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Transitions of Women's Substance Use Recovery Networks and 12-Month Sobriety Outcomes

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Abstract

Little is known about how the structure and composition of women's personal social networks (PSNs) combine to support recovery from substance use disorders, how PSNs change during early recovery, or how known covariates such as trauma, co-occurring mental health disorders, or treatment modality impact this relationship. This study used latent profile and transition analyses with 6 recovery-specific PSN indicators in a sample of women in early recovery ($N=377$) to identify three PSN typologies in relation to abstinence outcomes over 12 months, and track transitions between the typologies at 0–6 and 6–12 months. Women in the Highly Connected type (14.3%) had tightly-knit networks, more sober alters, and fewer treatment-related alters. Women in the Treatment-Related type (49.3%) had looser-knit networks with more sober and sobriety-supporting alters and alters they know from treatment. Women in the At-Risk type (36.3%) had more isolates, few sobriety-supporting alters, and more alters with whom they used. Women in the Treatment-Related Sobriety Support type were significantly more likely to maintain sobriety by 12 months ($B=-0.81$; $OR=2.09$, 95% CI [1.23–3.56]) than women in the At Risk type. Higher mean Trauma Symptom Checklist scores were positively related to membership in the At Risk type. The majority of women who transitioned did so by 6 months, with 41.6% transitioning then. Women in the At Risk group had the highest probability of transition ($P=0.55$). Being in residential treatment (versus outpatient) predicted lower odds of transitioning ($B=-0.81$, $p=.06$). This study provides a framework for conducting longitudinal latent variable analysis with social network data, and offers a clinically-useful starting point for research on individualized, targeted, and stage-based interventions for women in recovery.

Keywords

Social networks; network structure; substance use; trauma; women; latent transition analysis

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1. Introduction

The social aspects of recovery from substance use disorders (SUDs) are key targets for research and intervention (Lubben, Gironde, Sabbath, Kong, & Johnson, 2015; NIAAA, 2017; SAMHSA, 2015), but it can be difficult to disentangle the impacts of individual personal social network (PSN) characteristics on a person's ability to maintain abstinence during recovery. Methodologies that cluster PSN data into typologies can clarify this complexity and allow for more precise targeting of interventions in treatment (Lanza & Rhoades, 2013), which improves outcomes (SAMHSA, 2004). Latent profile analysis (LPA), accommodates the mix of count and continuous data frequently found in social network studies and theoretically assumes that an underlying latent variable determines a person's type of recovery network rather than simply making associations between data points (Collins & Lanza, 2010). This assumption aligns with theoretical models of recovery such as Recovery Capital, which posits that a latent construct, social recovery capital, influences the composition and structure of a person's recovery network (Cloud & Granfield, 2008).

Theoretically, the changes a person makes to their PSN increase or decrease their social recovery capital (Cloud & Granfield, 2008; A. B. Laudet & White, 2008), and these changes are tied to substance use outcomes (Tracy & Whittaker, 2015). The chronically relapsing nature of substance use disorders indicates that we may be able to identify how a person's PSN at treatment entry and their movement between different types of PSNs is related to ability to maintain abstinence during the first year of recovery. These shifts in recovery networks may also align with previously identified stages of recovery of 0–6 months (early remission) and 6–18 months (sustained remission; Laudet & White, 2010, 2008). Latent Transition Analysis (LTA) is the longitudinal extension of LPA, and can capture these changes in recovery networks over time.

Women are more influenced by the people in their networks (alters) during substance use or recovery than men (DeNavas-Walt & Proctor, 2015), and experience more traumatic events that impact their interactions with their networks (Ouimette & Read, 2014). Traumatic symptoms decrease ability to trust (Sun, 2007) and form close, recovery-supportive relationships (Min, Tracy & Park, 2014), and increase difficulty in managing interpersonal relationships (Cloitre, Miranda, Stovall-McClough, & Han, 2005) and cutting ties with substance-using network members (Sun, 2007). Women also tend to have relationships that simultaneously support and hinder recovery by, for example, a friend offering childcare so that the woman can use without endangering her children, but also so that she can attend recovery activities (Brown et al., 2015). Co-occurring mental health and substance use disorders are associated with less-supportive recovery networks for women. Women with co-occurring mental and substance use disorders can have more difficulty in accessing and using recovery supports (Biegel & Tracy, 2006) and experience less reciprocity within their relationships (Tracy & Johnson, 2007) than those who have only a substance use disorder. For example, compared to women in outpatient treatment, women in residential treatment have been found to have greater numbers of substance-using network members, fewer people providing support, and fewer people from treatment programs or peer-led recovery programs in their social networks (Kim et al. 2015; Min, et al, 2013). This may be related to

their having a greater severity of SUD than those in outpatient treatment (Harpaz-Rotem, Rosenheck, & Desai, 2011). It may be possible to disentangle the complexity of these factors using latent profile and transition analyses to identify typologies of recovery networks with trauma, co-occurring disorders, and treatment modality as covariates to determine how these factors interplay with recovery networks over time.

1.1 Latent Variable PSN Analysis

Typologies of PSNs in relation to various risk and resilience outcomes have been found in other populations using LCA or LPA, but there is no standard procedure in the literature for using this methodology to identify baseline typologies of PSNs for people in recovery from substance use disorders. Bohnert, German, Knowlton, and Latkin (2010) dichotomized count-type PSN data to identify five patterns of social support from PSNs in 1453 inner-city adults using LCA (Little/No Support, Low/Moderate Support, High Support, Socialization Support, and Financial Support). Those with little or no support from their PSN members were more likely to have used substances within the past 6 months and to have friends who also used. Buckman, Bates, and Cisler (2007) created dichotomized PSN variables representing patterns of alters' interactions with the participant, support for abstinence, and substance use and identified three typologies of support for abstinence among 1726 people using LCA (Frequent Positive, Limited Positive, and Negative); more abstinence support was related to more improvement in drinking outcomes. Hopfer, Tan, and Wylie (2014) dichotomized data of substance- and HIV-related social network interactions in LCA to identify four risk profiles in a sample of 600 inner-city youth and young adults (Low Risk, Solitary Use, Social—Non-injection, and Social—All Substances); those with higher risk of infection were more likely to use multiple substances with others in their PSN. Finally, one study (Reid, 2017) used LPA with percentages of alters with specific characteristics and network structure to identify three typologies of friendship networks among 144 male incarcerated youth related to their rate of misconduct during incarceration. While this study does not focus directly on substance use outcomes, it is of particular interest to this proposed study for its use of continuous variables and structural measures in relation to social network typologies. They found little difference in network size or density across these profiles, which the author attributed to the limitations imposed by the institutional setting and low sample size.

To this author's knowledge, only one study has used latent transition analysis to identify latent typologies of social networks and track how individuals transition between the classes over time. Bray, Smith, Piper, Roberts, and Baker's (2016) study identified five classes of social networks in 691 individuals enrolled in a smoking-cessation trial, and then assessed how the individuals moved between these network types in relation to their ability to maintain abstinence from nicotine over the course of three years. This study used categorical data to describe the social networks (small network vs. large network), the amount of smoking exposure (minimal, moderate, considerable) and the source of the smoking exposure (partner, smoking buddies, non-partner). The results of this study showed that level of exposure to smokers was inversely related to ability to abstain from smoking, but that maintaining abstinence was related to transitioning to a larger social network with less exposure to smokers.

These five studies show the utility of latent variable analysis with PSNs. Four of the studies categorized the PSN data, which makes the identification of latent typologies simpler (Collins & Lanza, 2010) but potentially misses clinically important relationships in the data. None incorporated trauma symptoms, co-occurring mental and substance use disorders, or treatment modality, which all affect the PSN and are therefore important considerations, or focused on women specifically. There is a need for studies that 1) focus on women with substance use disorders, 2) use continuous PSN data, 3) include covariates known to impact networks during recovery, and 4) examine transitions between network type over time.

1.2 Network member characteristics

Researchers have identified 6 aspects of PSNs that may impact recovery outcomes relevant to this study: Alter abstinence, use of substances with the alter, alter support of recovery, alter involvement with treatment, network density, and isolates.

Having more abstinent alters is related to significantly more abstinent days for the participant (Zywiak et al., 2002). For women, connection to alters with whom they used was related to more drinking days and higher levels of drinking (Manuel et al., 2007). Having abstinent alters in the network often goes hand-in-hand with having recovery-specific support, which can significantly improve a person's ability to maintain their sobriety during early recovery, and is related to fewer drinking days, and fewer drinks per drinking day during the first year of recovery (Manuel et al., 2007), and nearly half the odds of using cocaine by 12 months (Broome et al., 2002). Women who had recovery-supportive alters who encouraged participation in sober leisure activities had significantly lower odds of heavy drinking (Davey-Rothwell et al., 2011).

Having a social network with a diversity of types of relationships including mentors or professional helpers is associated with increased social capital for women in low-income, low-resource settings like those encountered by many women in recovery, and may provide them with the needed resources to balance out threats to their success (Domínguez & Watkins, 2003). Not having treatment-related support for recovery is related to increased relapse risk. Compared to those reporting having support for abstinence from treatment-related alters, those reporting no support for abstinence were significantly more likely to report using alcohol in the past 90 days 1 year after entering treatment (Bond et al., 2003). Similarly, women with low incomes who drank 6 or more drinks at a time at least once weekly had significantly fewer treatment-related alters in their networks (Davey-Rothwell et al., 2011). The effect of having these positive connections to treatment-related alters may depend on PSN support for treatment and recovery, as found in a social network study of people in mental health treatment (Perry et al., 2017).

Density, the percentage of existing network ties out of all potential ties, represents the availability and interconnectedness of resources in the network, and is an indicator of the network's potential for reinforcement of behaviors or beliefs with higher levels of density being more reinforcing (Rice & Yoshioka-Maxwell, 2015). Isolates represent bridges to resources outside of the network that can support or hinder recovery, such as a therapist or a dealer (Granovetter, 1973; Valente et al., 2004). While isolates refer to people who are not connected to anyone in the network in whole-network analysis, they are defined as those

only connected to the focal individual in egocentric network analysis (McCarty, Lubbers, Vacca, & Molina, 2019).

Two studies examining recovery networks to date have explored the role of PSN structure in adult recovery from SUDs. Higher density was associated with a higher likelihood of injecting drugs, possibly due to PSNs where the drug users are enmeshed and difficult to avoid (Latkin et al., 1995), but higher density supported recovery if the network had many abstinent alters (Tracy et al., 2016). Having isolates in the network at 6 months after treatment entry decreased the odds of using substances by 12 months for women, but only if those isolates were sober (Tracy et al., 2016). These studies demonstrate the need to examine PSN characteristics and structure in conjunction.

1.3 Aims

This study had three aims: 1) Identify latent typologies of recovery networks among women who have recently entered treatment for a substance use disorder, and determine how they differ from each other in demographic and clinical characteristics. 2) Identify how women move between typologies by 6 months and 12 months after entering treatment. 3) Determine how traumatic symptomatology, co-occurring disorders, and treatment modality affect latent typology membership at one week after treatment entry, and probability of transitioning between typologies at the aforementioned time points. 3) Determine how membership in the latent typologies is associated with a woman's ability to maintain abstinence by 12 months after entering treatment, after controlling for demographic and clinical characteristics. Hypotheses were: 1) Having more treatment-related peers and professionals, sober alters, and recovery-supportive alters, and fewer alters with whom they used would increase likelihood of maintaining abstinence, and that differences in the structural variables would further separate and define the classes. 2) Some women would maintain their typology over the time points, and others would transition to typologies representing higher or lower likelihood of maintaining abstinence at each time point. 3) Higher levels of traumatic symptomatology, having a co-occurring mental health disorder, and being in residential treatment will a) increase the probability of membership in latent classes with more difficulty in maintaining abstinence, and b) predict the probability of transitioning between typologies.

2. Methods

This study used de-identified data from the prospective, longitudinal study, The Role of Personal Social Networks in Post Treatment Functioning (R01 DA022994-01A2), which collected data from women 18+ years of age enrolled in residential or intensive outpatient SUD treatment for one week at study entry, as well as at 1 month, 6 months and 12 months after study entry in a mid-sized Midwestern US city, collected October, 2009 to May, 2012. Types of data collected included PSN information, substance use, psychological symptomatology and functioning, quality of life, and demographic data. Participants all had a DSM-IV diagnosis of substance dependence (American Psychiatric Association, 1994), and were excluded if diagnosed with or taking medication for a major thought disorder such as schizophrenia; those displaying symptoms of a major thought disorder that did not meet

the criteria for diagnosis were included. The parent study was approved by the Case Western Reserve University IRB.

This study's sample consisted of 377 women at baseline who provided PSN data, with 298 of those providing these data at 6 months. Complete demographic and clinical characteristics for the sample at baseline and 6 months are presented in Table 1. There were no missing data on the PSN variables used in the LPA model. Missing data on the trauma covariate and the outcome variable resulted in sample sizes of $N=375$ and $N=303$ for those analyses, respectively. Multiple imputation for pattern analysis indicated that any cases missing demographic or clinical data were missing at random.

2.1 Measures

2.1.1 PSN measures.—PSN data were collected by computer-assisted interview using Egonet software (McCarty, 2002; McCarty et al., 2007) by asking the respondent to 1) identify 25 alters with whom they had contact in the previous 6 months; 2) provide information about characteristics of those alters; and 3) how each unique pair of alters was connected to each other. PSN variables used in this analysis were: Alter sobriety; substance use with the alter; treatment-related alters (including treatment providers, peers in treatment, and peers in support groups); sobriety support; isolates; and network density. Network size was not examined for this study as this study limited participants to identifying exactly 25 alters, the minimum network size to obtain a valid density score (McCarty et al., 1997), an important variable in this analysis. Operationalization and descriptive statistics of these variables are shown in Table 2.

2.1.2 Trauma.—Total score on the 40-item adult Trauma Symptom Checklist (TSC-40; Briere, 1996) was used as a covariate. The TSC-40 measures traumatic symptomatology across 5 domains (dissociative, anxiety, depression, sleep disturbance, and sexual problems), and ranges from 0 – 120 with higher scores indicating increased traumatic symptoms; it has no clinical cutoffs. Previous studies have demonstrated the TSC-40's reliability with a range of $\alpha=.89$ to $\alpha=.91$ (Briere, 1996), and construct and discriminant validity in victims of sexual abuse (Briere & Runtz, 1987; Elliott & Briere, 1992), and in a psychiatric inpatient sample (Zlotnick et al., 1996). Chronbach's alpha for the 271 women who completed the TSC-40 in this sample was high, $\alpha=.93$.

2.1.3 Covariates.—Six covariates were considered for inclusion based on the literature and low indications of multicollinearity ($r<0.60$; Leech, Barrett, & Morgan, 2015): Age in years, race, educational level, income source, treatment modality, and co-occurring disorder. Co-occurring disorder ($r(303)=-.203$, $p<.001$) and treatment modality ($r(304)=.084$, $p=.144$) were correlated with the outcome at $p<.20$ warranting inclusion in the regression model (Mickey & Greenland, 1989).

2.1.4 Abstinence outcome.—While there are multiple ways to measure recovery outcomes such as reductions in use (Donovan et al., 2012), the study data only included self-report measures of abstinence. This dichotomous abstinence outcome was measured with this question from the Individualized Assessment Profile (IAP; Flynn et al., 1995): "Have

you used any substance once or more to get high or to feel better since the last interview?” Responses were reverse-coded such that positive responses indicated maintenance of abstinence. Abstinence outcomes over the first year after treatment entry were measured using the combined responses over the final 3 time points, with no reported use during the 12-month period coded as “abstinence.”

2.2 Analysis Plan

Univariate, bivariate, and regression analyses were conducted using SPSS, Version 24 (IBM Corp., 2016). Latent variable analyses were conducted using *MPlus*, Version 8 (Muthén & Muthén, 2017). This study used the three-step LPA method to create a latent profile indicator variable for the identified typologies and correctly estimate the classification error of the latent profile variable (*MPlus* R3STEP macro, Asparouhov & Muthén, 2014a), which was used in covariate analyses. These identified classes were then used in LTA to determine the movement of individuals between profiles over time.

Per recommendations for LPA analysis by Collins and Lanza (2010), fit for LPA models with one to five classes was considered using minimum values of the Akaike and Bayesian information criteria (AIC, BIC), entropy values $\geq .80$ (Lubke & Muthén, 2007), and the interpretability and clinical practicality of the models. Models with K and $K - 1$ profiles were compared using the Lo-Mendell-Rubin likelihood ratio test (LMR; Lo, Mendell, & Rubin, 2001). T -tests and chi-squared tests were used to compare the identified latent typologies on demographic and clinical characteristics. The R3STEP macro was used to perform multinomial logistic regressions of the latent profile indicator variable on the TSC-40 score at baseline.

LTA uses a Markov chain model to identify how the women moved between latent profiles between baseline and 6 months and 6 and 12 months, and assumes measurement invariance; means of the indicators for each group were held equal across timepoints to meet this assumption after testing for measurement invariance (Lanza & Collins, 2008). The probabilities of transitioning between groups as well as the latent profile prevalences for each time point were estimated using a mover-stayer analysis within the LTA. Covariates (trauma score, co-occurring disorder, treatment modality) were included in the model to determine if they influenced transition probabilities.

Hierarchical logistic regression using two blocks (demographic and clinical covariates, latent profile membership; excluding TSC-40 score) was used to predict abstinence outcomes based on latent profile membership while controlling for demographic and clinical characteristics.

3. Results

A 3-profile model provided the best fit to the data and was the most interpretable for clinical use (Table 3).

3.1 Latent typologies identified at study entry

Women in Typology 1, “Highly Connected” ($n=54$, 14.32%), had higher levels of sober alters and sobriety support, and fewer isolates or treatment-related alters, which, combined with higher density indicate tightly-knitted, immersive networks that reinforce recovery-oriented norms (Rice & Yoshioka-Maxwell, 2015). Women in Typology 2, “Treatment Related Sobriety Support” (“Treatment Related,” for brevity; $n=186$, 49.34%), also had higher levels of sober alters and sobriety support, but had higher numbers of isolates and treatment alters, indicating access to resources outside of their networks (Rivaux et al., 2008; Valente et al., 2004). Women in Typology 3, “At Risk” ($n=137$, 36.34%), had networks with higher numbers of isolates but had less sobriety support, fewer sober or treatment-related alters, and higher numbers of alters with whom they had used, indicating less potential for reinforcement of sobriety (Rice & Yoshioka-Maxwell, 2015). The variable characteristics of the 3-class model are presented in Table 4, with graphical representation of the z-scores for each PSN variable presented in Figure 1. Post hoc tests using the Bonferroni correction revealed significant differences between groups for all PSN variables. Table 5 shows the average latent class probabilities for most likely latent class membership by latent class, with values on the diagonal indicating the probability that the observations were classified into the correct class.

3.2 Comparison of demographic and clinical variables by latent typology

After applying the Bonferroni correction, the Treatment Related group was significantly older than Highly Connected ($t=-2.91$, $df=238$, $p=0.004$) or At Risk ($t=3.45$, $df=321$, $p=0.001$), with an average age of 38.62 (Table 6). There were no statistically significant differences in age between Highly Connected and At Risk. While there were no statistically significant differences between Treatment Related and At Risk on race, Highly Connected had a significantly higher percentage of Black participants than At Risk ($\chi^2=6.99$, $df=1$, $p=0.008$). At Risk had significantly more participants in residential treatment than Highly Connected ($\chi^2=9.22$, $df=1$, $p=0.002$) or Treatment Related ($\chi^2=20.91$, $df=1$, $p<0.001$), with no significant differences between Highly Connected and Treatment Related on treatment type.

3.3 Latent Transition Analysis

The majority of transitions between profiles occurred between baseline and 6 months ($N=157$) with only 40 women transitioning between 6 and 12 months, so the analysis focused on the first 6 months. The most interpretable model kept three groups at both baseline and 6 months, and the profiles had measurement invariance across the timepoints (Table 3).

Mover-stayer analysis showed that 41.6% ($N=157$) of the 377 women changed their network profile between baseline and 6 months with 37.1% ($N=140$) remaining in the same profile, and 21.2% ($N=80$) lost to attrition. At 6 months, typology membership was as follows: 25.6% Highly Connected ($N=76$), 61.6% Treatment Related ($N=183$), and 12.8% At Risk ($N=38$). Patterns of movement between baseline and 6 months are shown in Figure 2. Women in the At Risk group had the highest probability of transitioning ($P=0.55$), followed by Treatment Related ($P=0.28$) and Highly Connected ($P=0.17$).

3.4 Predictors of typology membership and transitions

Higher TSC-40 scores significantly predicted membership in the At Risk typology compared to Highly Connected ($B=0.024$, SE $B=0.009$, $p = .007$) or Treatment Related ($B=0.013$, SE $B=0.006$, $p = .032$). There was no statistically significant difference on TSC-40 scores between Highly Connected and Treatment Related.

Participating in outpatient treatment (compared to residential) at baseline decreased the odds of changing groups by .44 ($B=-0.81$, $p=.06$). Level of trauma and co-occurring disorder were not significant predictors of transitions. Those in the At Risk group at baseline were significantly more likely to be movers than those in the Highly Connected or Treatment Related groups ($\chi^2 = 20.80$, $df = 2$, $p < 0.001$). There were no other significant differences between the movers and stayers.

3.5 Relation of latent typology membership to abstinence outcomes

Those in Treatment Related had 2.09 times higher odds of successfully maintaining abstinence over the first year after entering treatment compared with those in the At Risk typology ($B=-0.74$, Wald $\chi^2 = 7.486$, $df=1$, $p=.006$; OR=2.09, 95% CI [1.23, 3.56]), after controlling for clinical characteristics (Table 7). There were no statistically significant differences between Highly Connected and At Risk or Highly Connected and Treatment Related on abstinence outcomes.

Of the clinical covariates, only co-occurring disorder significantly predicted the abstinence outcome with those having a co-occurring disorder being less likely to maintain abstinence ($B=-0.99$, Wald $\chi^2 = 11.97$, $p = .001$; OR=0.37, 95% CI [0.21, 0.65]), and it remained statistically significant after the entry of the typology variables ($B=-1.00$, Wald $\chi^2 = 11.65$, $p = .001$; OR=0.37, 95% CI [0.21, 0.65]).

3.6 Attrition

Attrition analysis showed that the 80 women who were missing at the 6 month time point were significantly more likely to be younger ($t = -2.31$, $df = 375$, $p = 0.02$), receiving government assistance ($\chi^2 = 9.72$, $df = 2$, $p = 0.008$), black ($\chi^2 = 10.19$, $df = 1$, $p = 0.001$) and in outpatient treatment ($\chi^2 = 21.59$, $df = 1$, $p < 0.001$) at baseline. There were no significant differences for substance use outcomes, education, co-occurring disorder, or TSC-40 scores.

4. Discussion

This study found significant variation in alter characteristics and network structure across three latent typologies of PSNs among women who had recently entered treatment for substance use disorders, and determined their movement between these typologies over the first year after they entered treatment. The three typologies differed primarily in three areas: Sobriety of alters and sobriety support; treatment-relatedness of alters; and network structure.

This study found support for the first hypothesis, that alter sobriety, recovery support, and treatment-relatedness in conjunction with network structure would define typology membership. Women in the Highly Connected typology showed a pattern of tight-knit networks with sober, sobriety-supportive members, and typically did not report connections to alters from treatment programs or self-help groups or connections to people with whom they used. While this was not the focus of this study, a simple review of the network members in this typology showed that the networks of the women in the Highly Connected typology were primarily made up of intimate partners, children, and other family members. Women in the Treatment Related Sobriety Support and At Risk typologies both showed patterns of more loosely-connected networks with lower density and more isolates. They differed in the number of treatment-related, sober, and used-with alters. Women in the Treatment Related typology had higher numbers of treatment-related and sober alters, and fewer alters with whom they had used, indicating that the isolates in their networks may represent new connections with treatment-related peers or providers who can provide them with sobriety support. Women in the At Risk typology had few sober or treatment-related alters, and more alters with whom they had used. This suggests that these isolates may represent the remnants of the women's using networks, or people they connected with through support groups or treatment.

This study also found support for the second hypothesis, that some women would transition to typologies representing higher or lower likelihood of maintaining abstinence, but found that the majority of transitions in PSN type occurred between treatment entry and 6 months later, indicating that these first 6 months after entering treatment may be a critical time for women to make social changes that impact their recovery. Overall, the women moved to lower-risk network types, with those in the At Risk group at baseline having the highest probability of switching types. Previous research shows that women actively make changes to their networks to mitigate the impact of potentially recovery endangering members, such as deliberately cutting ties or limiting contact with certain people (Francis et al., in press), suggesting that the movement observed in this study may be based in actions taken by the women rather than passive occurrences.

Finally, this study showed partial support for hypothesis 3, that traumatic symptomatology, co-occurring mental health disorder, and level of treatment will influence both initial typology membership and the probability of transitioning between typologies. Higher mean Trauma Symptom Checklist scores were related to increased likelihood of initial membership in the At Risk profile for women in this study. This indicates that trauma symptoms may be an important factor influencing women's recovery networks, and experiencing trauma may lead to having a recovery-endangering network (Smith et al., 2004). However, data on trauma symptoms were only collected at baseline in this study, making it impossible to determine the causal ordering of this relationship. For example, one woman's symptoms of trauma may make it more difficult for her to form recovery-supportive relationships, as seen in Min, Tracy and Park (2014). Another woman's substance-using network may have exposed her to trauma, resulting in a cycle of network destabilization, trauma symptoms, and substance use, as Gutierrez and Van Puymbroek (2006) describe. Neither trauma nor having a co-occurring disorder were significant predictors of transition, but participating in outpatient treatment decreased the odds of

moving between types. Treatment modality is a proxy for the level of Substance Use Disorder severity, with those in residential treatment typically having more severe symptoms. Women in residential treatment may not have had the personal and social capital needed to make significant changes to their recovery networks as compared to those with lower severity of disorder.

These typologies predicted abstinence outcomes over the 12 months after treatment entry, with women in the At Risk group being significantly less likely to maintain abstinence over the 12 months following treatment entry than those in the Treatment-Related Sobriety Support group. This indicates that having treatment-related alters in their networks may be important for women in recovery, even if they enter treatment with a tightly-knit support network. However, there were no differences in ability to maintain abstinence between the At Risk and Highly Connected groups. The lack of difference in outcome between the At Risk and Highly Connected groups was unexpected, as, theoretically, the Highly Connected group should have more social recovery capital. Given the dual nature of women's relationships during recovery, it may be that having the higher network density seen in the Highly Connected group allows for the substance-using and use-supportive network members to have higher reinforcement of their message despite the network being generally recovery-supportive. This finding warrants further exploration.

While not the focus of this study, as other studies show (e.g. Greenfield, Venner, Kelly, Slaymaker, & Bryan, 2012), having a co-occurring mental health diagnosis was associated with difficulty in maintaining abstinence. These findings reiterate that women with co-occurring disorders need additional support in clinical settings. It also suggests that co-occurring mental health disorders should be included in analyses of this type.

Attrition is a concern in any longitudinal study, and 80 women (21.2%) were lost to attrition between baseline and 6 months. It should be noted that a number of women missed the 6 month time point and returned for the 12 month time point. People in recovery tend to move in and out of contact, and this pattern was observed in the network members as well, with the women reporting that some alters leaving and returning to their networks at different time points. Nearly half of the women who were missing at the 6 month time point ($N=39$) were from the baseline At Risk group, suggesting that these women may have struggled with stability more than other groups.

4.1 Implications for Research

Mirroring the shift in addiction treatment from acute stabilization to one of sustained recovery (White, 2009), there is value in shifting the discussion about recovery from a focus on specific deficits and resources held by a person in recovery to a more holistic focus on how the individual components of a person's PSN work together to promote and sustain recovery. As White (2009) notes, it is the sum of the factors that promote recovery and those that hinder recovery within the person's social world and larger community that is important (Laudet et al., 2006). This latent variable analysis demonstrates the power of such an approach. Similarly, this study demonstrates the importance of including network structure in PSN analysis, along with important covariates such as traumatic symptoms and co-occurring disorders. Findings from the LTA suggest that it may be beneficial to further

explore specific actions that women take to change their social networks to be more recovery-supportive during first 6 months after treatment.

4.2 Implications for clinical practice.

While doing a full PSN analysis including network structure is beyond the scope of most psychotherapists, a simple exploration of an ecomap that shows the network members' characteristics in relation to recovery, how tightly-knit the network is (i.e. density), and whether there are any people that the woman knows that the alters in her network don't know directly (i.e. network isolates) could be helpful, and could foster discussion about how to enforce boundaries with recovery-endangering ties, how to leverage recovery-supportive bridging ties, or how to use very dense networks to provide high levels of reinforcement for recovery support.

Identifying a client's recovery network typology allows clinicians to precisely target their interventions for women (Lanza & Rhoades, 2013). For example, women who have sobriety support at treatment entry may benefit from work around strengthening existing supports and maximizing their use of resources. Women in the At Risk typology have comparatively little support for recovery, so the primary clinical targets for them might be to assess their overall support needs, identify potential sources of support, provide linkage as needed, and assist them in learning and rehearsing relationship-building skills using a PSN-supportive therapeutic approach such as Social Behaviour and Network Therapy (Copello, 2009). Clinicians can also consider using evidence-based, trauma-focused SUD treatments such as Seeking Safety (Najavits, 2002), or other combinations of psychosocial, behavioral, and pharmacological treatments (Berenz & Coffey, 2012) for clients in the At Risk type. Given the finding that most women who transitioned between network types did so in the first 6 months, clinicians may also want to prioritize development of stronger recovery networks in the early stages of treatment. This is particularly important for women in residential treatment, whose likelihood of changing network types was lower than those in outpatient treatment and who may need additional support in making these changes.

Finally, this study is consistent with the notion of multiple paths to recovery (White & Cloud, 2008), and it stands to reason that varying combinations of network characteristics may all lead to successful recovery for women. This necessitates an individualized approach to building and mobilizing recovery networks (Substance Abuse and Mental Health Services Administration, 2015).

4.3 Strengths and limitations.

This study provides a model for future research using LPA and LTA methodology with count variables of PSN characteristics and structural variables, an important addition to the literature. Additional strengths were its basis in theory, the longitudinal nature of the study, the inclusion of covariates known to influence recovery, the use of a strengths-based focus, and a focus on an under-studied population.

The main limitation of this study was that abstinence was the only available outcome variable to capture substance use during recovery. A broader set of outcome variables could capture a more nuanced picture of women's early recovery in relation to their social

networks, and is recommended for future studies. Finally, the use of inconsistent, less numerically-driven PSN measures across the literature on recovery from substance use disorders is a limitation in social network studies in general (Tracy & Whittaker, 2015), making comparison across samples to increase generalizability quite difficult.

4.4 Future research.

A finer-grained, longitudinal examination of the exact characteristics of the network members and how and when they enter and leave the network could provide information about who the network isolates are using an analytical approach such as Dynamic Network Analysis. Finally, replicating these findings in other samples could help in formulating effective, targeted treatment interventions.

4.5 Conclusion

This study contributes to the literature by providing a framework for conducting latent variable analysis with compositional and structural social network data. The identified typologies and transitions can provide a clinically-useful starting point for research on individualized, targeted, stage-based, and trauma-responsive interventions for women in recovery.

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Highlights

- Found 3 women's recovery network types: Highly Connected, Treatment-Related, At Risk
- Women in the Treatment-Related group were more likely to maintain abstinence
- Higher trauma scores predicted membership in the At Risk group
- 42% transitioned groups by 6 months after baseline; 54% of those were At Risk
- Being in residential treatment at baseline predicted lower odds of transitioning

Figure 1.

Graph of z-scores of estimated means by latent recovery typologies Note: Mean scores for the overall sample on each variable are indicated on the horizontal zero axis, with typology-specific means above or below indicating means that are above or below the overall sample mean for that variable. Standard deviations from the overall sample mean are marked on the Y-axis.

Figure 2.
Patterns of transition and stability of women's network typologies between baseline and 6 months ($N=377$).

Table 1.Demographic and clinical characteristics at one week and 6 months after treatment intake ¹

	<i>N</i>	1 week after treatment entry (<i>N</i>=377)	<i>N</i>	6 months after treatment entry (<i>N</i>=298)
		<i>N (%)</i>		<i>M (SD)</i>
Age in years *	377		298	37.1 (10.8)
Racial / ethnic group *	279		298	
African American		224 (59.4)		191 (64.1)
White, Caucasian		129 (34.2)		94 (31.5)
Biracial/Multiracial		9 (2.4)		6 (2.0)
American Indian		4 (1.1)		3 (1.0)
Latino		7 (2.5)		5 (1.7)
Other		3 (0.8)		1 (0.3)
Educational attainment	376		297	
< High School		154 (41.0)		127 (42.8)
GED/H.S.		167 (44.4)		129 (3.4)
> High School		55 (14.6)		41 (13.8)
Employment type *	360		283	
Gov. Assistance		261 (72.5)		215 (76.0)
On Jobs		37 (10.3)		28 (9.9)
Other		62 (17.2)		40 (14.1)
Dually diagnosed *	376	288 (76.6)	298	218 (73.4)
Treatment type *	377		298	
Outpatient		258 (68.4)		221 (74.2)
Residential		119 (31.6)		77 (25.8)
Co-occurring mental health diagnosis *	376	276 (73.4)	297	218 (73.4)
TSC-40 score *	375	44.7 (21.4)	296	43.1 (21.5)
Substances of dependence ²	372		293	
Cocaine		213 (57.3)		171 (58.4)
Alcohol		175 (47.0)		130 (44.4)
Marijuana		86 (23.1)		119 (40.6)
Opiates		86 (23.1)		62 (21.2)
Sedatives		19 (5.1)		14 (4.8)
Phencyclidine		12 (3.2)		11 (3.8)
Hallucinogens		9 (2.4)		7 (2.4)
Amphetamine		4 (1.1)		3 (1.0)
Inhalants		1 (0.3)		1 (0.3)
Other		4 (1.1)		4 (1.4)
Number of substances dependent *	372	1.81 (0.86)		1.78 (0.87)
Abstinence over 12 months *	304	178 (47.2)	279	167 (59.9)

* $p < 0.05$

¹ Measured at 1 week after treatment entry

² Percentages for substances of dependence do not add up to 100% due to some women being dependent on more than one type of substance.

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Table 2.

Variable descriptions and descriptive statistics for latent profile analysis (N=377)

Variable	Operationalization	<i>M</i> (<i>SD</i>)	Min	Max
Alter sobriety	The number (0–25) of alters for whom the focal individual answered no to “Does this person do alcohol or drugs?”	16.56 (4.90)	2	25
Sobriety support	The number (0–25) of alters for whom the focal individual responded “Almost Always” for “Would this person give you support to stay clean?”	19.62 (4.94)	0	25
Alters “used with”	The number (0–25) of alters for whom the focal individual answered yes to “Is this person someone you used with?”	6.26 (4.61)	0	20
Treatment-related alters	The combined responses for two options on the question, “How do you know this person?” (“Professional helper” and “From treatment program or AA/NA”). Range: 0–50.	3.54 (4.19)	0	22
Isolates	The number (0–25) of alters identified as only having a network tie with the focal individual and not with any other alters.	4.98 (5.43)	0	25
Density	Network density is measured by dividing the number of observed ties between alters by the number of possible ties, with a range of 0–1.00.	0.27 (0.25)	0.00	1.00

Table 3:

Latent profile analysis model fit test results for 2-, 3-, 4-, and 5-class models at baseline.

Number of classes	LL Value	Adj LMR Test	p	Boot strapped LRT	p	# of classes compared	AIC	BIC	Adj. BIC	Entropy
2	-5492.09	301.18	< 0.001	308.44	< 0.001	1 to 2	11022.16	11096.89	11036.61	0.95
3	-5361.57	215.84	< 0.001	221.03	< 0.001	2 to 3	10815.14	10917.38	10834.89	0.63
4	-5298.80	161.65	0.0153	165.54	< 0.001	3 to 4	10663.60	10793.37	10688.67	0.93
5	-5236.15	122.36	0.0857	125.31	< 0.001*	4 to 5	10552.29	10709.58	10582.67	0.91
Transition classes										
3 to 2	-9914.38	-	-	-	-	19898.75	20036.38	19925.33		0.76
3 to 3	-9822.00	-	-	-	-	19726.00	19887.22	19757.14		0.70
3 to 4	-9761.90	-	-	-	-	19617.81	19802.62	19653.50		0.75

* Some possibility of local maxima in this model.

LL: Log likelihood; LMR: Lo-Mendell-Rubin; LRT: Likelihood ratio test; AIC, BIC: Akaike and Bayesian information criteria.

Table 4.

Social network count variable means for the 3-class model

	Highly Connected (<i>n</i> =54)	Treatment Related Sobriety Support (<i>n</i> =186)	At Risk (<i>n</i> =137)	<i>p</i>	Pair-wise differences [†]
	<i>M (sd)</i>	<i>M (sd)</i>	<i>M (sd)</i>		
Sobriety support	19.52 (5.83)	21.18 (3.99)	17.55 (5.00)	<.001	1 3; 2 3
Alter sobriety	18.20 (4.76)	19.28 (3.37)	12.21 (3.44)	<.001	1 3; 2 3
Treatment-related alters [*]	1.048 (0.57)	1.50 (0.91)	0.81 (0.76)	<.001	1 2; 2 3
Alters “used with”	5.46 (4.12)	3.32 (2.64)	10.56 (3.45)	<.001	1 2; 1 3; 2 3
Network density	0.80 (0.17)	0.19 (0.12)	0.15 (0.11)	<.001	1 2; 1 3; 2 3
Isolates [*]	0.35 (0.24)	1.74 (0.70)	1.89 (0.74)	<.001	1 2; 1 3

^{*} Log-transformed;

[†] Bonferroni correction (0.05/3=0.017)

Table 5.

Average latent class probabilities for most likely latent class membership (row) by latent class (column)

	Highly Connected	Treatment Related Sobriety Support	At Risk
Highly Connected	0.959	0.038	0.003
Treatment Related Sobriety Support	0.007	0.934	0.058
At Risk	0.002	0.106	0.892

Table 6.

Sample characteristics by social recovery capital latent profile

	Profile 1: Highly Connected (<i>n</i>=54)	Profile 2: Treatment- based recovery support (<i>n</i>=186)	Profile 3: At risk (<i>n</i>=137)	<i>p</i>	Pair-wise difference[†]
Age, <i>m</i> (<i>sd</i>)	33.93 (9.59)	38.62 (10.64)	34.64 (9.34)	<.001	1 2; 2 3
African-American, <i>n</i> (%)	40 (74.10)	115 (61.80)	66 (51.8)	.014	1 2; 2 3
< High school education, <i>n</i> (%)	28 (51.90)	66 (35.70)	60 (43.80)	.073	
On public assistance, <i>n</i> (%)	43 (81.10)	130 (73.40)	88 (67.70)	.169	
Residential treatment, <i>m</i> (<i>sd</i>)	12 (22.20)	42 (22.60)	65 (47.40)	<.001	1 3; 2 3
Co-occurring disorder, <i>n</i> (%)	32 (60.40)	139 (74.70)	105 (76.60)	.064	

[†] Bonferroni correction

Table 7

Logistic regression of self-reported maintenance of abstinence over the first 12 months following treatment entry on social recovery capital latent profiles (N =303)

	Clinical Characteristics			Full Model		
	<i>B</i>	<i>SE B</i>	<i>OR</i> [95% CI]	<i>B</i>	<i>SE B</i>	<i>OR</i> [95% CI]
In residential treatment	0.38	0.26	1.45 [0.87–2.45]	0.22	0.28	1.25 [0.73–2.14]
Dually diagnosed	–0.99**	0.29	0.37 [0.21–0.65]	–1.0**	0.29	0.37 [0.21–0.65]
Highly Connected				0.35	0.38	1.41 [0.66–3.01]
Treatment Related				0.74**	0.27	2.09 [1.23–3.56]
Constant	0.81*	0.31	2.26	0.51	0.34	1.67
–2 <i>LL</i>	396.42			388.77		
Model X^2 (<i>df</i>)	15.00 (2)**			22.65 (4)***		
Pseudo R^2	0.06			0.10		

*
 $p < .05$

**
 $p < .01$

 $p < .001$

Reference group = At risk; CI = confidence interval for odds ratio (OR) Meredith Francis, Dissertation, Latent Profile Analysis