

SUPPLEMENTAL MATERIAL**The role of social connection in opioid use disorder treatment engagement**

Emma M. Schweitzer^{1,2,3}, Adelya Urmanche³, Julia Kong^{2,3}, Sahar Hafezi^{2,3}, Joshua Zhao², Nina

A. Cooperman², Anna B. Konova^{1,2,3*}

¹Graduate Program in Neuroscience, Rutgers University–New Brunswick

²Department of Psychiatry, Rutgers University–New Brunswick

³University Behavioral Health Care & Brain Health Institute, Rutgers University–New Brunswick

***Correspondence:** Anna B. Konova PhD, Department of Psychiatry, University Behavioral

Health Care, & Brain Health Institute, Rutgers University—New Brunswick, 671 Hoes Lane

West, Piscataway, NJ 08855; e-mail: anna.konova@rutgers.edu

Supplemental Methods

Participant inclusion/exclusion criteria

Inclusion criteria for both individuals currently enrolled in a medications for opioid use disorder (MOUD) outpatient treatment program and $N=62$ healthy community controls without history of problematic substance use included: 1) ≥ 18 years of age, 2) ability to provide informed consent, and 3) ability to understand and complete study procedures. Participants were included in the MOUD group if they additionally 4) had a diagnosis of OUD (as determined by clinic staff), 5) had ≥ 12 -month history of opioid use, and 6) were currently participating in MOUD treatment at one of the three collaborating clinics. Exclusion criteria for both groups were: 1) active psychosis or mania; 2) current or past diagnosis of schizophrenia (self-reported or as obtained from patient charts); 3) history of intellectual disability or developmental or neurological disorder; 4) history of seizures or epilepsy; 5) history of loss-of-consciousness >30 minutes; and 6) severe medical conditions requiring hospitalization or that could compromise study participation (e.g., renal or liver failure, end-stage AIDS). Participants in the control group were further excluded if they had: 7) a positive urinalysis drug screen for substances (e.g., heroin/opioids, cocaine, THC) or their metabolites at any point during the study; 8) current or past problematic substance use other than nicotine and/or alcohol misuse confined to college or military service; and 9) a current or past bipolar disorder diagnosis (self-reported). Among others not relevant for this study, screening procedures included the Addiction Severity Index (ASI) (McLellan et al., 1980), which probed lifetime and recent use of different substances, a medical history checklist, urinalysis, and a battery of psychological questionnaires and cognitive tests.

Supplemental Results

Influence of sociodemographic variables

Participants receiving MOUD and healthy comparison controls were matched on age, sex, and ethnicity (see **Table 1** in the main text); however, more individuals in the MOUD group identified as Black/African American (and more in the control group as Asian), and demonstrated significantly lower levels of educational attainment, as well as significantly higher severity of depression and anxiety compared to the control group.

To inspect for potential confounds in between-group analyses, we examined the impact of these sociodemographic variables as well as participant sex on an exploratory basis.

Black/African American individuals reported higher perceived criticism, and those with lower income levels had lower social network indices and reported higher perceived criticism and lower social status (all $P < 0.024$), perhaps underscoring the sociopolitical climate of the U.S., where people of color and lower-income individuals are marginalized (IAF, 2022). We did not, however, observe any significant differences by sex (exploratory) or education (all $P > 0.07$). Including race and (separately) income as covariates in between-group comparisons, we found that group differences in perceived criticism remained when controlling for race ($P = 5.34 \times 10^{-05}$), suggesting separate contributions of race and M/OD status to this variable. Differences between MOUD and control groups also remained for perceived criticism and most social network indices when controlling for income ($P < 0.016$) but were reduced to nonsignificant for network embeddedness and subjective social status (all $0.05 < P < 0.085$).

Influence of COVID-19 and psychological distress

As data collection occurred pre- and post-COVID-19 restrictions, with $n=42$ participants receiving MOUD treatment and $n=30$ controls enrolled after lockdowns began in New Jersey and

$n=40$ and $n=32$, respectively, enrolled before lockdowns (**Figure S1**), we examined whether COVID-19 had any differential impact on social connection between groups in $2 \text{ (group)} \times 2 \text{ (time)}$ between-group ANOVAs. While social network embeddedness was lower after relative to before lockdowns (time main effect: $P<0.006$), we did not observe any significant interactions between time and group (interaction effect: $P>0.10$). By contrast, all aggregate-level group differences remained as reported in the main text (group main effect: $P<0.017$). A related concern is potentially increased psychological distress due to COVID-19 restrictions, but we found psychological distress (anxiety and depression symptoms) also did not significantly differ in participants enrolled pre- vs. post-COVID-19 or differentially by group (time main effect: $P>0.21$; interaction effect: $P>0.27$).

Nevertheless, because people receiving MOUD treatment had higher depression and anxiety symptoms overall (**Table 1**, as also observed above), we assessed whether they related to social connection, and could thus potentially confound between-group interpretations. Higher depression correlated with lower social network indices and higher perceived criticism, while higher depression *and* anxiety correlated with lower subjective social status ($P<0.016$). Between-group differences in social status remained after controlling for anxiety ($P=0.04$). Controlling for depression, we continued to observe significant group differences in social network quantity and perceived criticism ($P<0.016$), but not network diversity and embeddedness or social status, which became nonsignificant (all $0.05<P<0.095$).

Influence of MOUD medication type, treatment program, and treatment duration

Participants were drawn from three different outpatient treatment programs: two that primarily provided MOUD with suboxone/buprenorphine (one located in Newark, NJ: $n=41$ participants enrolled, all receiving suboxone/buprenorphine, and another located in New

Brunswick, NJ: $n=32$ participants enrolled, 75% receiving suboxone/buprenorphine) and one primarily providing MOUD with methadone (located in New Brunswick, NJ: $n=9$ participants enrolled, all receiving methadone). Therefore, we assessed whether the medication participants were receiving and/or the program they were enrolled in had any significant impact. It should be noted that given the distribution of medication types across programs, it is not possible to evaluate differences fully separated by program vs. by medication; therefore, here we focused only on medication effects.

Participants receiving methadone ($n=15$), relative to those receiving suboxone/buprenorphine ($n=65$; **Table 1**), had higher overall MOUD treatment engagement and lower opioid (re)use rates ($P<0.04$; naltrexone participants were excluded due to small N) but there were no differences in social measures ($P>0.35$). All of the main analyses with clinical outcome held in the subgroup receiving suboxone/buprenorphine but not those receiving methadone. For participants receiving methadone, there was no significant relationship between social network indices and group attendance, or between perceived criticism and opioid (re)use (all partial- $R/R_s<0.01$, $P>0.85$, controlling for length of follow-up). By contrast, for participants receiving suboxone/buprenorphine, these relationships remained (partial- $R/R_s>0.30$, $P<0.02$) and in all but one case, were significantly stronger than observed for methadone participants (Fisher's $Z>1.74$, $P<0.04$; for social network diversity and group attendance: $Z=1.42$, $P=0.078$). However, given the large sample imbalance in favor of buprenorphine/suboxone, these differences should be deemed preliminary.

Finally, we also assessed for modulation by length of MOUD treatment at the time of study enrollment, regardless of medication type or treatment program. Participants had been receiving MOUD treatment at the current program for 0.37-354.5 months (mean=21.8 mos.,

median=12 mos.; see **Table 1**). Treatment duration did not significantly correlate with social measures (all $P>0.11$), and it did not correlate with most clinical outcomes except for a significant positive relationship with opioid use rates (partial- $R_s=0.24$, $P=0.033$ controlling for length of follow-up; all others, $P>0.52$). When controlling for both length of treatment and length of follow-up, however, the relationship between social criticism and opioid re(use) rate remained (partial- $R=0.25$, $P=0.03$).

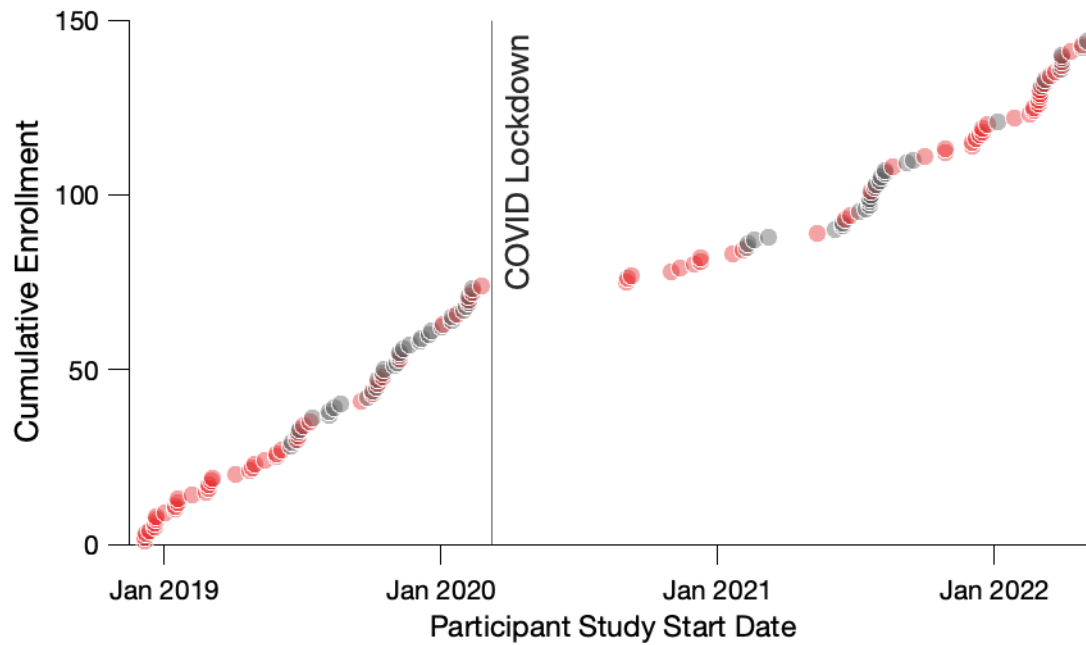
Supplemental Figures

Figure S1. Approximate enrollment dates for each study participant in chronological order across the study, from December 2018 to May 2022, with individuals receiving MOUD shown in red, and healthy community controls in gray.

Supplemental References

IAF. (2022). *Historically Marginalized Groups*. Inter-American Foundation.

<https://www.iaf.gov/what-we-do/publications/reports/cbj/historically-marginalized-groups/>

McLellan, A. T., Luborsky, L., Woody, G. E., & O'Brien, C. P. (1980). An improved diagnostic evaluation instrument for substance abuse patients. The Addiction Severity Index. *J Nerv Ment Dis*, 168(1), 26-33. <https://www.ncbi.nlm.nih.gov/pubmed/7351540>