**Online Supplementary Material**

**Changes in cocaine consumption are associated with fluctuations in self-reported impulsivity and gambling decision-making**

Lea M. Hulka1\*, Matthias Vonmoos1\*, Katrin H. Preller1, Markus R. Baumgartner2, Erich Seifritz3,4, Alex Gamma5, Boris B. Quednow1,4

*1Experimental and Clinical Pharmacopsychology, Department of Psychiatry, Psychotherapy, and Psychosomatics, Psychiatric Hospital, University of Zurich, Switzerland*

*2Center of Forensic Hairanalytics, Institute of Forensic Medicine, University of Zurich, Switzerland*

*3Director of the Department of Psychiatry, Psychotherapy, and Psychosomatics, Psychiatric Hospital, University of Zurich, Switzerland*

*4Neuroscience Center Zurich, University of Zurich and Swiss Federal Institute of Technology Zurich, Switzerland*

*5Division of ADHD Research, Department of Psychiatry, Psychotherapy, and Psychosomatics, Psychiatric Hospital, University of Zurich, Switzerland*

**\*L. M. Hulka and M. Vonmoos share first authorship and are both corresponding authors:**

Lea M. Hulka, PhD Matthias Vonmoos, PhD, MA

Experimental and Clinical Pharmacopsychology Experimental and Clinical Pharmacopsychology

Psychiatric Hospital of the University of Zurich Psychiatric Hospital of the University of Zurich

Lenggstrasse 31 Lenggstrasse 31

CH-8032 Zurich, Switzerland CH-8032 Zurich, Switzerland

Tel.: 0041-44-205-5835 Tel.: 0041-44-384-2666

Fax: 0041-44-205-5802 Fax: 0041-44-384-3396

E-Mail: lea.hulka@bli.uzh.ch E-Mail: matthias.vonmoos@bli.uzh.ch

**Method S1**

*Participant recruitment:* Participants were recruited in the greater area of Zurich from January 2010 until March 2013. Study participants were recruited via advertisements in local newspapers, online media, drug prevention and treatment centers, psychiatric hospitals, and by word of mouth. Eight-hundred-and-four prospective participants underwent a standardized telephone interview, whereof 240 subjects were tested in the cross-sectional study. Six participants were not re-invited to participate in the follow-up study (refusal of study participation, psychiatric disorders or first-grade family member with schizophrenia). The remaining 234 participants (138 cocaine users, 96 healthy psychostimulant-naive controls [HC]) (Hulka *et al.* 2014; Preller *et al.* 2014; Vonmoos *et al.* 2014) were contacted and invited for a follow-up test session twelve months after baseline testing. One-hundred-and-two participants (59 cocaine users, 43 controls) were not available for the follow-up study due to different reasons (no response, losing interest, time reasons, death). One-hundred-and-thirty-two participants (79 CU [57.3% of baseline], 53 HC [55.2%]) participated in the 1-year-follow-up. Twenty-seven of these subjects (22 cocaine users, 5 controls) had to be excluded from the final analyses due to hair analyses revealing illegal drug use not allowed by our exclusion criteria (e.g., opioids or excessive MDMA intake) or due to starting use of psychotropic medication (e.g., antipsychotics or antidepressants), leaving a final sample of 57 CU and 48 matched HC.

**Method S2**

*Rapid Visual Processing Task (RVP):* The RVP is a visual continuous performance task from the Cambridge Neuropsychological Test Automated Battery (CANTAB; [www.cantab.com](http://www.cantab.com)) using predefined sequences of three digits presented at a rate of 100 per minute to assess sustained attention over a period of 4 min. In order to assess impulsive action, we assessed the response bias B’’ reflecting the tendency to respond regardless of the presence of a target and can therefore be interpreted as a measure for impulsive behavior (Nuechterlein *et al.* 2008).

*Iowa Gambling Task (IGT):* The IGT assesses the ability to choose between favorable card decks yielding lower gains but also a lower risk for losses eventually resulting in long-term benefit and unfavorable card decks resulting in higher gains but also higher losses leading to long-term loss. A computerized version of Grasman and Wagenmakers (University of Amsterdam, Netherlands) was used (http://purl.oclc.org/NET/rgrasman/jscript/IowaGamblingTask). Participants had to draw 100 cards from four different card decks, each containing 50 cards. The net score of good and bad cards drawn served as the dependent variable. At the end of the task, points were converted by the factor .002 and paid out in real money. All participants started out with 4000 points, with the maximum number of points that could be gained at 8000, equaling 16 CHF.

*Delay Discounting (DD):* In theDD, 27 choices between immediately available lower monetary rewards and higher rewards available with a temporal delay were presented. The discounting rate, how strongly larger but later available rewards are discounted, was calculated with the Formula *V=A/(1+ kD)(V* is the present value of the delayed reward *A* at delay *D*, and *k* is a free parameter that determines the discount rate) (Mazur 1987). A computerized version (implemented in Presentation®) of the DD paradigm according to Kirby et al. (1999) was used. The steepness of discounting of delayed rewards (expressed as *k total*; the larger the parameter *k*, the stronger the discounting of larger delayed rewards) was used as the dependent variable.

**Method S3**

*Linear multilevel models:* For any given dependent variable, to assess whether a random intercept was appropriate, we fitted a model without predictors and checked whether a) the standard deviation of the random intercept was significantly different from zero and b) whether the Intraclass Correlation Coefficient (ICC), which is the proportion of between-subjects variance, was significantly greater than zero. This was the case for all models. The appropriateness of a random slope was assessed for each level-1 predictor of each model separately, using one-tailed Likelihood-Ratio-Tests. In one case, a random slope was added. Finally, model fit, in particular linearity of the relation between outcome and predictors, was checked by residual vs fitted plots.

Because the number of parameters in multilevel models should be adjusted to the sample size (Tabachnik & Fidell 2006), we reduced the number of predictors using a strategy adopted from (Hosmer & Lemeshow 2000): to fit univariate models, predictors at p<.2 were included in a full model. Predictors at p>.1 were then eliminated step-by-step, starting with the least statistically significant one. It was ensured that when eliminating a predictor, coefficient estimates for the remaining predictors did not change by more than about 25%. Final models included only predictors at p<.10.

In predictors relevant only to CU such as level or duration of consumption, collinearity was to be expected with the grouping variable, since the HC always have zero-values, while CU have positive values. Therefore, all models were repeated in a dataset excluding HC to check for coefficient differences in cocaine-related predictors. In a few cases these coefficients were no longer statistically significant.

**Figure S1**

Figure S1: Distribution of IGT total ratio scores for each group at t1 and t2.

**References**

**Hosmer D, Lemeshow S** (2000). *Applied Logistic Regression*. Wiley-Interscience: New York.

**Hulka LM, Eisenegger C, Preller KH, Vonmoos M, Jenni D, Bendrick K, Baumgartner MR, Seifritz E, Quednow BB** (2014). Altered social and non-social decision-making in recreational and dependent cocaine users. *Psychological Medicine* **44**, 1015-28.

**Kirby KN, Petry NM, Bickel WK** (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology. General* **128**, 78-87.

**Mazur J** (1987). *An adjusting procedure for delayed reinforcement*. Erlbaum: New Jersey.

**Nuechterlein KH, Green MF, Kern RS, Baade LE, Barch DM, Cohen JD, Essock S, Fenton WS, Frese FJ, 3rd, Gold JM, Goldberg T, Heaton RK, Keefe RS, Kraemer H, Mesholam-Gately R, Seidman LJ, Stover E, Weinberger DR, Young AS, Zalcman S, Marder SR** (2008). The MATRICS Consensus Cognitive Battery, part 1: test selection, reliability, and validity. *American Journal of Psychiatry* **165**, 203-13.

**Preller KH, Hulka LM, Vonmoos M, Jenni D, Baumgartner MR, Seifritz E, Dziobek I, Quednow BB** (2014). Impaired emotional empathy and related social network deficits in cocaine users. *Addiction Biology* **19**, 452-66.

**Tabachnik B, Fidell L** (2006). *Using Multivariate Statistics*. Pearson Education: Boston.

**Vonmoos M, Hulka LM, Preller KH, Minder F, Baumgartner MR, Quednow BB** (2014). Cognitive Impairment in Cocaine Users is Drug-Induced but Partially Reversible: Evidence from a Longitudinal Study. *Neuropsychopharmacology* **39**, 2200-10.