

Supporting Information

Supplemental Methods and Materials

Participants

Subjects were excluded for (1) history of head trauma with loss of consciousness (> 30 min) or other neurological disorders (including seizures); (2) abnormal vital signs at time of screening or history of major medical conditions, encompassing cardiovascular (including high blood pressure), endocrinological (including metabolic), oncological, or autoimmune diseases; (3) except for cocaine within the CUD, positive urine screens (using a urine panel, BiopsyTM, conducted on study day) for psychoactive drugs or their metabolites (cocaine, amphetamines/methamphetamines, phencyclidine, benzodiazepines, cannabis, opiates, barbiturates and inhalants); and (4) signs of current intoxication, as detected by a psychiatric interview and direct participant monitoring and observation throughout all testing procedures.

Diagnostic Interview

Subjects were administered the following diagnostic instruments during a comprehensive interview conducted by a licensed clinical psychologist: (A) Structured Clinical Interview for DSM-IV Axis I Disorders (First *et al.*, 1996); (B) Addiction Severity Index (McLellan *et al.*, 1992), a semi-structured interview that assesses history and severity of substance-related problems, as expressed in seven problem areas (i.e., medical, employment, legal, alcohol, other drug use, family-social functioning, and psychological status); (C) 18-item Cocaine Selective Severity Assessment Scale (Kampman *et al.*, 1998), measuring cocaine abstinence/withdrawal signs and symptoms (i.e., sleep impairment, anxiety, energy levels, craving, and depressive symptoms) 24 hours within time of interview; (D) 3-item Severity of Dependence Scale (Gossop

et al., 1992); and (E) 5-item Cocaine Craving Questionnaire (Tiffany *et al.*, 1993). As part of a full neuropsychological testing battery, subjects were also administered a measure of non-verbal intellectual functioning, the Matrix Reasoning scale of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999). Results from all measures are presented in Table 1.

Based on the extensive psychiatric interview, all CUD met DSM-IV criteria for current cocaine dependence. Two CUD also met criteria for current marijuana dependence. Current use or dependence on other drugs was denied and corroborated by urine tests in all subjects. In addition to cocaine, history of *past* drug use was identified in 34 CUD and 2 controls, and included alcohol abuse (N=17), alcohol dependence (N=6), marijuana abuse (N=12), marijuana dependence (N=9), or heroin dependence (N=2) (all under fully sustained remission). Further, history of *past* (remitted) psychiatric diagnoses (other than drug use disorders) was identified in 5 CUD [unipolar depression (N=1), adjustment disorder (N=1), post-traumatic stress disorder (N=2), and cocaine induced panic attacks (N=1)] and 1 control subject (pathological gambling).

Picture Stimuli

Normative valence ratings significantly differed between all categories of picture content: pleasant ($M = 7.51$, $SD = .46$) and neutral ($M = 5.20$, $SD = .47$; $t(58) = -19.1$, $p < .001$), unpleasant ($M = 2.26$, $SD = .63$) and neutral ($t(58) = 20.5$, $p < .001$), and pleasant and unpleasant ($t(58) = 36.8$, $p < .001$). Additionally, pleasant ($M = 5.71$, $SD = .90$) and unpleasant ($M = 6.05$, $SD = .60$) pictures were reliably higher on normative arousal ratings than neutral ($M = 2.82$, $SD = .48$) pictures ($t(58) = -15.5$, $p < .001$ and $t(58) = -22.9$, $p < .001$, respectively), but did not differ from each other ($t(58) = -1.7$, $p > .05$).

Supplemental Analyses and Results

Picture ratings

Analyses

The averaged valence and arousal rating scales were analyzed using two separate 4 (Picture Type: pleasant, unpleasant, neutral, cocaine-related) x 3 (Group: CUD+, CUD-, controls) mixed-model ANOVAs. Since ratings of liking and wanting cocaine were only meaningful in the CUD groups, two separate 4 (Picture Type: pleasant, unpleasant, neutral, cocaine-related) x 2 (Group: CUD+, CUD-) mixed-model ANOVAs were used in these analyses. Interaction effects for the non-normally distributed ratings were followed with Wilcoxon tests to assess within-group differences. Similar to the procedure used for the ERP data, ratings difference scores were created and used for testing between-groups differences via Mann-Whitney tests. Means and standard deviations for all rating scales are presented in Supporting Information Table S1.

Effects of Possible Covariates

To control for the effects of possible covariates, we conducted correlations between picture ratings with depression. For history of cigarette smoking, differences in the dependent variables were inspected with *t*-tests. If significantly associated with the dependent variables across all study subjects ($p < 0.05$), these variables were entered as covariates in the relevant ANOVA (Stevens, 1992).

Correlations

Correlations were conducted between ERPs and all picture rating scales (using raw scores; across all subjects and within each group separately). Since ratings were distributed non-normally, non-parametric Spearman correlations were used. All correlations were corrected for a family-wise error rate ($p < 0.01$).

Results

Valence. Main effects of Picture Type ($F(3,237)=207.76, p < 0.001$) and Group ($F(2,79)=19.43, p < 0.001$), and an interaction between Picture Type and Group ($F(6,237)=19.22, p < 0.001$) were all significant. Within-group comparisons showed higher pleasant > cocaine > neutral > unpleasant ratings for CUD+ (all significant $Zs > |2.23|, ps < 0.03$), for CUD- the rating pattern was pleasant > neutral = cocaine > unpleasant (all significant $Zs > |3.50|, ps < 0.001$), and for controls it was pleasant > neutral > unpleasant = cocaine (all significant $Zs > |4.39|, ps < 0.001$).

In examining valence difference scores, between-group analyses revealed differences in ratings of cocaine (CUD+ > CUD- > Controls; all significant $Zs > |2.67|, ps < 0.01$) and pleasant pictures (CUD+ > CUD-, Controls = CUD+ and CUD-; $Z = -2.05, p < 0.05$). Valence ratings for unpleasant pictures did not differ between groups (all $Zs < |1.41|, ps > 0.15$). Hence, for all groups, pleasant pictures were rated as most pleasant. Further, both CUD groups rated cocaine pictures as more pleasant than unpleasant pictures, but controls rated cocaine and unpleasant picture valence equally. Finally, CUD+ rated both cocaine and pleasant pictures as more pleasant than CUD-.

Arousal. For arousal ratings, results revealed significant main effects of Picture Type ($F(3,237)=15.46, p < 0.001$) and Group ($F(2,79)=7.76, p < 0.005$), qualified by a significant

interaction between Picture Type and Group ($F(6,237)=5.07, p<0.001$). This interaction was driven by different patterns of arousal ratings within each group: for CUD+ it was pleasant=cocaine>neutral=unpleasant (all significant $Zs>|2.89|, ps<0.005$), for CUD- it was pleasant>unpleasant=neutral, cocaine=all picture types (all significant $Zs>|2.39|, ps<.02$), and for controls it was pleasant>neutral=cocaine, unpleasant=pleasant>cocaine (all significant $Zs>|3.49|, ps<0.001$). Examination of arousal difference scores revealed differences in cocaine pictures (CUD+=CUD->Controls; all significant $Zs>|2.42|, ps<0.015$). Therefore, CUD+ rated cocaine and pleasant pictures highest and indistinguishable on arousal, whereas controls rated cocaine pictures as less arousing than both pleasant and unpleasant pictures. Also, CUD+ and CUD- found cocaine pictures more arousing than controls.

Like and Want Cocaine. For like and want cocaine ratings, there were significant main effects of Picture Type ($F(3,159)=56.48, p<0.001$ and $F(3,159)=62.49, p<0.001$, respectively) and Group ($F(1,53)=7.43, p<0.01$ and $F(1,53)=11.12, p<0.005$, respectively), qualified by significant interactions between Picture Type and Group ($F(3,159)=9.76, p<0.001$ and $F(3,159)=7.30, p<0.001$, respectively). Within each group, the pattern of results was very similar across both like and want cocaine ratings: for CUD+, cocaine>pleasant>neutral>unpleasant (all significant $Zs>|3.01|, ps<0.005$), and for CUD- it was cocaine>pleasant>neutral=unpleasant (all significant $Zs>|2.12|, ps<0.04$). Examination of difference scores revealed group differences in like and want cocaine ratings to cocaine pictures (CUD+>CUD-; all significant $Zs>|2.34|, ps<0.05$) and unpleasant pictures (CUD+<CUD-; all significant $Zs>|2.25|, ps<0.05$). Hence, within both CUD groups, cocaine pictures elicited the strongest reports of liking and wanting cocaine. In addition, CUD+ compared to CUD- had

stronger ratings of liking and wanting of cocaine in response to cocaine pictures, but weaker ratings in response to unpleasant pictures.

Control for depression and cigarette smoking

Depression correlated with arousal, like cocaine, and want cocaine rating scales (all significant $r_s > |.23|$, $ps < 0.05$). Entering depression as a covariate in these ANOVAs revealed that all originally significant effects were maintained for these rating scales [(Picture Type (all $F_s > 9.60$, $ps < 0.001$); Group (all $F_s > 7.29$, $p < 0.01$); interaction (all $F_s > 4.99$, $p < 0.001$)]. In regard to smoking history, smokers provided higher valence, arousal, and like and want cocaine ratings than non-smokers for pleasant and cocaine pictures (all significant $t_s > |2.14|$, $ps < 0.05$). After entering smoking history as a covariate in the four rating scale ANOVAs, all originally significant effects were maintained [Picture Type (all $F_s > 4.22$, $ps < 0.01$); Group (all $F_s > 4.00$, $ps < 0.05$); interaction (all $F_s > 2.95$, $ps < 0.05$)].

Discussion of findings

The overall pattern of LPP and arousal ratings across picture types in the control group were in line with previous work: only pleasant and unpleasant pictures elicited increased LPPs—these were also the pictures rated as more arousing. Yet, several dissociations between LPPs and self-report ratings are of mention. For instance, there were no significant correlations between LPPs and arousal ratings. It is possible that the psychophysiological and self-report measures assess unique information (Tomarken, 1995)—the LPP may index neurobiological processes that only map broadly to self-reports or processes not readily accessible to self-report in the present study. Further, despite decreased LPPs to pleasant (both windows as compared to controls) and cocaine pictures (late window as compared to neutral pictures), CUD+ compared to the other

groups rated pleasant pictures highest in arousal and valence; they also rated cocaine images highest in valence, arousal, and liking and wanting of cocaine. Thus, the largest dissociation between LPP and self-report data was evident in CUD+, consistent with a recent report suggesting that this subgroup displays the most severe behavioral insight deficits (Moeller *et al.*, 2010), and with a general poor interoceptive sensitivity in drug addiction as reviewed elsewhere (Goldstein *et al.*, 2009).

Exploratory Analyses

Results from a males-only sample

EPN

The EPN varied as a function of Picture Type ($F(3,225) = 11.80, p < .001$), but no interaction emerged between Picture Type and Group ($F(6, 225) = 1.45, p > .15$). In addition, groups did not differ overall ($F(2,75) = .59, p > .55$). The main effect of picture type was further examined by collapsing EPN amplitudes across all groups; paired samples *t*-tests revealed the following pattern: unpleasant = cocaine = pleasant > neutral (all significant *ts* > |3.60|, *ps* < .001). Hence, all affective compared to neutral pictures elicited relative larger EPNs across all study groups.

LPP (400-1000 ms)

In the early window (400-1000 ms), the LPP varied as a function of Picture Type ($F(3,225) = 27.55, p < .001$) and was qualified by a significant interaction between Picture Type and Group ($F(6, 225) = 3.72, p < .005$). Groups did not differ overall ($F(2,75) = .03, p > .95$).

Inspecting the interaction using paired samples *t*-tests within each group separately revealed the following results: in both the CUD+ and CUD- groups, LPPs elicited by cocaine-related pictures were significantly larger than neutral picture LPPs (CUD+: $t(26) = -3.13, p < .005$; CUD-: $t(25) = -4.94, p < .001$), but did not differ from either pleasant (CUD+: $t(26) = -.87, p > .35$; CUD-: $t(25) = 1.31, p > .20$) or unpleasant (CUD+: $t(26) = -.76, p > .45$; CUD-: $t(25) = -.76, p > .45$) LPPs. Furthermore, pleasant and unpleasant pictures elicited LPPs that were significantly larger than the LPPs elicited by neutral pictures ($t(26) = 3.65, p < .001$ and $t(26) = 3.98, p < .001$ respectively for CUD+, and $t(25) = 6.40, p < .001$ and $t(25) = 4.71, p < .001$ respectively for CUD-), but did not differ from each other ($t(26) = -.35, p > .70$ in CUD+ and $t(25) = 2.05, p > .05$ in CUD-). In control subjects, however, cocaine-related pictures elicited LPPs that were comparable in magnitude to neutral pictures ($t(24) = -1.50, p > .10$), and were also significantly smaller than both pleasant ($t(24) = 5.46, p < .001$) and unpleasant ($t(24) = 3.83, p < .001$) pictures. As typical in previous research, pleasant and unpleasant pictures elicited larger LPPs than neutral pictures ($t(24) = 5.57, p < .001$ and $t(24) = 5.47, p < .001$, respectively), but did not differ from each other ($t(24) = .92, p > .35$).

In examining LPP difference scores, between-group analyses for each picture category revealed that CUD- had larger cocaine LPPs than controls (all significant $t = 2.38, p < .05$), CUD- and controls had larger pleasant LPPs than CUD+ (all significant $ts > |2.23|, ps < .05$), and there were no group differences for the unpleasant LPPs (all $ts < |1.38|, ps > .15$). Thus, in the early LPP window (400-1000 ms), results are similar to the original findings with the exception that CUD+ no longer differ from controls in magnitude of cocaine LPPs.

LPP (1000-2000 ms)

In the 1000-2000 ms window, the LPP again varied as a function of Picture Type ($F(3,225) = 10.00, p < .001$) and was qualified by a significant interaction between Picture Type and Group ($F(6, 225) = 4.64, p < .001$). As in the early LPP window, a main effect of group was not significant ($F(2,75) = .12, p > .85$). Inspecting the interaction further using paired samples t -tests within each group separately revealed the following results. In CUD+, no statistically significant differences emerged between LPPs (all t s $< |1.81|, p$ s $> .05$). In CUD-, however, the LPP elicited by cocaine-related pictures was significantly larger than neutral ($t(25) = -4.60, p < .001$) and unpleasant pictures ($t(25) = -2.34, p < .05$), but did not differ from pleasant pictures ($t(25) = -.55, p > .50$). Furthermore, pleasant and unpleasant pictures elicited LPPs that were significantly larger than the LPPs elicited by neutral pictures ($t(25) = 3.90, p < .001$ and $t(25) = 2.53, p < .05$ respectively). In control subjects, the pattern of results was identical to the early LPP window (all significant t s $> |3.36|, p$ s $< .005$).

In comparing difference scores across groups, results were similar to the earlier LPP window, except that in this later window, enhanced processing of the cocaine pictures was only discernible in the CUD- group (CUD- $>$ Controls, $t(49) = 2.35, p < .05$; CUD+ = Controls, $t(50) = .93, p > .35$; CUD- = CUD+, $t(51) = -1.55, p > .10$). In the later window, CUD+ displayed decreased processing of *both* pleasant (CUD+ $<$ Controls and CUD-, $t(51) = -2.40, p < .05$) and unpleasant (CUD+ $<$ Controls, $t(50) = -2.44, p < .05$) pictures. Again, in the late LPP window (1000-2000 ms), results were similar to the original findings with the exception that CUD+ had decreased processing of pleasant pictures compared to controls and now CUD- as well.

Picture Ratings

Valence. There were significant main effects of Picture Type ($F(3,219) = 184.47, p < .001$) and Group ($F(2,73) = 15.40, p < .001$), qualified by a significant interaction between Picture Type and Group ($F(6,219) = 16.40, p < .001$). Within-group comparisons showed higher pleasant > cocaine > neutral > unpleasant ratings for CUD+ (all significant $Zs > |2.20|, ps < .03$), for CUD- the rating pattern was pleasant > neutral = cocaine > unpleasant (all significant $Zs > |3.59|, ps < .001$), and for controls it was pleasant > neutral > unpleasant = cocaine (all significant $Zs > |4.01|, ps < .001$).

In examining valence difference scores, between-group analyses revealed differences in ratings of cocaine pictures (CUD+ > CUD- > Controls; all significant $Zs > |2.50|, ps < .05$) and pleasant pictures (CUD+ > CUD-, Controls = CUD+ and CUD-; $Z = -2.00, p < .05$). Valence ratings for unpleasant pictures did not differ between groups (all $Zs < |1.70|, ps > .05$). Hence, the pattern for valence ratings remained identical to the original findings.

Arousal. For arousal ratings, results revealed significant main effects of Picture Type ($F(3,219) = 14.90, p < .001$) and Group ($F(2,73) = 5.71, p < .01$), qualified by a significant interaction between Picture Type and Group ($F(6,219) = 4.83, p < .001$). This interaction was driven by different patterns of arousal ratings within each group: for CUD+ it was pleasant = cocaine > neutral = unpleasant (all significant $Zs > |2.71|, ps < .01$), for CUD- it was pleasant > unpleasant = neutral, cocaine > neut, but equal to pleasant and unpleasant (all significant $Zs > |2.18|, ps < .03$), and for controls it was pleasant > neutral = cocaine, unpleasant = pleasant > cocaine (all significant $Zs > |3.28|, ps < .001$). Similar to valence ratings, examination of difference scores in arousal ratings revealed differences in cocaine pictures (CUD+ = CUD- > Controls; all significant $Zs > |2.40|, ps < .02$). Therefore, results remain similar to original

analyses with the exception that in CUD-, cocaine pictures were rated as more arousing than neutral, but equivalent to pleasant and unpleasant pictures.

Like and Want Cocaine. For like and want cocaine ratings, there were significant main effects of Picture Type ($F(3,153) = 55.88, p < .001$ and $F(3,153) = 62.34, p < .001$, respectively) and Group ($F(1,51) = 6.18, p < .05$ and $F(1,51) = 9.45, p < .005$, respectively), qualified by significant interactions between Picture Type and Group ($F(3,153) = 9.24, p < .001$ and $F(3,153) = 6.88, p < .001$, respectively). Within each group, the pattern of results was very similar across both like and want cocaine ratings: for CUD+, cocaine > pleasant > neutral > unpleasant (all significant $Z_s > |3.18|, p_s < .005$), and for CUD- it was cocaine > pleasant > neutral = unpleasant (all significant $Z_s > |2.19|, p_s < .04$). Examination of difference scores revealed group differences in like and want cocaine ratings to cocaine pictures (CUD+ > CUD-; all significant $Z_s > |2.23|, p_s < .05$) and unpleasant pictures (CUD+ < CUD-; all significant $Z_s > |2.00|, p_s < .05$). Therefore, all original like and want cocaine results remained the same.

Correlations

The more money spent per each cocaine use in the last 30 days, the larger (more positive) the cocaine-related LPPs in the late window ($r_s = .682, p < .001$) for CUD+. This was still the only correlation reaching family-wise correction level after removing females from the sample.

Control for depression, cigarette smoking, and age as covariates

LPPs. There were no significant correlations between the LPPs and depression scores (all $r_s < |.28|, p_s > .15$) or age (all $r_s < |.33|, p_s > .05$) in either time window. Further, smoking did not cause differences in LPPs. Hence, it is unlikely that between-groups differences on

depression, age, or smoking could have accounted for the differential LPP patterns reported in the current study.

Ratings. Depression did not correlate with any rating scales (all $r_s < |.36|$, $ps > .05$); however, age correlated with valence and arousal ratings (all significant $r_s > |.45|$, $ps < .05$). Entering age as a covariate in these ANOVAs revealed that all originally significant effects were maintained for arousal ratings (Picture Type ($F(3,216) = 5.13$, $p < .005$); Group ($F(2,72) = 3.97$, $p < .05$); interaction ($F(6,216) = 4.53$, $p < .001$), but the main effect of Picture Type was attenuated in valence ratings ($F(3,216) = 2.32$, $p < .08$); Group ($F(2,72) = 11.88$, $p < .001$) and interaction ($F(6,216) = 13.36$, $p < .001$) effects remained significant. In regard to smoking history, smokers provided higher valence, arousal, and want cocaine ratings than non-smokers for pleasant and cocaine pictures (all significant $t_s > |2.38|$, $ps < .05$). After entering smoking history as a covariate in the three rating scale ANOVAs, all originally significant effects were maintained for valence and want cocaine [Picture Type (all $F_s > 10.07$, $ps < .001$); Group (all $F_s > 8.93$, $ps < .001$); interaction (all $F_s > 12.15$, $ps < .001$)]. For arousal, the main effect of Group was slightly attenuated ($F(2,72) = 2.96$, $p < .06$), but Picture Type ($F(3,216) = 4.61$, $p < .005$) and interaction ($F(6,216) = 2.71$, $p < .05$) remained significant.

Results from collapsing CUD+ and CUD- into one group

EPN

The EPN varied as a function of Picture Type ($F(3,246) = 13.44$, $p < .001$), but no interaction emerged between Picture Type and Group ($F(3,246) = .79$, $p > .50$). In addition, groups did not differ overall ($F(1,82) = .01$, $p > .90$). The main effect of picture type was further

examined by collapsing EPN amplitudes across all groups; paired samples *t*-tests revealed the following pattern: cocaine = unpleasant = pleasant > neutral (all significant *ts* > |4.15|, *ps* < .001). Hence, all affective compared to neutral pictures elicited relative larger EPNs across both study groups.

LPP (400-1000 ms)

In the early LPP window (400-1000 ms), the LPP varied as a function of Picture Type ($F(3,246) = 26.38, p < .001$) and was qualified by a significant interaction between Picture Type and Group ($F(3,246) = 8.05, p < .001$). Groups did not differ overall ($F(1,82) = .57, p > .45$). Inspecting the interaction using paired samples *t*-tests within each group separately revealed the following results: in CUD, LPPs elicited by cocaine-related pictures were significantly larger than neutral picture LPPs ($t(54) = -5.63, p < .001$), but did not differ from either pleasant ($t(54) = -.29, p > .75$) or unpleasant ($t(54) = -1.13, p > .25$) LPPs. Furthermore, pleasant and unpleasant pictures elicited LPPs that were significantly larger than the LPPs elicited by neutral pictures ($t(54) = 6.93, p < .001$ and $t(54) = 5.78, p < .001$, respectively), but did not differ from each other ($t(54) = .91, p > .35$). In control subjects, however, cocaine-related pictures elicited LPPs that were comparable in magnitude to neutral pictures ($t(28) = -.79, p > .40$), and were also significantly smaller than both pleasant ($t(28) = 6.23, p < .001$) and unpleasant ($t(28) = 4.62, p < .001$) pictures. As typical in previous research, pleasant and unpleasant pictures elicited larger LPPs than neutral pictures ($t(28) = 6.17, p < .001$ and $t(28) = 5.80, p < .001$, respectively), but did not differ from each other ($t(28) = 1.22, p > .20$). In examining LPP difference scores, between-group analyses for each picture category revealed that CUD had larger cocaine LPPs than controls ($t(82) = 2.99, p < .005$), and there were no group differences for the pleasant or unpleasant LPPs (all *ts* < |1.40|, *ps* > .16).

Thus, in the early window (400-1000 ms), the magnitude of LPPs elicited by cocaine, pleasant, and unpleasant pictures was each significantly larger than the LPPs elicited by neutral pictures for CUD; further, for CUD, the cocaine picture LPPs did not differ from the LPPs elicited by the other emotional pictures. In controls by contrast, LPPs elicited by cocaine and neutral pictures were comparable in magnitude and both significantly smaller than LPPs elicited by the pleasant and unpleasant pictures. Compared to controls, CUD exhibited increased response to cocaine pictures, but did not differ in response to pleasant or unpleasant LPPs.

LPP (1000-2000 ms)

In the 1000-2000 ms window, the LPP again varied as a function of Picture Type ($F(3,246) = 12.56, p < .001$) and was qualified by a significant interaction between Picture Type and Group ($F(3,246) = 11.77, p < .001$). As in the early LPP window, a main effect of group was not significant ($F(2,81) = .29, p > .55$). Inspecting the interaction further using paired samples *t*-tests within each group separately revealed the following results. In CUD, the LPP elicited by cocaine-related pictures was significantly larger than neutral ($t(54) = -4.37, p < .001$) and unpleasant pictures ($t(54) = -2.52, p < .05$), but did not differ from pleasant pictures ($t(54) = -1.54, p > .10$). Furthermore, pleasant and unpleasant pictures elicited LPPs that were significantly larger than the LPPs elicited by neutral pictures ($t(54) = 3.52, p < .001$ and $t(54) = 2.62, p < .05$ respectively) and did not differ from each other. In control subjects, the pattern of results was identical to the early LPP window (all significant *ts* $> |4.15|, ps < .001$). Examining LPP difference scores revealed that CUD compared to controls had larger cocaine LPPs ($t(82) = 2.68, p < .01$), but smaller unpleasant LPPs ($t(82) = -2.48, p < .05$).

In the late LPP window (1000-2000 ms), CUD maintained enhanced processing of cocaine compared to unpleasant and neutral pictures. Both CUD and controls also continued to show an increased LPP in response to both pleasant and unpleasant compared to neutral pictures.

Picture Ratings

Valence. There were significant main effects of Picture Type ($F(3,240) = 170.77, p < .001$) and Group ($F(1,80) = 25.53, p < .001$), qualified by a significant interaction between Picture Type and Group ($F(3,240) = 25.52, p < .001$). Within-group comparisons showed for CUD the rating pattern was pleasant > neutral = cocaine > unpleasant (all significant $Zs > |4.46|, ps < .001$), and for controls it was pleasant > neutral > unpleasant = cocaine (all significant $Zs > |4.39|, ps < .001$). In examining valence difference scores, CUD rated cocaine pictures as more pleasant than controls ($Z = -.505, p < .001$).

Arousal. For arousal ratings, results revealed significant main effects of Picture Type ($F(3,240) = 12.48, p < .001$) and Group ($F(1,80) = 10.32, p < .005$), qualified by a significant interaction between Picture Type and Group ($F(3,240) = 8.38, p < .001$). This interaction was driven by different patterns of arousal ratings within each group: for CUD it was pleasant = cocaine > neutral = unpleasant (all significant $Zs > |3.53|, ps < .001$), and for controls it was pleasant > neutral = cocaine, unpleasant = pleasant > cocaine (all significant $Zs > |3.49|, ps < .001$). Similar to valence ratings, examination of difference scores in arousal ratings revealed that CUD rated cocaine pictures as more arousing than controls ($Z = -3.36, p < .001$).

Like and Want Cocaine. For like and want cocaine ratings, there were significant main effects of Picture Type ($F(3,162) = 49.33, p < .001$ and $F(3,162) = 56.65, p < .001$, respectively). Within CUD, the pattern of results was very similar across both like and want cocaine ratings:

cocaine > pleasant > neutral > unpleasant (all significant $Zs > |2.76|$, $ps < .01$). Hence, cocaine pictures elicited the strongest reports of liking and wanting cocaine.

Correlations with Days Since Last Cocaine Usage

No correlations emerged between LPP amplitudes and abstinence length or days since last cocaine use (all $r_s < |.19|$, $ps > .20$). Correlations with ratings, however, revealed that longer abstinence length was associated with less liking and wanting of cocaine in response to pleasant, neutral, and cocaine pictures in the CUD (all significant $r_s > |.35|$, $ps < .01$). Also, the longer the abstinence, the less pleasant and arousing CUD rated cocaine pictures (all significant $r_s > |.44|$, $ps < .001$).

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Table S1

Averaged Self-reported Ratings of All Picture Types

	CUD+	CUD-	Controls
Pleasant Picture Valence	2.26 (.93)	2.88 (1.41)	2.92 (1.09)
Pleasant Picture Arousal	3.55 (2.05)	4.28 (1.90)	4.70 (1.97)
Pleasant Picture Like Cocaine	5.57 (2.04)	7.11 (2.00)	8.50 (1.11)
Pleasant Picture Want Cocaine	5.96 (2.14)	7.67 (1.63)	8.56 (1.63)
Unpleasant Picture Valence	7.90 (1.12)	7.55 (1.09)	7.77 (1.15)
Unpleasant Picture Arousal	6.12 (2.58)	5.99 (2.04)	5.71 (2.15)
Unpleasant Picture Like Cocaine	7.44 (1.88)	7.58 (2.02)	8.57 (0.99)
Unpleasant Picture Want Cocaine	7.58 (1.91)	8.06 (1.75)	8.55 (1.61)
Neutral Picture Valence	4.46 (1.05)	4.57 (1.38)	4.63 (1.40)
Neutral Picture Arousal	5.70 (1.85)	6.28 (2.16)	6.33 (2.11)
Neutral Picture Like Cocaine	6.52 (2.01)	7.54 (2.04)	8.46 (1.22)
Neutral Picture Want Cocaine	6.87 (2.08)	8.05 (1.65)	8.56 (1.59)
Cocaine Picture Valence	3.30 (1.76)	5.54 (2.30)	7.88 (1.46)
Cocaine Picture Arousal	3.62 (2.16)	5.21 (2.15)	7.25 (2.00)
Cocaine Picture Like Cocaine	3.41 (2.02)	5.99 (2.56)	8.67 (0.91)
Cocaine Picture Want Cocaine	3.52 (2.02)	6.15 (2.54)	8.68 (1.43)

Note. Mean (standard deviation). Low numerical ratings correspond to higher levels of pleasantness, arousal, and liking and wanting of cocaine.

Figures

Figure S1. Scatterplot of the correlation between cocaine-related LPPs (late window) and money spent per each cocaine use in the past 30 days (US dollars) in CUD+ ($N=22$) and CUD- ($N=13$) groups. Spearman correlation coefficients are presented.

