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Semantic Networks, Schema Change, and Reincarceration Outcomes of Therapeutic Community Graduates

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Abstract

Background—Therapeutic community (TC) clinical theory assumes that peer interaction forms a framework for social learning that will displace ingrained cognitive schema that underlie substance abuse. There has been no direct test of this hypothesis.

Methods—We analyzed the content of a large corpus of written affirmations (pushups) and corrections (pull-ups) exchanged between 2,342 male TC graduates. We encoded the content of the written communications as semantic networks of words, in which words that appear in the same brief document are connected and are referred to as word combinations. Loss of combinations and gain of combinations each measured an aspect of change in word combination patterns across time. These measures were used in a multivariable Cox model to predict the hazard of reincarceration for residents while controlling for race, age, score on the Level of Service Inventory-Revised and the total number of pushups and pull-ups sent to peers.

Results—Residents' reincarceration risk varied significantly with changes in word combinations used over the course of treatment. The implications of the model were visualized to reveal the complicated nature of the interaction terms included in the model. The visuals suggested that residents who changed their expression patterns the least – lost and gained few word combinations – had the highest reincarceration risk after graduation.

Conclusions—The results suggest that TC success, in terms of increasing time to reincarceration, depends on how residents change their interaction patterns through the treatment process. Merely interacting with others does not explain success; but whether those interactions change does explain outcomes, which may imply more fundamental changes are occurring.

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No conflict declared.

Keywords

Therapeutic Community; reincarceration; schema; network analysis; survival analysis

1 Introduction

Therapeutic community (TC) clinical theory sees addiction as a disorder of the entire human being (Broekaert, 2001; De Leon, 2000; Perfas, 2012). TC residents often arrive with serious social deficits traceable to their years of substance abuse, including unrealistic thinking and dysfunctional interpersonal interactions (Broekaert, 2001; De Leon, 2000). While these deficits may stem from substance abuse, they also serve to maintain it (De Leon, 2000). Treatment is unlikely to succeed unless it displaces these deeply ingrained anti-social approaches to living (De Leon, 1995). This view extends naturally to criminogenic traits (Day & Doyle, 2010; Stevens, 2013), and randomized studies, systematic reviews and meta-analyses demonstrate that TCs can be effective in treating both substance abuse and criminal behavior (Lees, Manning, & Rawlings, 2004; Mitchell, Wilson, & MacKenzie, 2007; Pearson & Lipton, 1999; Sacks, Sacks, McKendrick, Banks, & Stommel, 2004; Shuker, 2013; Vanderplasschen et al., 2013; Wexler, De Leon, Thomas, Kressel, & Peters, 1999). Though the evidence of TC effectiveness includes numerous studies, the effect size is moderate² and there is evidence of variability in the existing set of outcome studies (Mitchell et al., 2007). Much work has yet to be done to explain the variability through examination of the mechanisms of treatment (Kazdin & Nock, 2003), which could lead to improvements in program outcomes by way of identifying key ingredients. This study takes a step in the explanatory direction by examining changes in resident expressions throughout TC treatment and their relationship with reincarceration.

The TC tool for achieving the changes that have been attributed to TCs is the community of residents and staff as a whole (De Leon, 2000). Community is so central to TCs that the physical facilities are constructed in such a way as to foster prosocial interactions. For instance, recreation rooms are small and lack hidden corners and furniture is placed such that individuals will be in close proximity and face one another (De Leon, 2000; Hawkins & Wacker, 1986). Constant interaction with peers is also necessary since residents must maintain the community, they do so in teams, and they do so according to a rigorous schedule (Debaere, Vanheule, & Inslegers, 2014).

TC clinical theorists argue that the structured TC community influences residents through social learning (De Leon, 1990; Miller, Sees, & Brown, 2006). De Leon (2000), states that, "Learning, both formal and informal, is a central value in the TC...All experiences in recovery can and should be used to advance personal growth..." (pg. 79). Peer feedback is continuous throughout the day, and is formalized in peer to peer interventions known as pull-ups and pushups (De Leon, 2000). A pull-up is a peer correction for norm violating

²A 2007 meta-analysis of 30 evaluations gleaned from the literature suggests a combined odds ratio of 1.38, or a 38 percent higher odds of avoiding reincarceration for TC participants (graduates and non-completers) within one year of leaving a TC. This amounts to an approximate 8 percentage point reduction in the probability of one-year reincarceration assuming a control group with a 50 percent reincarceration probability.

behavior, while a pushup is an affirmation, in which a resident identifies a peer who has shown personal growth or benefitted others (De Leon, 2000; Doogan, Warren, Hiance, & Linley, 2010; Hawkins & Wacker, 1986; Miller et al., 2006; Patenaude, 2005; Warren, Doogan, et al., 2013; Warren, Hiance, Doogan, De Leon, & Phillips, 2013). Simpson's TCU treatment process model (Simpson, 2004) sees this and other peer interactions as a part of program participation that leads to a therapeutic relationship with the community, which can result in psychosocial and behavioral changes.

One way to conceptualize psychological change in residents through interaction with peers and the broader social environment is that it causes a change in their cognitive structures known as schemas (Rumelhart, 1980; Simons & Burt, 2011; McVee, Dunsmore, & Gavelek, 2005), theoretical constructs that act as the building blocks for an individual's understanding of the world (Plant & Stanton, 2013; Simons & Burt, 2011). There is evidence that substance abuse is characterized by maladaptive schemas (Brotchie, Hanes, Wendon, & Waller, 2007; Shorey, Stuart, Anderson, & Strong, 2013), and that maladaptive schemas stemming from childhood stresses can result in maladaptive adult behavior, which can result in crime (Simons & Burt, 2011). There is further evidence that residential substance abuse treatment can alter schema (Roper, Dickson, Tinwell, Booth, & McGuire, 2010). To the TCU treatment process model, changes in schema are the psychosocial changes required to lead to behavioral change and to positive long term outcomes. At this point, however, no researcher has sought to link changes in an individual's schema during TC treatment with outcomes such as reincarceration after graduation.

Several methods of quantifying schemas have been proposed. The most common method in mental health and substance abuse research has been to administer the Young Schema Questionnaire (Young, 1994), which taps into specific dysfunctional schema which serve as targets of therapeutic intervention (Stopa, Thorne, Waters, & Preston, 2001). Social network researchers have taken a different approach. In a seminal article, Carley and Palmquist (1992) cited symbolic interactionists (Blumer, 1969; Stryker, 1980), social constructivists (Knorr-Cetina, 1981), and others (Goffman, 1974; Johnson-Laird, 1986) as theorists recognizing that the human brain stores information in a form that is reasonably modeled as a network of constructs. They view speech, behavior, and other expressions as manifestations stemming directly from individuals' cognitive schematic organization. Thus, speech or written text can be seen as a sample from underlying knowledge structures (Carley & Palmquist, 1992). Logically structuring written communications as word or construct networks—referred to hereafter as semantic networks—to denote the relationships among words or constructs may facilitate study of an individual's latent schematic structures. Examples of this approach can be found in Carley (1997) and Danowski (2010). We adapted these approaches for use in our study of TC residents.

Some TCs, as a normal part of their operation, collect formalized communications from individual residents to their peers. Such communications were available from the TCs we studied throughout individuals' treatment processes in the form of personal affirmative and corrective messages (pushups and pull-ups) given to peers. These communications act as the source of personal expression from which semantic networks are drawn. Importantly, while these messages include two different classifications (affirmative and corrective), we do not

differentiate them in the analysis because regardless of their valence, they are still expressions of underlying knowledge or beliefs. That some residents may be prone to giving a different ratio of corrective to affirmative interactions can be controlled in a multivariable analysis.

We use well known Piagetian constructs to link theory of cognitive schemas to the methods and results of the present study. Three important terms for discussing schema change are disequilibrium, assimilation, and accommodation. The following is a simplification which can be further explored in the work of Piaget and Cook (1952). Disequilibrium is a state of mind in which observations of the world do not fit with expectations. To release the tension of disequilibrium, one must find harmony between observation and expectation. This is most easily achieved if the new observations can be made sense of given one's current schemas; this is called assimilation, the metaphorical bolting on of new internally consistent information. If the observations contradict existing schemas, the schemas need to be adapted to bring observation and expectation back into alignment; this is called accommodation, the metaphorically more intensive disassembly and restructuring of schema.

The goal of TCs is to address social deficiencies and replace existing maladaptive understandings of and approaches to successfully operating in society (De Leon, 1995). In Piagetian terms, the TC aims to facilitate accommodation of beliefs and behaviors that displace residents' incompatible and often deeply ingrained criminal value systems. On this fundamentally new structure, the TC also facilitates the assimilation of psychological and behavioral mechanisms that link the new structure to successful navigation of the complexities of social living. We argue that textual expressions from residents may contain information about these changes as they occur through treatment. Cognitive structural changes and in turn semantic network changes could vary considerably in their effect on prosocial behavior that relates to treatment outcomes. However, the lack of previous work led us to the simple approach of attempting to identify a relationship between semantic network change, broadly defined, and treatment outcomes.

In this study we drew on an archive of affirmative and corrective messages sent by TC residents to their peers. We represented an individual's given messages as networks of selected constructs that appeared together in small pieces of text. We treated these networks as though they reflected a part of residents' cognitive schemas that are relevant to community life. We referred to the networks as semantic networks, and characterized change in the semantic networks of TC residents over time in the form of simple individual level measures that captured deletions and additions of construct connections in this network. While we recognize that there could be many sources of variation in the translation from cognitive schema to construct networks, we treated these measures as though they, potentially noisily, reflected change in the underlying schemas of the residents. The measures were used as predictors of post-graduation reincarceration in a multivariable analysis (i.e., to evaluate the likelihood of a signal within the noise). We hypothesized that residents who showed more change in their semantic networks during treatment by additions and deletions would have a lower risk of reincarceration after graduation from the TC program.

2 Methods

2.1 Data

The resident data examined in the study were gathered from three minimum security facilities for felony offenders operated as TCs. Two of the TCs served predominantly rural catchment areas, while the third served a mixed urban, rural, and suburban catchment area. Among the three TCs, there were a total of four all male units. The number of beds in each unit ranged from 50 to 90. The length of the data collection periods varied by TC unit. Two of the units collected the necessary data from early 2006 until late 2008. The other two collected data from early 2001 until late 2008. In total, the sample of 2,342 residents gave 89,628 pull-ups and 177,238 pushups. Individuals that were expelled from the programs for any reason prior to graduation were not included in this study. Thus, this study is focused on all residents that graduated from the TCs during the specified time periods.

The data were originally captured for clinical purposes in the TCs. When giving a pull-up or a pushup residents would fill out a form including the sender, the receiver, the date and the content of the pull-up or pushup. A committee of senior residents and staff reviewed them for legitimacy; for instance, if the committee believed that a pull-up was given in revenge for a previous pull-up received, it would be disallowed. Generally, the committee vetted the content for legitimacy; bogus affirmations or corrections—perhaps given to game the system—were excluded if identified. Vetted pull-ups and pushups would then be read aloud at community meetings and subsequently entered into an electronic database. Thus, the studied messages are only those that passed the committee's vetting process. Pushups and pull-ups tended to be about one sentence long; some are two sentences long, and some were a single word.

2.2 Measures

2.2.1 Control variables—Upon entrance to the TC program, residents' *age*, *race*, and score on the *Level of Service Inventory—Revised (LSI-R)* were captured. The *LSI-R* is a 54 item self-report additive scale intended for offender classification. It measures substance abuse history in addition to such predictors of reincarceration as antisocial attitudes, educational attainment, and employment skills (Andrews & Bonta, 1995). High scores indicate a higher risk for misbehavior in custody and a higher risk of reincarceration after release. In a study of the predictive validity of the LSI-R when used with substance abusing criminal offenders Kelly and Welsh (2008) found that the instrument had good internal consistency reliability (Chronbach's alpha of .86) and predicted reincarceration ($p < .001$). *Race* is a dichotomous indicator capturing whether the individual was European American or of minority ethnicity (Minority = 1). *Sentpush* and *sentpull* capture the number of pushups and pull-ups a resident sent during his or her stay in the program. The *unit* variable indicates the TC unit to which an individual belonged.

2.2.2 Semantic network independent variables—The semantic network variables captured additions or deletions of word combinations used by a given resident. A word combination was a dyad of words, both of which were found in the *same* pushup or pull-up message given by an individual resident. For example, the simple phrase “helpful brother”

contains two words and thus constitutes a single word combination—helpful-brother. In terms of schema, this word combination signifies a potential underlying acknowledgement of the relationship between the constructs of brotherly social bonds and helpfulness. Because schema are thought to connect concepts rather than words (Carley & Palmquist, 1992), we took steps to consolidate words with similar meanings as has been done in other works (Carley, 1997; Danowski, 2010). Specifically, we extensively stemmed the full collection of words. Using “help” as an example, the small collection of words including “help,” “helpful,” “helping,” and “helpfulness” were all tagged to belong to the construct “help.” Thus, variations in word use were reduced.

Longer phrases include more word combinations. For example, a three word phrase constitutes a total of three two-word combinations, or a triangle of three connected words. In total, one can imagine a set of such combinations forming a single, possibly large and complex network of words—the *semantic network*. Variables drawn from it constituting our change measures were referred to as *semantic network variables*.

In order to capture *changes* in a resident's semantic network, we needed to know how many word combinations were added, removed, or exhibited no change between the two halves of the treatment period for a given resident. Two semantic network variables—*gain* and *loss*—captured the change. If the helpful-brother combination, for example, was found in the first period but not the second, then it contributed to the *loss* value because the resident stopped using phrases containing that combination in the second half of the program. If the helpful-brother combination was found in the second period but not the first, it contributed to the *gain* value. Finally, no contribution was made to either value if the helpful-brother combination was found in either both periods or neither period because no change was evidenced.

A third semantic network variable, *initial combinations*, captured the initial number of word combinations created during the first time period. This controlled for the possibility that loss of combinations may simply reflect a higher initial number. It is also possible that residents who were initially more complex in their verbalizations differed in some way from their peers with respect to reincarceration outcomes.

The described calculations were completed for all residents individually, for all of their given messages, but only for a subset of 514 constructs deemed *a priori* by the researchers to be relevant constructs. Constructs were deemed relevant if found at least 20 times in the data among all participants. Pronouns, articles, conjunctions or other words mostly used for proper sentence construction and not having meaning important to the TC were excluded. As previously mentioned, a preprocessing step including altering word synonyms by converting them to the same base form. Synonyms included primarily typographical errors and misspellings found in the data, but also included modified versions of the same word (e.g., “help,” “helping,” and “hleping” [sic]).

2.2.3 Dependent variable—The dependent variable was the amount of time to reincarceration or to the follow-up point at which no reincarceration had occurred yet. For some individuals it is not known whether they were reincarcerated after the follow-up point;

these are right-censored observations. The follow-up point was in October of 2010 for all residents, when the local state department of rehabilitation and corrections supplied reincarceration information for the entire sample, regardless of when the individuals' graduated the TC. Graduation dates varied between 2001 and 2008.

2.3 Quantitative Analysis

Due to the censored nature of the dependent variable, the Cox proportional hazards model was used in this analysis. Notably, our use of this model is a departure from much of the TC outcome research published thus far, which have focused on one-year probability of re-offense, relapse, or other relevant outcome. Model fitting resulted in an estimate of the relative hazard rate of reincarceration conditional on the variables included in the model. Thus, while the dependent variable is time until reincarceration, the model captures differences across groups not as differences in time, but rather differences in risk, or a rate of reincarceration. Controlling for *race*, *age*, *LSI-R*, *sentpush*, and *sentpull*, the primary goal was to estimate how the hazard rate differs depending on the semantic network variables *initial combinations*, *loss*, and *gain*. Because the initial number of combinations, the loss condition, and the gain condition may all be interwoven in complex ways, we additionally included the three two-way interactions possible between the three semantic network variables. Thus, the model additionally included *loss* $\times$ *gain*, *initial combinations* $\times$ *loss*, and *initial combinations* $\times$ *gain*. This provided the ability to assess, for example, how *loss* affected the hazard rate conditional on low versus high values of *initial combinations*, as opposed to assuming *loss* had the same effect on the hazard regardless of the level of *initial combinations*.

The data were drawn from four different TC units that could be heterogeneous in terms of overall reincarceration rate. To properly control for this we stratified the analysis by the *unit* variable. This is similar to a fixed effects approach to hierarchically structured data (Allison, 2009) and is more appropriate than a random effects approach due to the small number of higher level units.

3 Results

3.1 Descriptive

Table 1 contains descriptive statistics for each independent variable in the analysis. Data from a total of 2,342 residents were included in the analyzed dataset. Twenty-three percent of the residents reported African heritage. The mean age was 28.13 years (SD=8.73). The mean LSI-R was 27.29 (SD=6.98), which is very similar to the mean *LSI-R* of a nationally representative sample of the US prison population (M=27.1, SD=7.9; Kelly & Welsh, 2008). The mean numbers of pushups and pull-ups sent were 75.68 (SD=70.29) and 38.27 (SD=36.03), respectively. The pushup and pull-up distributions were skewed, and the pushup distribution contained 17 zeros while the pull-up distribution contained none. The mean number of initial combinations was 80.60 (SD=76.97), the mean number of lost combinations (*loss*) was 62.72 (SD=60.88), and the mean number of gained combinations (*gain*) is 74.62 (SD=74.46). The three semantic network variables and the numbers of sent pushups and pull-ups were all positive skewed, as evidenced by the difference between their

respective means and medians and the high maximum values relative to their means and minimums shown in Table 1.

3.2 Multivariable Cox Proportional Hazards Model

Table 2 contains the parameter and standard error estimates representing the model results. *Sentpush*, *sentpull*, *initial combinations*, *loss*, and *gain* were all divided by 100 prior to analysis in order to scale up their parameter estimates and standard errors proportionally. We report relationships with a *p*-value between .05 and .10 as marginally significant, and that below or equal to .05 as significant. We refer to the hazard rate as the risk of reincarceration, or simply risk, which should not be confused with the *LSI-R* measure that is often described as a composite measure that is *correlated* with the risk of reincarceration.

Starting with the control variables in the models, minority status was unrelated to the risk of reincarceration ($b = -.048$, $p = .524$). Age was negatively and significantly associated with risk ($b = -0.012$, $p < .001$). LSI-R was positively and significantly associated with risk ($b = 0.046$, $p < .001$). The model suggests that the numbers of sent pushups ($b = .075$, $p = .192$) and pull-ups ($b = .004$, $p = .969$) were unrelated to risk.

Here we report parameter estimates for semantic network variables. However, due to the inclusion of interactions, and the resulting complicated nature of individual parameter estimates, we reserve technical interpretation for the next two paragraphs that describe a visualization of the results. The parameter estimate for *initial combinations* was positively and marginally associated with risk ($b = 0.742$, $p = .059$). The *loss* variable had a negative and marginally significant association with risk ($b = -0.903$, $p = .062$). The model showed no relationship between *gain* ($b = -.063$, $p = .496$) or *initial combinations* $\times$ *loss* ($b = -.034$, $p = .400$) and risk, controlling for other variables and interactions in the model. The model showed a positive and significant association between the *loss* $\times$ *gain* interaction and risk ($b = 0.670$, $p = .016$) and a negative and significant association between the *initial combinations* $\times$ *gain* interaction and risk ($b = -0.453$, $p = .025$).

Because of the presence of interactions terms among the focal independent variables, it was difficult to interpret them directly. Instead of trying to make sense of the parameter estimates *per se*, we produced a visualization to facilitate a stylized understanding of the model results as a whole. Figure 1 shows predictions of the hazard rate given various values of the focal independent variables *loss* and *gain*. Two sets of predictions are drawn and shown in two separate panes, one for each of two fixed values of *initial combinations*. For the conditional predictions that are visualized, continuous independent variables (e.g., age, LSI-R) were set at their mean and the race dichotomous variable was set at zero, which indicated non-minority residents.

The plots in figure 1 show a fairly simple pattern. The surface shows a strong risk spike in the region of the plot where the measures of change—loss and gain—are lowest. Aside from this region, the surface shows a downward slope towards a relatively uniform risk in other regions. The second pane in Figure 1 shows that the steepness of this spike appears to increase with the number of initial combinations a resident exhibited, and the reincarceration risk at the zero *gain* and *loss* point is nearly double that found in the first pane. However, the

essential shape of the prediction surface is approximately the same across the two plots; the condition in which a resident is measured to have zero *gain* and *loss* is a condition associated with a relatively high risk of reincarceration.

4 Discussion

The purpose of this study was to examine how the risk of reincarceration varies with changes in the way therapeutic community residents express themselves through transcribed affirmative and corrective interactions with other residents. We characterized these expressions as semantic networks of constructs, and we viewed our results as though changes in semantic networks signified some change in underlying schemas. While it is understood that semantic networks are likely to be the result of a combination of cognitive schematic organization and noise from many sources, our results suggest that changes in semantic networks have a detectable relationship with reincarceration risk. Given empirical work on network representations of knowledge drawn from textual expressions, the theoretical work connecting these representations to cognition, and the observed relationship between semantic network change and reincarceration in our study, a causal connection from cognitive structural change to textual expression change is plausible and potentially attributable to TC treatment. This is also consistent with the TCU treatment process model, in which personal change is said to be due to real engagement and investment in the therapeutic relationship with treatment components (i.e., the community in TCs) (Simpson, 2004). Conversely, results showed that variation in external behaviors, as measured by sending more pushups or pull-ups, was insufficient to explain resident reincarceration outcomes. This is consistent with the TC clinical literature, in which De Leon (2000) has commented, "Some residents can learn to walk and talk the expectations of the community yet still not achieve sufficient change to assure their recovery in the larger community..." (pg. 362). In sum, our study findings are suggestive of a useful link between cognition change that is detectable through expression change and TC treatment.

Overall, the relationship between semantic network change and reincarceration appears fairly straightforward. Change, as we operationalized it, could consist of discarding construct relationships, adding them, or both. Residents who showed either type of change or both were reincarcerated at a lower rate than individuals that showed little or no change. Interestingly, the model did not show evidence that the combination of discarding old patterns *and* adding new patterns had any uniquely beneficial effect.

The theoretical background of schema and the basic mechanisms by which they change have a reasonable fit with the findings of this study and the theoretical basis of the TC. On the one hand, the finding that residents who lost considerable proportions of their initial written expression patterns show better outcomes is consistent with Piaget's learning construct called accommodation. The removal of old written patterns in tandem with relatively good outcomes suggests, at the least, the consideration of a behavioral change through restrictions on older speech patterns that may have been deemed counterproductive in the context of the TC. To the extent that expression restriction reflects schema change, it suggests a restructuring of one's schemas to bring the resident's understanding of the world into harmony with experiences in the community (i.e., accommodation). Such residents may be

pruning schema to eliminate ideas or modes of operation that are counter to the TC way of living. That these residents were better at avoiding reincarceration suggests that the results reflect a fundamental beneficial change. On the other hand, even residents who show little loss of old patterns may be similarly better off in the case of the substantial emergence of new expression patterns. This finding is more consistent with Piaget's construct of assimilation, in which perhaps a skeleton of a schematic structure that is consistent with TC ideals is already present, and therefore only requires the existing structure to be fleshed out. Such residents may have a higher level of readiness prior to treatment, which can be measured by the Circumstances, Motivation, Readiness, and Suitability (CMRS) scales (De Leon, Melnick, Kressel, & Jainchill, 1994). Both of these findings are contrasted with the group of residents that changed the least (i.e., lost and gained relatively few written patterns) that showed the fastest rate of reincarceration.

While theory might suggest that the strongest benefit would come from the simultaneous loss of old structure and the gain of new structure, the results show no apparent special benefit of both occurring despite each showing benefit in and of itself. This finding highlights the importance of designing studies to identify or rule out mechanisms of therapeutic change (Kazdin & Nock, 2003). While the finding itself does not clearly point to a mechanism, it does raise potential directions of thought about the mechanisms at work. The finding may be the result of the short time frame allotted for treatment in the TCs that were studied. While new schema patterns may have begun emerging, perhaps they had insufficient time to develop and solidify. Alternatively, perhaps the use of word patterns as a proxy for schemas resulted in an error such that the newly emerging word structures actually represent a *process* of change, rather than a complete and stable cognitive change. While the short treatment period may have opened the door for a new structure to emerge, the replacement structure may take considerably more time to develop than is available in a six month treatment program. This possibility aligns with research that has shown the benefits of longer treatment times and aftercare on TC resident outcomes (Burdon, Messina, & Prendergast, 2004; Knight, Simpson, & Hiller, 1999; Martin, Butzin, Saum, & Inciardi, 1999; Wexler, De Leon, et al., 1999; Wexler, Melnick, Lowe, & Peters, 1999).

Our results also showed that residents exhibiting little or no change are worse off in terms of reincarceration rate if their written patterns were initially more complex. Intuitively, and theoretically, this could represent residents that entered the program with a commitment to their TC-incompatible beliefs to the extent that they had no problem voicing them and took few steps to change. This may suggest the need for closer attention by practitioners to the patterns of affirmations and corrections residents are giving early in treatment. Though, given only this initial study, the precise patterns to look for are not yet clear.

This type of research could be expanded in several ways. To maintain a level of simplicity for an initial attempt at using routinely collected qualitative TC data to examine resident change across time, the methods did not go beyond measuring the additions and deletions from a set of word (construct) combination patterns of TC residents. Indeed, multiple qualitative changes to a network could result in equivalent change statistics given the measures that were used. We therefore acknowledge that our simplified approach could not identify more complex patterns of structural change that might be able to further delineate

TC residents in terms of the quality of semantic changes that occurred. For example, is there a structural change measure that can differentiate between residents who learned to talk the TC talk, but who failed to make any lasting fundamental changes? One possibility is that residents learning to talk the talk may be more likely to repeat common phrases than they are to make similar expressive statements in varying ways. The latter would be indicative of integrated knowledge while the former would be more reflective of memorization. These different patterns of expression may show up as distinctive network structures; the challenge then is to use the right set of characterizing network summary statistics. The fields of graph theory and network science offer a systematic mathematical language for characterizing and comparing networks. Whereas more traditional techniques could be used to cluster these results to reveal typology. Distinguishing the types of structural change that predict positive and adverse outcomes is likely to be a fruitful direction in which to take this research. Moreover, as this research is aimed at delineating mechanisms of change in TCs or related treatment modalities, Kazdin and Nock (2003) and Nock (2007) provide a useful design framework for advancing this and other therapeutic treatment research to the end of identifying the mechanisms operating to create therapeutic change.

There are two additional limitations that deserve attention. The first is that textual patterns produced by an individual are likely to be affected by educational attainment, but we had no measure specifically capturing education. The LSI-R measure used for control in this study does include items pertaining to education, but these are conflated with other indicators of reincarceration risk. Future work in this area may be enhanced by more specific control of individual characteristics that are likely to bear directly on the textual expressions. The second is that the pushup and pull-up vetting done jointly by staff and residents (see the Methods section) introduces a potential for bias in the sample of messages that were analyzed. Revengeful or otherwise bogus records of interaction with peers are expressions of underlying thought, regardless of their objective inaccuracy. TC programs systematically expunge such interactions from the records. That they were likely to be excluded from analysis suggests there may be important textual patterns missing from the data analyzed.

To conclude, this research links routinely collected TC data with quantitative methods for qualitative data and with theory of psychosocial change. While the theory of schema and schema change is not common in TC literature, it was suitable for this work due to its ability to link the textual data commonly available to TC practitioners and researchers to underlying psychological change deemed necessary for the successful treatment of substance abusing offenders. To the extent that further work strengthens this link between theory and practice, the utility of the schema construct in TC research and practice could become more important in future work. The textual data produced by TC residents has not seen considerable use in TC research to date, but may contain information far richer than what the present study was able to extract. Thus, we believe this is a good first step to enhancing TC research with existing data and with existing and emerging methods. The fields of complexity science and network science are growing rapidly due to the recognition that complex interactions—those observed in systems of many interacting parts that exhibit patterns of nonlinearity, feedback, and self-organization as a whole—are ubiquitous. Systems exhibiting such characteristics include, but are not nearly limited to, human interactions in groups (Kadushin, 2012; Valente, 2010), learning processes in our brains and in groups (Davis & Dennis, 2006), and

substance abuse patterns (Dean, 1997), all of which are key features of many therapeutic communities.

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Highlights

- Links constructs of schema to a network characterization of textual data.
- Schema change is measured and used in a survival model of reincarceration.
- Changes in resident schemas during treatment explain the risk of reincarceration.
- Subtler examination of schema change that builds on this work is warranted.

Figure 1.

Three dimensional surface plots visualizing the hazard rate (haz) for varying values of loss and gain across two values of the initial combinations variable (75 on the left, and 150 on the right). Hazard estimates are derived from the Cox proportional model such that age, LSI-R, sentpush and sentpull are held constant at their means, and race is set to 0 (non-minority). While hazard values can be compared across plots, a given shade of gray does not necessarily represent the same hazard value across both plots.

Table 1

Descriptive statistics for all four units.

Numeric Variables	n	mean	sd	median	min	max
<i>age</i>	2342	28.13	8.73	25	18	61
<i>LSI-R</i>	2342	27.29	6.98	27	5	48
<i>sent pushups</i>	2342	75.68	70.29	54	0	686
<i>sent pull-ups</i>	2342	38.27	36.03	29	1	426
<i>initial combinations</i>	2342	80.60	76.97	56	0	619
<i>loss</i>	2342	62.72	60.88	43	0	562
<i>gain</i>	2342	74.62	74.46	55	0	590
Dichotomous Variable	n	Proportion				
<i>race (African American)</i>	2342	0.23	-	-	-	-

Table 2

Parameter estimates (*b*), standard errors (*se*), p-values, and 95% confidence intervals (CI) from the Cox proportional hazards model fit.

Variables	<i>b</i>	<i>se</i>	<i>p</i>	95% CI
<i>race (black)</i>	-0.053	(0.074)	0.472	(-0.197, 0.091)
<i>age</i>	-0.012 ^{**}	(0.004)	0.001	(-0.019, -0.005)
<i>LSI-R</i>	0.044 ^{***}	(0.005)	0.000	(0.035, 0.053)
<i>sent pushups</i> [~]	0.034	(0.054)	0.526	(-0.071, 0.139)
<i>sent pull-ups</i> [~]	-0.026	(0.086)	0.762	(-0.194, 0.142)
<i>initial combinations</i> [~]	0.802 [*]	(0.381)	0.035	(0.056, 1.548)
<i>loss</i> [~]	-0.952 [*]	(0.467)	0.041	(-1.867, -0.037)
<i>gain</i> [~]	-0.076	(0.090)	0.399	(-0.253, 0.101)
<i>loss × gain</i>	0.726 ^{**}	(0.270)	0.007	(0.197, 1.255)
<i>init × loss</i>	-0.039	(0.039)	0.320	(-0.116, 0.038)
<i>init × gain</i>	-0.481 [*]	(0.196)	0.014	(-0.866, -0.096)

+ $p < .10$

 $p < .001$

**
 $p < .01$

*
 $p < .05$

[~] original variable divided by 100 to scale estimates up