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A Latent Class Approach to Treatment Readiness Corresponds to Transtheoretical (“Stages of Change”) Model

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Abstract

Motivation for treatment among people with substance use problems is an important aspect of treatment success. Models for treatment motivation are widely debated. Latent Class Analysis can help to demonstrate the appropriateness of available models. The current study utilizes Latent Class Analysis to analyze treatment readiness statements as they relate to the reduction or cessation of marijuana, cocaine, and opioid use among 539 cocaine and opioid users recruited from the community of Baltimore, MD, USA. Participants completed an in-person structured interview including demographic questions, a treatment readiness questionnaire with items on Intention to Stop Use (ISU) and Problem Recognition (PR), current substance abuse treatment utilization, and urinalysis testing for marijuana, cocaine, and heroin. Latent class models were fit to the treatment readiness questionnaire. A four-class model provided the best fit with one class low on both ISU and PR (“Pre-contemplative”), a second class low on ISU, but high on PR (“Contemplative”), a third class high on both (“Preparation/Action”), and a final class high on ISU, but low on PR (“Post-Action”). Compared to the “Contemplative” class, the “Pre-contemplative” class was significantly more likely to be positive for marijuana, and the “Post-Action” class was significantly less likely to be positive for opioids. The “Preparation/Action” class was significantly more likely to be in treatment. With the exception of the “Post-Action” class, the analysis appears similar to the “Stages of Change” model and suggests that problem recognition and intention to stop use are important domains in the model. However, further longitudinal research is needed to assess predictive validity of model.

Keywords

stages of change; treatment motivation; latent class analysis; substance abuse treatment; cocaine; heroin

1. Introduction

Substance use disorders (SUDs) differ drastically from other medical conditions in that many of the afflicted do not desire change. More than 4 million Americans aged 12 years or older received alcohol or other SUD treatment in 2010, but more than 5 times as many reported abusing or being physiologically dependent on alcohol, illicit drugs, or non-medical use of prescription drugs (Substance Abuse and Mental Health Services Administration

[SAMHSA], 2011). Further, one of the strongest predictors of SUD treatment success is retention. SUD treatment is most effective when it involves multiple sessions over an extended period of time (Brunner et al., 2004; Hubbard, Craddock, & Anderson, 2003; McLellan, Arndt, Metzger, Woody, & O'Brien, 1993). However, many individuals with SUDs do not enter treatment (Heimer, 1998; Henderson, Vlahov, Celentano, & Strathdee, 2003; Kidorf et al., 2005; Kidorf, King, & Brunner, 2005; Metzger & Navaline, 2003; Riley et al., 2002; Tempalski, Cleland, Pouget, Chatterjee, & Friedman, 2010) or drop-out from treatment early (Crosby, Stall, Paul, & Barrett, 2000; King & Canada, 2004). This results in poorer treatment outcomes and higher rates of substance use relapse. Thus, researchers have attempted to categorize substance users both quantitatively and qualitatively in terms of awareness of a problem and willingness to change (Migneault, Adams, & Read, 2005; Prochaska, Diclemente, & Norcross, 1992; Schwarzer, 2008; Weinstein, Rothman, & Sutton, 1998).

Arguably, the most popular model for this among substance abuse treatment clinicians is the transtheoretical model (TTM). The TTM of behavior change has been widely applied to the field of substance use and its treatment (e.g., Callaghan et al., 2005; Dino, Kamal, Horn, Kalsekar, & Fernandes, 2004; Prochaska, 2001). This model, commonly referred to as stages of change, consists of four phases. These stages are: 1) precontemplation – no intention to change future behavior; 2) contemplation – problem awareness and thoughts about taking action arise; (3) preparation/action – intention to take action in the near future and overt changes in behavior and commitment to change, and 4) maintenance – relapse prevention and treatment gains (Prochaska, et al., 1992).

Support for this model has been moderate and mixed (Schwarzer, 2008; Wei, Heckman, Gay, & Weeks, 2011). Criticism includes that a stage model suggests that individuals cannot move backwards in stage transition or progress from one stage to another (Bandura, 2000; Schwarzer, 2008) and that the stages may be simply arbitrary subdivisions of a continuous process (Kraft, Sutton, & Reynolds, 1999; Sutton, 2000; Weinstein, et al., 1998). Studies do not always find predictive power of the stages of change. For example, one study found that “taking steps”, a component of the stages of change, predicted treatment outcome for benzodiazepines, but not for heroin, methadone, or stimulants; leading the authors to note that this component failed to be predictive for a majority of the substances (Gossop, Stewart, & Marsden, 2007). As such, some have argued that the model should be abandoned (West, 2005).

Despite these criticisms, more recent evidence suggests the theory does have pragmatic value (e.g., Dino, et al., 2004; Henderson, Saules, & Galen, 2004; Schwarzer, 2008; Velicer et al., 2006; Velicer, Redding, Anatchkova, Fava, & Prochaska, 2007) including a meta-analysis of 39 studies which found clinically significant effect sizes (Norcross, Krebs, & Prochaska, 2011). Nonetheless, this evidence should be considered in the context of other models (Webb, Sniehotta, & Michie, 2010) including continuous models of change (Carey, Purnine, Maisto, Carey, & Barnes, 1999; Field, Duncan, Washington, & Adinoff, 2007; Schwarzer, 2008; Webb, et al., 2010) and unconscious influences on behavior change (Bargh & Ferguson, 2000; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). In addition, there are a number of other factors associated with unmet need for substance abuse treatment, including stigma, lack of knowledge about where to obtain treatment, lack of transportation, and an inability to afford treatment (Appel, Ellison, Jansky, & Oldak, 2004; Evans, Li, & Hser, 2008; Jackson & Shannon, 2011; Kurtz, Surratt, Kiley, & Inciardi, 2005). Treatment dropout rate can also be a function of the potency of the treatment. For example, in a clinical trial of opioid dependence where all participants received similar counseling regimens, long-term suboxone maintenance treatments led to increased retention over short-term detox-only treatment (Woody, et al., 2008).

Several studies within the substance abuse literature have specifically sought to identify factors that contribute to one's treatment readiness, or intention to take action for behavior change. For example, female sex, bipolar disorder, and physical health concerns (Pollini, O'Toole, Ford, & Bigelow, 2006), as well as experiencing the feeling of regret as a result of negative consequences (Blume & Schmalting, 1998) have been found to contribute to high levels of readiness for change. Others have found that frequency of recent substance use is associated with desire to change (Gossop, et al., 2007; Henderson, et al., 2004; Trenz et al., 2012).

One continuous model of change is the Treatment Readiness scale (Severtson, von Thomsen, Hedden, & Latimer, 2010; Trenz et al., 2012), based on a validated measure of intention to quit drug use (Henderson, et al., 2003). The current research uses Latent Class Analysis (LCA) to examine classes of individuals based on answers to this scale. Classes are then examined in relationship to demographics, treatment status, and urine drug samples.

2. Methods

2.1. Participants and design

The present study sample consisted of 539 self-identified Black and White adult drug users in Baltimore, Maryland, United States, from the NEURO-HIV Epidemiologic study, a longitudinal investigation funded by the National Institute on Drug Abuse to evaluate neuropsychological and social-behavioral risk factors of contracting infectious diseases among injection and non-injection drug users (Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Latimer et al., 2007; Severtson, Hedden, Martins, & Latimer, 2012; Trenz, Harrell, Scherer, Mancha, & Latimer, 2012). Recruitment involved advertisements in local newspapers, referrals, and street outreach. To be eligible for this sample, participants needed to report using cocaine or heroin in the past 6 months and be between 18 and 50 years old. Upon arrival, participants provided informed consent, received blood tests, gave urine samples, and completed the HIV-Risk Behavior Interview, a semi-structured interview about drug use and sexual practices which includes the Treatment Readiness Scale. Participants were compensated for their time. The study was approved and monitored by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health. The sample included 310 men (57.5%) and 229 women (42.5%). Half self-identified as Black (n=269, 49.9%) and the other half self-identified as White (n=270, 50.1%).

2.2. Latent class indicators

As shown in Table 3, the HIV-risk behavior interview included 16 items regarding treatment motivation, reported on in prior research (Mitchell, Severtson, & Latimer, 2008; Severtson, et al., 2010; Trenz, et al., 2012). Cronbach's alphas for sub-scales were over 0.7 (Trenz et al., 2012) indicating adequate reliability and internal validity (Bland & Altman, 1997; Cronbach, 1951; Santos, 1999). The questionnaire is similar to measures used by Henderson and colleagues (Henderson, et al., 2003). Participants answered on a scale from 1–4, with 1 and 2 indicating disagreement and 3 and 4 indicating agreement. To facilitate Latent Class Analysis, scores of the scale were dichotomized (i.e., numbers 1–2 were changed to 0 and numbers 3–4 were changed to 1).

2.3. Statistical analysis

Latent class analysis (LCA) was used to examine profiles of beliefs about substance use and substance abuse treatment, based on the Treatment Readiness Scale (TRS). LCA generates subgroups or classes of individuals who exhibit a similar pattern of responses (McCutcheon, 1987), assuming that the class structure accounts for the similar reporting by individuals on the indicator variables within each class (Reboussin & Anthony, 2006; Reboussin, Song,

Shrestha, Lohman, & Wolfson, 2006). Responses to the indicator variables are assumed to be statistically independent conditional on class membership, i.e., the class membership explains any association between the reported indicators (McCutcheon, 1987). Based on this assumption, classes are interpreted as homogenous and distinct from each other; within any class, the item reporting patterns differ only by random error (McCutcheon, 1987; Reboussin & Anthony, 2006; Reboussin, et al., 2006). Mplus uses a full information maximum likelihood estimation and assumes data is missing at random (Hogan, Roy, & Korkontzelou, 2004; Schafer & Graham, 2002). Covariance coverage ranged from 0.900–0.993, well over minimum thresholds for adequate coverage (Muthén & Muthén, 2010).

The sixteen TRS items were entered into the LCA model. Starting with a one class model and incrementally increasing the number of classes, a series of LCA models were fit to the data. In order to ensure that global, rather than local, maxima were reached, we used a minimum of 500 random starts. If necessary, the number of starts was increased until the log likelihood was replicated a minimum of five times. Multiple fit statistics were used to determine the best-fitting, most parsimonious model, including the Bayesian Information Criteria (BIC) (Schwartz, 1978) and the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR) (Lo, Mendell, & Rubin, 2001). Entropy, ranging from 0 to 1 with higher values indicating better class functioning, uses individual estimated posterior probabilities to summarize the degree to which the latent classes are distinguishable and the precision of assignment of individuals into classes (Ramaswamy, Desarbo, Reibstein, & Robinson, 1993). Finally, the choice of latent class solution presented was also informed by substantive criteria, such as meaningfulness in terms of the current epidemiology of drug use.

Mplus version six was used for the LCA modeling (Muthén & Muthén, 2010). Mplus assigns each individual a probability of membership in all classes. To assess the appropriateness of using Most Likely Class Membership (MLCM), we examined the average probabilities class membership by MLCM assignment (i.e., modal class). Classes were then regressed onto demographics, treatment status, and drug urinalysis results in Stata 10.0 (StataCorp, 2008).

2.5. Class associations

After deciding on the appropriate number of classes that best fit the data, we examined the association between class membership and several demographic variables as well as drug use and drug treatment factors. Although in Latent Class Analysis each individual is assigned a probability of membership in each class that can be used in subsequent analyses (Bandein-Roche, Miglioretti, Zeger, & Rathouz, 1997; Harrell, et al., 2012; Muthén & Asparouhov, 2007; Wang, Brown, & Bandein-Roche, 2005), assigning individuals to groups based on their Most Likely Class Membership is a technique often used as well (Kuramoto, Bohnert, & Latkin, 2011; Martins, Carlson, Alexandre, & Falck, 2011). We examined intra- and inter-class average probabilities to assess the appropriateness of this option. As the intraclass probabilities were high and the interclass probabilities were low (see Table 2), we felt confident with this option and exported class membership into Stata for further analyses. Examining associations with other factors is a useful step in understanding and evaluating the fidelity and utility of the resultant profiles (Petras & Masyn, 2010), as well as providing useful information for understanding relationships between drug beliefs and drug use.

3. Results

3.1. Class Membership

As shown on Table 1, Bayesian Information Criteria and Lo-Mendell-Rubin test both supported a four-class model. The model showed good fit as demonstrated by entropy of

0.82. Thus, we chose the four class model. As shown in Table 2, the classes were distinct, as demonstrated by high average intraclass probabilities ($M = 0.90$, $SD = 0.03$, minimum = 0.88) and low average interclass probabilities ($M = 0.03$, $SD = 0.04$, maximum = 0.11). The highest average probability for class membership separate from assigned class was for Class 4 being in Class 1, but was below 20% (0.11). Thus, we felt comfortable using Most Likely Class Membership.

As can be seen in Figure 1 and Table 3, Class 1 (C1) had zero probability of intention to quit right now. Thus, we referred to C1 as “Pre-contemplative”. Class 2 (C2) had higher probabilities of intention to quit, but significantly lower than class 3 (C3) and 4 (C4). Thus, we referred to C2 as “Contemplative”. Regarding Problem Recognition items 4 and 5 and Social Consequences items 15 and 16, C4 was not significantly different than C1, but was significantly lower than C2 and C3. Thus, we labeled C4 as “Post-Action”, as we interpreted this class as no longer experiencing difficulties due to substance abuse. Finally, C3, which included high probabilities for both intention to quit and problem recognition, was labeled as “Preparation/Action”.

“Preparation/Action” (C3) reported the lowest probability for “You’re going to quit using drugs someday, but not right now.” “Post-Action” (C4) reported significantly lower probabilities than the 3 other classes for ratings of Ambivalence regarding wanting to quit drugs, whereas “Contemplative” (C2) reported the highest probability. “Preparation/Action” reported the highest probability for endorsing that drug abuse treatment helps problems and they desire to attend treatment, whereas “Pre-contemplative” (C1) reported the lowest probability for both of these items. The “Contemplative” group reported the highest probability for reporting that drugs help dealing with problems and was similar to the “Pre-contemplative” group in reporting that drugs feel good. All groups had low probabilities for reporting that their drug use was “of help”, but “Preparation/Action” and “Contemplative” were significantly lower than the other two groups.

Given the complexity of figure 1, we created a separate figure using only two items, “RightNow” from the Intention to Stop Use domain and “Problem” from the Problem Recognition domain. This figure demonstrates more clearly the separation between the four groups. “Pre-contemplative” (C1) is low on both Intention to Stop Use and Problem Recognition. “Contemplative” (C2) is low on Intention to Stop Use, but high on Problem Recognition. “Preparation/Action” (C3) is high on both Intention to Stop Use and Problem Recognition. “Post-Action” (C4) is high on Intention to Stop Use, but has significantly lower Problem Recognition than the other three groups.

3.2. Associations of Class Membership with Demographic and Substance-Related Attributes

As shown in Table 4, members of the “Preparation/Action” class were significantly more likely than members of the “Contemplative” class likely to be female. Compared to “Contemplative” class members, members of the “Pre-Contemplative” class were significantly less likely to be Black and “Post-Action” members were significantly less likely to have a high school degree or GED. “Pre-Contemplative” members were less likely to have injected heroin in the past 30 days, either any day or every day. “Post-Action” members were less likely to have used over nine substances in their lifetime.

“Preparation/Action” class members were over two times more likely than “Contemplative” class members to currently be in drug treatment. We also examined any treatment in the past 6 months. Naturally, all participants who were currently in treatment were also in treatment in the past 6 months. About a quarter (23.7%) of “Pre-Contemplative” members, 38.3% of “Contemplative” participants, a majority (59.8%) of “Preparation/Action” participants, and

forty percent of “Post-Action” participants were in treatment in the past six months. When re-running the entire model using past six month treatment as opposed to current treatment, all significant results remained the same and no new significant results were added with the exception of “Post-Action” members being significantly less likely to have a high school degree or use over eight substances in lifetime, both of which were no longer significant. “Preparation/Action” members were still over 2 times more likely (AOR: 2.4, 95% C.I.: 1.5–3.7) than “Contemplative” members to have been in treatment in the past 6 months.

Compared to “Contemplative” class members, “Pre-Contemplative” individuals were more likely to have a positive urinalysis for marijuana, whereas “Post-Action” members were less likely to be positive for opioids. Although these were the only significant differences, “Post-Action” members had the lowest percentage of positive urinalyses for marijuana and cocaine as well.

4. Discussion

4.1 Review of Major Findings

The classes defined in the current study generally conformed to the Stages of Change model. Although it is sometimes conceived of as a five class model, the originators of the theory note that some investigators prefer a four-class model which conceptualizes the preparation stage as the beginnings of the action stage (Prochaska, et al., 1992). Based on fit statistics, we chose to do that here. The “Contemplative” group thought drug use helps problems, which may explain their combination of problem recognition and lack of intention to stop use. Simultaneously, however, the “Contemplative” group also endorsed that being in drug treatment would help with problems, and expressed a desire to be involved in treatment. This may be indicative of openness to the idea of treatment – perhaps the early signs of thinking about changing their substance use behaviors – which differentiates the “Contemplative” group from the “Pre-Contemplative” group.

These results are unique in that two classes that appear very similar on some items are actually very different based on responses to other items. Namely, the “Post-Action” group members and the “Pre-Contemplative” group members differed markedly in items related to intention to stop use, but answered similarly in the domains of problem recognition, drug treatment, and social consequences. Nonetheless, the “Post-Action” group was less likely than the “Contemplative” group to be positive for opioids, whereas the “Pre-Contemplative” group was actually more likely to be positive for marijuana. This suggests that clinicians may need to be careful about how they categorize individuals. That is, an intervention to promote advancement from the pre-contemplative stage toward changing substance use behavior would be different from one designed to reduce relapse rates as we would expect to see of an individual in the maintenance or “Post-Action” stage (Callaghan, et al., 2005; Migneault, et al., 2005). Correct stage identification may be an important component of treatment success.

We examined current and lifetime severity in the sample. The “Pre-Contemplative” class was less likely to be regular users of heroin. Similarly, the “Post-Action” class was less likely to have ever used nine or more substances. This finding is similar to prior research in that severity is associated with increased problem recognition (Gossop, et al., 2007; Trenz, et al., 2012). This study adds to this prior research by finding that among these cocaine and heroin users, lower levels of current severity were associated with the “Pre-Contemplative” class, whereas lower levels of lifetime severity were associated with the “Post-Action” class.

We found that females were more likely than males to be in the “Preparation/Action” stage, consistent with prior research. For example, regular female heroin injectors are more likely

to endorse intention to stop use than men (Trenz, et al., 2012). Among current substance users admitted for acute care in hospitals, significantly more women than men report being in the contemplation stage compared to the precontemplation stage of behavior change (Pollini, et al., 2006). Further, being female is associated with stated desire for cessation of both marijuana (Chen & Kandel, 1998) and cigarette smoking (Woods, Harris, Ahluwalia, Schmelzle, & Mayo, 2001). Despite prior research finding associations between physical/mental health and readiness to change (Pollini et al., 2006), we did not find that here.

4.2 Limitations

There are some limitations to this study. The classic form of the latent class model assumes observed variables within each class to be independent. This assumption is questionable in many cases including the current study. It seems likely that there are factors, such as the domains listed, along which there are continuous dimensions of severity. For example, an individual who reports they are ready to quit “right now” seems more likely to also report they plan to quit using drugs in the next 30 days. Factor Mixture Models can be useful in addressing these concerns in future research (Lubke & Muthen, 2005). Nonetheless, LCA is a useful approach and helpful complement to other methods of classification across the Dimensional-Categorical spectrum (Masyn, Henderson, & Greenbaum, 2010). In addition, if the classes truly represented only a ranking in severity, we would not expect profile classes to intersect, but yet we found the classes do intersect in interesting ways that suggest qualitative differences. It seems likely that among these items there are both quantitative and qualitative differences.

Participants in the current study are all individuals who used cocaine and/or heroin in the past 6 months. However, the Stages of Change model was developed for the full spectrum of individuals. In addition, the questionnaire for which data were available, the Treatment Readiness Scale (TRS), did not include items specific to the concept of Maintenance, unlike scales explicitly tailored to the Stages of Change model. For example, the URICA includes an item indicating the participant wants “to prevent myself having a relapse of my problem” (McConaughy, Prochaska, & Velicer, 1983; Napper, Wood, Jaffe, Fisher, Reynolds, & Klahn, 2008). Similarly, SOCRATES includes an item noting, “I want help to keep from going back to the...problems that I had before” (Hodgins, 2001). These items referring to combinations of success, but not overconfidence, are not represented in the TRS. As such, rather than use the term “Maintenance”, we used the term “Post-Action”. Further research will be needed to determine if adding items more relevant to the traditional concept of Maintenance results in similar classifications.

Further, we used Most Likely Latent Class Membership, a commonly used method, to assign participants to classes. When entropy is high, as in this study (0.82), the bias due to incorrect classification is small (Clark & Muthen, 2009). However, there was some minimal chance that some members could belong to another class. Although still less than 15% on average, this probability was highest for “Preparation/Action” members being mislabeled as “Contemplative”.

Given these concerns, it is important not to fall victim to what is referred to as the naming fallacy (Kline, 2005; Reid & Sullivan, 2009). The naming fallacy refers to the tendency to believe that a class actually is in reality what it has been named. The classes reported here were derived empirically using mathematical formulas from a computer program with no understanding of substance abuse theory. The labels were then added afterwards. Based on the outcomes, the labels do seem to be useful and consistent with the theory. In particular, the finding that “Post-Action” class members had the lowest percentages of positive urinalyses results for biomarkers of marijuana, opioid, and cocaine use suggests that they are

not simply in denial about substance use problems. However, replication is needed to be confident about these findings.

4.3 Implications

The “Contemplative” group differed from other groups in that class members indicated that they felt they had a problem and showed some openness to treatment, but were less likely to be willing to quit right now. Notably, they were the group most likely to report that using drugs helps them deal with problems. To assist patients in moving from contemplative to preparation/action stages, treatment providers may attempt to target this type of belief. Research indicates that substance beliefs can be altered in the laboratory (Copeland & Brandon, 2000), although it is easier to change beliefs in a way that is consistent with participant’s experiences (Harrell & Juliano, 2009, 2012). Thus, for example, rather than attempt to change participants’ beliefs that withdrawal will be difficult and painful, it may be better to note that withdrawal effects will subside in time or that substitution therapy can be used to counteract these withdrawal effects. Further, it may be useful to help patients develop stronger self-efficacy and expectations in their own ability to handle problems without the use of drugs.

The similarities between the “Post-Action” group and “Pre-contemplative” are somewhat difficult to interpret. It may be that problem recognition should be thought of uniquely depending on treatment readiness. In other words, clinicians may have less need to worry about problem recognition among participants who indicate they are ready to quit. On the other hand, it may be that this supports the idea that confidence in quitting is itself a warning sign. Longitudinal models may help to answer this question in greater detail. Overall, this study demonstrates the usefulness of Latent Class Analysis in providing empirical data to inform a prevalent paradigm of behavior change.

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Figure 1.

Four class solution of a latent class analysis of 539 users of cocaine and/or heroin in Baltimore, MD. Estimated probabilities for item endorsement are graphed based on latent class membership. Error bars indicate standard errors of estimated probabilities.

Figure 2.

Two items extracted from larger 16-item four class solution of a latent class analysis of 539 users of cocaine and/or heroin in Baltimore, MD. Estimated probabilities for item endorsement are graphed based on latent class membership. Error bars indicate standard errors of estimated probabilities.

Fit statistics and entropy for a latent class analysis of 16 treatment readiness statements among 539 users of cocaine and heroin.

Table 1

Classes	LL ^a	parameters	BIC ^b	LMR ^c	Entropy	s.c. r.f. (f) ^d
1	-4343.82	16	8788.27	N/A ^e	N/A ^e	N/A ^e
2	-3853.09	33	7913.74	p < .001	0.927	.19 (104.1)
3	-3718.69	50	7751.87	p < .001	0.780	.18 (97.2)
4	-3664.12	67	7749.66	p = .022	0.817	.09 (47.4)
5	-3624.75	84	7777.84	p = .053	0.838	.02 (11.2)
6	-3589.59	101	7814.44	p = .395	0.788	.02 (11.3)

^aLog Likelihood;
^bBayesian Information Criteria;
^cLo-Mendell-Rubin adjusted likelihood ratio test;
^dsmallest class relative frequency (frequency);
^eNot Applicable
Ideal number of classes based on fit statistic shown in bold.

Table 2

Average latent class probabilities for Most Likely Latent Class Membership (MLLCM) by Latent Class

	Latent Class 1	Latent Class 2	Latent Class 3	Latent Class 4
MLLCM 1	0.914	0.034	0.012	0.025
MLLCM 2	0.026	0.875	0.113	0.000
MLLCM 3	0.004	0.098	0.890	0.007
MLLCM 4	0.025	0.001	0.036	0.939

Intra-class probabilities are shown in bold.

Table 3

Overall class prevalence and conditional probabilities for “Treatment Readiness” responses among cocaine and heroin users.

Domain	Abbreviation	Statement	n (%)	Latent Class Assignment based on ML-LCM			
				C1% (N)	C2% (N)	C3% (N)	C4% (N)
				11.3 (61)	37.6(203)	42.5(229)	08.5 (46)
Conditional Probabilities (Standard Errors)							
Intention to Stop Use	RightNow	You are ready to quit using drugs right now.	72.9	00.0(.00)	62.5(.06)	99.2(.01)	90.5(.08)
Intention to Stop Use	30Days	You plan to quit using drugs in the next 30 days.	71.3	12.7(.06)	54.4(.06)	99.1(.02)	89.5(.05)
Intention to Stop Use	SixMonths	You plan to quit using drugs in the next six months.	88.8	52.9(.08)	85.6(.03)	98.3(.02)	95.4(.03)
Problem Recognition	Problem	Your drug use is a problem for you.	85.8	41.0(.08)	97.2(.01)	100.0(.00)	25.0(.15)
Problem Recognition	Trouble	Your drug use is more trouble than it's worth.	87.3	42.7(.08)	96.8(.02)	98.8(.01)	46.0(.12)
Problem Recognition	UnderControl(R)	Your drug use is under control.	24.5	61.3(.08)	09.0(.03)	17.1(.03)	81.2(.09)
Ambivalence	Someday	You're going to quit using drugs someday, but not right now.	62.3	84.6(.05)	92.7(.04)	29.9(.02)	47.6(.09)
Ambivalence	Ambivalence	Part of you wants to keep using drugs and another part of you wants to quit.	77.1	73.7(.06)	94.0(.03)	67.2(.04)	52.2(.09)
Drug Treatment	TxHelpProblems	Being in drug treatment would help you with a lot of your problems.	85.4	28.9(.07)	92.3(.03)	98.2(.02)	57.6(.10)
Drug Treatment	DrugTx	You would like to get into drug treatment.	83.1	20.1(.06)	93.3(.02)	97.4(.02)	48.7(.10)
Drug Treatment	NoDrugTx(R)	You can solve your problems without a drug treatment program.	23.2	79.7(.06)	14.3(.03)	05.9(.03)	72.0(.09)
Positive Drug Beliefs	HelpProblems	Using drugs helps you deal with your problems.	46.0	40.6(.07)	65.8(.04)	31.2(.05)	34.9(.09)
Positive Drug Beliefs	FeelGood	Using drugs makes you feel good.	75.0	86.6(.05)	89.7(.03)	61.7(.05)	56.8(.09)
Positive Drug Beliefs	Helpful	Your drug use is of help to you.	13.4	24.7(.06)	08.8(.03)	10.0(.03)	35.8(.08)
Social Consequences	FamilyFriends	Your drug use is causing problems with your family or friends.	77.2	32.8(.07)	84.7(.03)	88.2(.03)	48.3(.09)
Social Consequences	JobTrouble	Your drug use is causing problems in finding or keeping a job.	68.9	22.3(.06)	84.9(.03)	75.8(.04)	24.8(.08)

Note: (R) indicates that the meaning of the statement is “Reverse” of other items in the domain. Original scoring is retained.

Table 4
Association between latent class membership and characteristics of 539 heroin and cocaine users in Baltimore, MD.

	Class 1 "Pre-Contemplative" N = 61, 11.3%		Class 2 "Contemplative" N = 203, 37.6%		Class 3 "Preparation/Action" N = 229, 42.5%		Class 4 "Post-Action" N = 46, 8.5%	
	N (%)	aOR (95%CI)	N (%)	Reference class	N (%)	aOR (95%CI)	N (%)	aOR (95%CI)
<i>Gender</i>								
Male	43 (70.5)	1.0	129 (63.5)	-	111 (48.5)	1.0	27 (58.7)	1.0
Female	18 (29.5)	0.8 (0.4, 1.7)	74 (36.5)	-	118 (51.5)	1.6 (1.0, 2.6)	19 (41.3)	1.5 (0.6, 3.7)
<i>Age</i>								
18–25 years old	15 (24.6)	1.0	51 (25.1)	-	30 (13.1)	1.0	7 (15.2)	1.0
26–34 years old	14 (23.0)	1.0 (0.4, 2.5)	69 (34.0)	-	82 (35.8)	1.7 (0.9, 3.3)	16 (34.8)	1.2 (0.3, 4.6)
35–39 years old	19 (31.2)	1.8 (0.6, 5.4)	50 (24.6)	-	73 (31.9)	1.7 (0.8, 3.5)	11 (23.9)	0.9 (0.2, 4.0)
40–50 years old	13 (21.3)	1.9 (0.6, 6.1)	33 (16.3)	-	44 (19.2)	1.5 (0.7, 3.5)	12 (26.1)	1.7 (0.4, 7.7)
<i>Race</i>								
White	35 (57.4)	1.0	116 (57.1)	-	102 (44.5)	1.0	17 (37.0)	1.0
Black	26 (42.6)	0.3 (0.1, 0.7)	87 (42.9)	-	127 (55.5)	1.1 (0.6, 2.0)	29 (63.0)	0.8 (0.3, 2.5)
<i>Education</i>								
Less than High School	23 (37.7)	1.0	103 (50.7)	-	96 (41.9)	1.0	20 (43.5)	1.0
High School Grad/GED	23 (37.7)	1.0 (0.5, 2.1)	77 (37.9)	-	96 (41.9)	1.2 (0.8, 2.0)	16 (34.8)	0.4 (0.1, 1.0)
More than High School	15 (24.6)	1.8 (0.7, 4.5)	23 (11.3)	-	37 (16.2)	1.1 (0.6, 2.1)	10 (21.7)	1.5 (0.5, 4.4)
<i>Injection Heroin Use</i>								
Never Used	30 (49.2)	1.0	42 (20.7)	-	71 (31.0)	1.0	22 (47.8)	1.0
No Use in Past 30 Days	10 (16.4)	0.8 (0.3, 2.1)	28 (13.8)	-	40 (17.5)	0.7 (0.4, 1.5)	8 (17.4)	0.4 (0.1, 1.5)
Some Use Past 30 Days	10 (16.4)	0.3 (0.1, 0.9)	51 (25.1)	-	45 (20.0)	0.6 (0.3, 1.1)	13 (28.3)	1.5 (0.5, 4.5)
Everyday Use Past 30	11 (18.0)	0.2 (0.1, 0.5)	82 (40.4)	-	73 (31.9)	0.7 (0.4, 1.5)	3 (6.5)	0.3 (0.1, 1.2)
<i>Drugs Used in Lifetime</i>								
Less than Nine	28 (47.5)	1.0	77 (37.9)	-	101 (44.3)	1.0	31 (68.9)	1.0
Nine or More	31 (52.5)	0.6 (0.3, 1.3)	126 (62.1)	-	127 (55.7)	1.0 (0.6, 1.7)	14 (31.1)	0.3 (0.1, 1.0)
<i>Physical Health^a</i>								
No Med/Physical Ill	16 (26.2)	1.0	72 (35.8)	-	79 (34.5)	1.0	13 (28.3)	1.0
Medical/Phys Illness	45 (73.8)	1.4 (0.7, 3.1)	129 (64.2)	-	150 (65.5)	0.9 (0.5, 1.4)	33 (71.7)	1.5 (0.6, 3.8)
<i>Mental Health^b</i>								

	Class 1 "Pre-Contemplative" N = 61, 11.3%		Class 2 "Contemplative" N = 203, 37.6%		Class 3 "Preparation/Action" N = 229, 42.5%		Class 4 "Post-Action" N = 46, 8.5%	
	N (%)	aOR (95%CI)	N (%)	Reference class	N (%)	aOR (95%CI)	N (%)	aOR (95%CI)
No Emo/Behav	31 (50.8)	1.0	102 (50.8)	-	98 (42.8)	1.0	22 (47.8)	1.0
Emotional/Behavioral	30 (49.2)	1.0 (0.5, 2.1)	99 (49.3)		131 (57.2)	1.3 (0.8, 2.0)	24 (52.2)	(0.6) 0.2, 1.6
<i>Drug Treatment</i>								
No Current Drug Tx	53 (89.8)	1.0	165 (82.1)	-	145 (64.4)	1.0	31 (68.9)	1.0
Current Drug Tx	6 (10.2)	0.4 (0.2, 1.2)	36 (17.9)	-	80 (35.6)	2.5 (1.4, 4.5)	14 (31.1)	0.7 (0.2, 1.9)
<i>Urinalyses</i>								
Negative for Marijuana	40 (71.4)	1.0	158 (87.3)	-	182 (89.7)	1.0	30 (90.9)	1.0
Positive for Marijuana	16 (28.6)	2.8 (1.2, 6.3)	23 (12.7)	-	21 (10.3)	0.9 (0.5, 1.8)	9 (9.1)	0.6 (0.1, 2.8)
Negative for Cocaine	26 (46.4)	1.0	82 (45.3)	-	79 (38.9)	1.0	22 (66.7)	1.0
Positive for Cocaine	30 (53.6)	1.0 (0.5, 1.9)	99 (54.7)	-	124 (61.1)	1.4 (0.9, 2.2)	11 (33.3)	0.5 (0.2, 1.2)
Negative for Opioids	23 (41.1)	1.0	51 (28.2)	-	59 (29.1)	1.0	20 (60.6)	1.0
Positive for Opioids	33 (58.9)	0.5 (0.5, 2.6)	130 (71.8)	-	144 (70.9)	1.7 (1.0, 3.0)	13 (39.4)	0.4 (0.1, 1.0)

Significant (p < .05) findings are in bold. aOR = Odds Ratio adjusted for all variables in the model.

^a Ever went to hospital due to medical or physical illness

^b Ever went to psychologist/psychiatrist due to emotional or behavioral problem