| CTQ SA | 5.1 (0.81) | 7.0 (5.13) | 8.6 (6.44) | 16.234 |
| CTQ EN | 6.7 (2.76) | 9.8 (4.60) | 11.1 (5.15) | 32.654 |
| CTQ PN | 5.7 (1.43) | 7.5 (3.60) | 8.1 (3.47) | 20.464 |
| CTQ Total | 29.4 (6.32) | 41.6 (16.15) | 46.6 (16.95) | 46.584 |
| % ADHD | 17.6% | 63.6% | 72.1% | 71.214 |
| % CD | 4.0% | 74.5% | 68.6% | 124.704 |
| % GAD | 8.0% | 36.3% | 32.6% | 26.644 |
| % MDD | 5.6% | 18.2% | 19.8% | 10.994 |
| % PTSD | 0.8% | 14.5% | 24.4% | 29.144 |
| *N=*266, \* indicates significant differences at *p*<.05. HC=Healthy Controls, SU/RB=Substance Use/Rule-Breaking. Superscript numbers indicate specific significance patterns among groups: 1 SU/RB > ADHD and HC, and ADHD=HC; 2HC>SU/RB, HC>ADHD, and SU/RB=ADHD; 3SU/RB>ADHD, SU/RB>HC, and ADHD>HC; 4SU/RB=ADHD, SU/RB>HC, and ADHD>HC. |

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| **Table S6. Brain regions demonstrating significant Profile-by-Feedback interactions with a three profile solution** |
| Coordinates of Peak Activationb |
| Regiona | Hemisphere | BA | x | y | z | *F* | Partial η2 | Voxels |
| Profile-by-Feedback |
| Dorsolateral Prefrontal Cortex | L | 10 | -31 | 50 | 20 | 14.63 | 0.147 | 76 |
| Dorsolateral Prefrontal Cortex | L | 8 | -19 | 29 | 38 | 13.00 | 0.133 | 57 |
| Rostromedial Prefrontal Cortex | R/L | 9,10 | 2 | 59 | 26 | 12.51 | 0.128 | 18 |
| Dorsomedial Prefrontal Cortex | R/L | 8 | 5 | 20 | 44 | 12.50 | 0.128 | 32 |
| Posterior Cingulate Cortex/Precuneus | R/L | 31 | -4 | -31 | 38 | 18.23 | 0.177 | 347 |
| Precuneus | R/L | 7 | 2 | -70 | 41 | 10.22 | 0.107 | 27 |
| Posterior Cingulate Cortex | R | 39 | 5 | -43 | 8 | 11.41 | 0.118 | 20 |
| Postcentral Gyrus | R | 3,4 | 14 | -34 | 65 | 11.45 | 0.119 | 44 |
| Lingual Gyrus | R | 18 | 17 | -85 | -10 | 12.97 | 0.132 | 38 |
| Thalamus | R/L | - | 2 | -10 | 17 | 12.20 | 0.125 | 27 |
| Lingual Gyrus | L | 17 | -16 | -88 | -4 | 11.03 | 0.115 | 18 |

Note: a According to the Talairach Daemon Atlas (<http://www.nitrc.org/projects/tal-daemon/>), b Based on
the Tournoux & Talairach standard, BA = Brodmann’s Area

**Figure Titles and Legends**

**Figure S1. Latent Profile Analysis indicator measure scores in the Study 2 subsample (N=174).** HC is the Healthy Comparison Profile, SU/RB is the Substance Use/Rule-Breaking Profile, ADHD is the primarily ADHD Profile, and ELS is the primarily Early Life Stress Profile. Error bars represent Standard Error of the Mean.

**Figure S2. Passive Avoidance Task schematic.** Panel A represents a participant choosing to respond and receiving reward feedback, and panel B represents a participant choosing to respond and receiving punishment feedback. Panel C represents a participant choosing not to respond and receiving no feedback.