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Derived Relations Moderate the Association Between Changes in the Strength of Commitment Language and Cocaine Treatment Response

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Abstract

The psycholinguistic analysis of client– counselor interactions indicates that how individuals talk about their substance use is associated with treatment outcome. However, the processes by which client speech influences out-of-session behaviors have not been clearly delineated. This study investigated the relationships between deriving relations–a key behavioral process by which language and cognition may come to influence behavior, shifts in the strength of client talk in favor of change, and treatment outcome among 75 cocaine-dependent participants (23% Female). Participants were trained to relate cocaine words, nonsense syllables, and negative-consequence words and were then assessed for a derived relation of equivalence before starting treatment. The DARN-C coding system was used to quantify the strength of participant speech during an early cognitive behavior therapy counseling session. Cocaine use during treatment was the outcome of interest. The analyses (a) characterized the process of deriving relations among individuals seeking help for their misuse of cocaine, (b) tested the relationships between shifts in the strength of participants' speech in favor of change and treatment outcome, and (c) tested if deriving equivalence relations moderated the relationship between shifts in the strength of in-session speech and treatment response. Results indicated that a minority of participants derived equivalence relations, however increases in the strength of commitment language predicted less cocaine use during treatment only among those who did. The findings suggest deriving relations

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may be an important process by which changes in the strength of commitment language comes to influence substance use.

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Keywords

preparatory language; stimulus equivalence; commitment language; cocaine dependence; relapse prevention therapy

Counseling based interventions are central components of contemporary treatments for substance misuse (Crits-Christoph et al., 1999; Project MATCH Research Group, 1997; Substance Abuse and Mental Health Services Administration, Office of Applied Studies, 2010), although their effects are generally modest and relapse remains a frequent outcome (Dutra et al., 2008). It has been argued that understanding the mechanisms by which psychosocial treatments influence behavior can help guide the development of more targeted intervention strategies (Kazdin, 2007). However, studies of the processes by which psychosocial interventions for substance use disorders exert their effects have not supported treatment-specific mechanisms of change (Morgenstern & McKay, 2007). This suggests common factors that operate across different counseling modalities may account for their effectiveness (Laska, Gurman, & Wampold, 2014). Thus, identifying factors that transcend specific treatment modalities and delineating the processes by which they influence behavior may help guide the development of more effective treatment protocols.

Two independent lines of investigation suggest that the verbal behavior of clients may be an important mechanism by which psychosocial interventions influence substance use. Psycholinguistic investigations, which primarily focus on the content of client speech, indicate that the words clients use to talk about their substance use relates to treatment outcome across different therapeutic modalities (Aharonovich, Amrhein, Bisaga, Nunes, & Hasin, 2008; Miller, Benefield, & Tonigan, 1993; Morgenstern et al., 2012). However, the mechanisms by which the content of client language comes to influence motivational states and other behaviors are not well understood. Thus, linking content-based analyses of client speech to other conceptual frameworks may increase our understanding of how clinical discussions promote change and identify individuals more or less likely to benefit from counseling based interventions (e.g., Feldstein Ewing, Filbey, Hendershot, McEachern, & Hutchison, 2011).

Relational frame theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001), a behavior analytic account of how human language takes on symbolic and functional significance, emphasizes the central role of verbal behavior in understanding complex behavioral patterns. A central premise of RFT is that relational responding, or responding to one event or stimulus in terms of another based on contextual cues to do so, is a key process by which the verbal regulation of behavior develops (Hayes, 1992). RFT moves away from association-based models of learning and proposes that when individuals listen or speak with meaning they do so by

deriving relations among stimuli or events (e.g., words and events; words and words; Hayes, 2004). The process of deriving relations, that is relating stimuli in a manner that was not directly trained, has been extended to theoretical analyses of drug use (Wilson & Hayes, 2000) and motivational interviewing (MI; Christopher & Dougher, 2009), an empirically supported treatment for a range of health related behaviors including substance use (Hettema, Steele, & Miller, 2005). Derived relational responding may also provide a useful conceptual and empirical link between the content analysis of client speech and treatment outcome. It is important to note that experimental methods have been developed to directly assess the derivation of untrained relations under controlled laboratory conditions (Fields & Verhave, 1987), which provides a platform for bringing this analytic framework to bear on content-based analyses of client speech.

The Content of Client Speech: A Transtherapeutic Indicator of Change

Analyzing the content of client speech has been a central component of research focusing on the mechanisms by which MI, an intervention that addresses a client's ambivalence and language about change, affects behavior (Miller & Rollnick, 2013; Miller & Rose, 2009). Clients can express themselves in a manner that favors making changes in their substance use (i.e., change talk) or in a manner that favors continued use (i.e., sustain talk, counter change talk; Miller & Rollnick, 2013). Psycholinguistic coding procedures have been developed to quantify the frequency (CLEAR [Glynn & Moyers, 2012], The Motivational Interviewing Skill Code [MISC; Miller, Moyers, Ernst, & Amrhein, 2008]) of client utterances that are consistent with each perspective. Alternatively, coding procedures have been developed to quantify the *strength* of client utterances in favor of changing or sustaining substance use across different categories of speech. Amrhein, Miller, Yahne, Palmer, and Fulcher's (2003) coding system places client utterances into one of five categories: Desire, Ability, Reasons, Need, and Commitment and quantifies the strength of an utterance within each from —5 (*strong sustain talk*) to + 5 (*strong change talk*).

Theoretical formulations of client speech during MI sessions have differentiated preparatory language, utterances that do not indicate change is going to happen (Desire, Ability, Reasons, and Need statements; DARN), from Commitment language, utterances that signal movement away or toward change (DARN-C; Miller & Rose, 2009). This conceptualization proposes that stronger preparatory language in favor of change increases the probability of stronger commitments to change. In turn, stronger commitment language is hypothesized to influence treatment outcome. However, evidence concerning the importance of disaggregating individual speech categories along the preparatory and commitment language distinction has been mixed. Studies applying broader groupings of client speech (e.g., change talk vs. sustain talk across all DARN-C categories) have demonstrated more frequent talk in favor of change is associated with lower levels of substance use (Barnett et al., 2014; Moyers et al., 2007; Moyers, Martin, Houck, Christopher, & Tonigan, 2009; Vader, Walters, Prabhu, Houck, & Field, 2010) and more frequent talk in favor of continued substance use (i.e., counterchange, sustain talk) is associated with poorer treatment response (Miller et al., 1993; Vader et al., 2010). In contrast, among studies employing the DARN-C coding framework, stronger and more frequent commitment utterances in the direction of change have been specifically associated with better treatment response in individual (Aharonovich

et al., 2008, 2014; Morgenstern et al., 2012) and group-based treatment protocols (Osilla et al., 2015) for substance misuse, respectively. Preparatory language (e.g., reasons and ability), has also been directly related to treatment outcome (Baer et al., 2008; Daeppen, Bertholet, & Gaume, 2010; Walker, Stephens, Rowland, & Roffman, 2011). These later findings support the disaggregation of speech utterances and suggest that the type of client talk that relates to treatment response may be different depending on the specific population being assessed (e.g., adolescents).

Although a majority of investigations have quantified client speech by utilizing frequency counts or strength indices that are averaged over the course of a counseling session, the *magnitude of change* in the strength of commitment language during a counseling session may be a particularly important indicator of treatment response (Miller & Rose, 2009). An increase in the strength of commitment language (i.e., a positive slope) has been associated with abstinence following an MI intervention, whereas changes in the strength of other utterance types (i.e., preparatory language) have not been associated with outcome (Amrhein et al., 2003). Moreover, increasing the strength of commitment language during a cognitive–behavioral intervention for cocaine dependence has predicted greater treatment retention (Aharonovich et al., 2008). The later findings suggest changes in the strength of commitment language may be important process across different therapeutic modalities. It is important to note that counselors can influence the probability of clients discussing changing or sustaining their behavior (Moyers & Martin, 2006; Moyers et al., 2009; Vader et al., 2010) thus suggesting how clients talk about their substance use may be key mechanism by which counseling based interventions influence behavior change. However, stronger talk in favor of change does not account for all the variance in treatment outcome (Amrhein et al., 2003). Thus, identifying the processes by which the content of client speech comes to influence treatment response may be an important step in identifying individuals who may be more or less likely to benefit from these interventions.

Deriving Relations: A Behavioral Process Model of Language

Deriving relations has been proposed to be a fundamental process by which the content of human language and cognition becomes related to events or things in the world, thus acquiring symbolic and functional significance (Hayes et al., 2001; Sidman, 1994). Although individuals can derive numerous types of relations (Dymond & Barnes, 1995), it has been argued that a significant proportion of everyday learning involves the formation and modification of equivalence classes (Leslie, Tierney, Robinson, Keenan, & Watt, 1993). Deriving equivalence relations has been used as a model for understanding the development of reading comprehension (Sidman, 1994) as well as other cognitive processes, such as the alteration of preferences (Valdivia-Salas, Dougher, & Luciano, 2013).

Studies that examine the process of deriving equivalence relations often use a matching-to-sample (MTS) training procedure during which individuals are taught to relate stimuli based on social convention. That is, the experimenter decides which stimuli go with each other (i.e., the relations are arbitrary); the relationships are not typically based on the physical characteristics of the stimuli (e.g., such as shape or color, which would be examples of nonarbitrary relations). For example, individuals can be trained to relate one stimulus (A)

with two other stimuli (B and C). These relations are not based on physical attributes but are related because the experimenter reinforces the relationship as part of the training procedures (i.e., the relationships are arbitrarily defined). A large body of evidence demonstrates that the direct training of these two relations (A = B and B = C) often results in the emergence of other relationships, ones that were not directly trained during the procedure (i.e., derived). These relations have been termed reflexivity (A = A; B = B), symmetry (B = A; C = B) and transitivity (A = C; Sidman, 1994; see Hayes et al., 2001 for an extension of this process to other types of relations). The simultaneous demonstration of both symmetry and transitivity has been used to denote the emergence of a group of stimuli that function in an equivalent manner (A = B = C), thus highlighting a process by which certain stimuli (e.g., words) may come to relate to other stimuli without direct training.

The derivation of untrained relations highlights the potential utility of the relational responding paradigm for understanding the process by which words can come to represent physical properties of the world and how verbal networks can be developed or expanded based on the training of only a few relations (Fields, Reeve, Adams, & Verhave, 1991; see Blackledge, 2003 and Wilson & Hayes, 2000 for more specific discussions of RFT). Critically, evidence suggests the types of relationships individuals derive can be brought under contextual control (Meehan & Fields, 1995). For example, for an individual, cocaine stimuli can be related (e.g., verbally) to positive outcomes in the presence of a friend, although related to negative outcomes in the presence of a spouse. The contextual control of deriving relations has important implications for understanding the processes by which counseling-based interventions may influence the verbal relations evidenced in client talk (Wilson & Hayes, 2000). Specifically, a counselor can come to serve as an important contextual cue for deriving relationships between substance use and consequences, which, in turn can influence the way individuals discuss and respond to their substance use during the course of a counseling session.

A particularly important phenomenon of derived relational responding is the transfer of stimulus functions (Belanich & Fields, 2003; see Hayes et al., 2001 for an extension of this phenomenon to other types of relations), a process by which the meaning (i.e., function) of stimuli can be acquired or changed without direct experience. For example, if a B stimulus serves as a punisher (e.g., consequential function) and A and C are in an equivalence relation with B, they could also function as punishers even though the individual never had direct experience with them. Studies have demonstrated the transfer and transformation of a wide range of stimulus functions via derived relations, including equivalence, such as conditioned reinforcing functions (Hayes, Brownstein, Devany, Kohlenberg, & Shelby, 1987), classically conditioned physiological responding (Dougher, Augustson, Markham, Greenway, & Wulfert, 1994), and discriminative functions in the context of interoceptive drug experiences (DeGrandpre, Bickel, & Higgins, 1992). In addition, human laboratory studies have demonstrated that neutral stimuli (i.e., stimuli having no reinforcing or punishing functions) can acquire reinforcing or punishing functions in accordance with their derived relations with other stimuli that have been previously established as reinforcers or punishers (Greenway, Dougher, & Wulfert, 1996; Hayes, Kohlenberg, & Hayes, 1991; Whelan & Barnes-Holmes, 2004). It is important to note that the methodological procedures employed

in these studies reduce the probability that alternative processes (e.g., higher order conditioning, association based processes) can account for these outcomes.

Relational networks may also *alter* the degree to which previously established reinforcers or punishers influence behavior (Hayes et al., 2001). For example, verbally relating cocaine to negative consequences may alter the reinforcing functions of its use in a given situation thus decreasing the probability of situational drug taking (Barnes-Holmes, Keane, Barnes-Holmes, & Smeets, 2000; Carpenter, Martinez, Vadhan, Barnes-Holmes, & Nunes, 2012). Within the context of a therapeutic discussion, verbally relating cocaine use to negative consequences or abstinence to positive consequences (i.e., reasons talk in the DARN-C categorization of client speech) may increase the likelihood of a client making a verbal commitment to change their behavior (Amrhein et al., 2003) or have a direct impact on treatment outcome (Bear et al., 2008; Osilla et al., 2015; Walker et al., 2011). Consistent with this hypothesis, Ju and Hayes (2008), have demonstrated that presenting verbal stimuli that are in an equivalence relation with other reinforcers can increase behavior that produces these reinforcing consequences. Thus, the alteration of consequential functions (e.g., making the reinforcing or punishing consequences of a behavior more present in accordance with derived relations) maybe a particularly important process by which the content of client speech comes to influence motivational states and changes in behavior outside the counseling session.

Study Aims

Conceptualizing counseling based interventions as a context by which individuals derive relations among stimuli and the functions of these stimuli are altered in accordance with these relations provides one potential process by which the content of in-session language may influence motivational states and alter the reinforcing effects of drug use (Christopher & Dougher, 2009; Wilson & Hayes, 2000). However, few empirical studies have directly investigated how deriving relations and shifts in the strength of client speech relate to each other and to treatment response. Thus, the aims of this preliminary investigation were first, to characterize stimulus equivalence training and performance among a sample of adults seeking help for their misuse of cocaine and examine the relationship between deriving equivalence relations and treatment response in the context of a cognitive– behavioral treatment for cocaine dependence. We hypothesized that participants deriving equivalence relations would demonstrate better treatment response compared with those who do not. Second, we wanted to test the association between changes in the strength of participant speech in favor of change during an initial cognitive behavior therapy (CBT) counseling session and treatment response. We hypothesized that increases in the strength of preparatory (i.e., DARN) and Commitment language in favor of change would predict better treatment outcome. The third aim was to test if performance on an equivalence relations training task moderated the relationship between changes in the strength of client speech and treatment response. We hypothesized changes in the strength of utterances in favor of change would be more strongly associated with less cocaine use among individuals demonstrating the ability to derive equivalence relations.

Method

Participants and Procedures

The Institutional Review Board of the New York State Psychiatric Institute approved the research protocol and all participants provided informed consent prior to completing the study procedures. Participants were recruited from an outpatient university based treatment clinic in New York City that was conducting five double-blind placebo-controlled research protocols each investigating the efficacy of combining a medication (Study 1, $n = 18$; Study 2, $n = 14$; Study 3, $n = 20$; Study 4, a vaccine, $n = 30$ [Kosten et al., 2014]; Study 5, $n = 1$) with CBT relapse prevention therapy (Carroll, 1998). Study durations varied between 8 and 14 weeks. Although each study investigated a different medication, all studies utilized the same CBT treatment protocol.

All participants completed a general screening protocol that included the Structured Clinical Interview for the *DSM–IV* (SCID-IV; First, Spitzer, Gibbon, & Williams, 2002), which assessed the frequency and magnitude of substance use, treatment history, and the presence of *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV*; American Psychiatric Association, 1994) AXIS I disorders. Participants received a physical examination and met with a board certified addiction psychiatrist. Participants were ineligible for enrollment if they had bipolar or psychotic disorders; unstable physical disorders (e.g., abnormal EKG, uncontrolled hypertension); concurrent use of other psychotropic medication; or a physiological dependence to alcohol, opioids, or sedative-hypnotics. Individuals deemed eligible and consenting to a treatment study were then approached to participate in the present investigation. All participants consented to this study prior to beginning their respective active treatment and received up to $40 for completing the assessments. All study assessment and training procedures were scheduled prior the first counseling session.

Eight-three individuals meeting *DSM–IV* criteria for cocaine dependence were enrolled in the present study. Demographically, the sample was primarily male (77%) and ethnically diverse (36% African American; 30% Caucasian; 28% Hispanic; 2% Asian). On average, participants were 43.8 years of age ($SD = 7.9$ years) and completed 13.2 years of education ($SD = 2.1$ years). Cocaine use was reported to have occurred on 16.8 days ($SD = 8.5$ days) in the month prior to seeking treatment and was used regularly (i.e., a minimum 3 times per week) for an average of 17.5 years ($SD = 10$ years). Participants reported using approximately $127 dollars of cocaine per using day ($SD = $135) in the month prior to treatment. The primary route of administration was intranasal (57%) with approximately 42% and 1% of the participants reporting smoking and oral administration, respectively. On average, participants reported having 1.1 ($SD = 1.3$) previous treatment episodes.

The concurrent use of other substances was reported by 68.7% of the participants. Of those reporting other substance use ($n = 57$), 93% reported consuming alcohol, 44% reported smoking marijuana, 4% opioids, 2% MDMA, and 2% benzodiazepines (categories were not mutually exclusive). Twenty-four percent of the participants met current criteria for another *DSM–IV* substance use disorder that did not require a medical detoxification (18% alcohol use disorders; 5% cannabis dependence; 1% opioid abuse) and 42% met criteria for a co-

occurring *DSM–IV* nonsubstance use disorder (16% substance-induced mood disorder; 10% major depressive disorder; 7% dysthymia; 7% posttraumatic stress disorder; 1% other anxiety disorders; and 1% attention deficit disorder).

Measures

Wisconsin Card Sorting Test (WCST; Heaton, 2008).—The WCST assesses perseveration and abstract thinking. It has been utilized as a measure of frontal lobe dysfunction and has been associated with treatment response and the strength of client speech in previous cocaine treatment trials (Aharonovich et al., 2008). A computerized version of WCST was utilized in the present study. Three performance indices were calculated: Percent perseverative errors, percent nonperseverative errors, and the learning to learn index. The percent errors scores were converted to age- and education-adjusted standard scores (M = 100; *SD* = 15) with higher scores indicating better cognitive performance relative to the normative sample. The learning to learn index quantifies a client's ability to become more efficient across the different stages of the task. Positive scores index an increase in efficiency.

Vocabulary subtest of the Wechsler Adult Intelligence Scale—3rd edition (WAIS–III; Wechsler, 1997).—Participant performance was scored and then compared with an age-matched sample yielding a standard score (*T* score M = 50; *SD* = 10). Previous studies have demonstrated a moderate relationship between WAIS–III vocabulary scores and the number of training trials needed to reach criterion on a stimulus equivalence-training task (O'Hora, Pelaez, & Barnes-Holmes, 2005).

Client speech (DARN-C; Amrhein et al., 2003).—The DARN-C coding system (Amrhein et al., 2003) has been utilized to quantify preparatory and commitment utterances in different therapeutic modalities, including CBT protocols for cocaine use (e.g., Aharonovich et al., 2008). Evidence suggests the continuum based rating protocol may be particularly useful for assessing the relationship between participant language strength and treatment response (Magill et al., 2014). Digital recordings of counseling sessions conducted in the first two weeks of treatment were coded. The CBT protocol was topic driven for all studies, although there was flexibility in how the topics were ordered over the course of treatment. In general, topics (e.g., coping with cravings, managing thoughts of cocaine use) were dependent upon the specific clinical issue presented during the session. However, for all studies, the early sessions focused on reviewing the pros and cons of cocaine use, reasons for entering treatment, and developing treatment goals. These topics constituted most of the discussions from which the content of participant speech was captured.

Recordings of the counseling sessions were divided into 10 equal temporal segments (i.e., deciles), which standardized the coding process across sessions of different time durations. Participant utterances about their substance use were placed in one of five mutually exclusive statement categories: desire, ability, reasons, need, or commitment. Each utterance was given a strength rating. Utterance strength was based on assigned values ranging from —5 to + 5, in which a negative value indicated the content of a client's speech was in the direction of supporting continued drug use (e.g., "cocaine use helps me cope") and a positive

value was in the direction of change (e.g., “my cocaine use has cost me my family”), a zero value indicated equipoise. For each direction, larger values were assigned to indicate a stronger utterance.

All coding was done blind to the outcomes of the assessments and treatment. Utterance strength ratings within each speech category were averaged to yield a single strength value for each DARN-C category per decile. For analytical purposes we were interested in differentiating preparatory language (DARN) from Commitment language. Thus, Desire, Ability, Reason, and Need categories were averaged to yield a DARN strength value per decile. Changes in the magnitude of the strength for preparatory and commitment language during the sessions were estimated in the regression analyses by including ratings for the 1st and 10th deciles in the regression models. By including both deciles as covariates (see below), the regression weight for the 10th decile ratings quantified the relationship between a change in strength from the beginning to the end of the counseling session and cocaine use (Cohen & Cohen, 1983). Missing values were recorded for the DARN and C categories that did not have a representative utterance in a given decile and were addressed during the analysis of the data.

Psycholinguistic coding training.—Two research assistants were trained by the second author to conduct the psycholinguistic coding. The training protocol included an orientation to the DARN-C coding framework (Amrhein et al., 2003), coding exercises based on practice transcripts, and the coding of practice audiotapes. Coders received feedback on the practice coding sessions and differences between their codes and the second author’s reference codes were discussed until an acceptable level of concordance was achieved (intraclass correlation coefficient; ICC; Shrout & Fleiss, 1979; $ICC_{(2,1)} = 0.75$). Twenty-five percent ($n = 16$) of the counseling sessions were randomly selected and coded by both research assistants to assess interrater reliability (e.g., $ICC_{(2,1)}$). The double coding of audiotaped sessions began during data collection and continued past the enrollment phase of the study.

Relational training.—Participants were taught 6 conditional stimulus (CS) relations (stimulus pairs: A1–B1; B1–C1; A2–B2; B2–C2, A3–B3; B3–C3) using a simple-to-complex (STC) training protocol (Adams & Fields, 1993). The STC training protocol is an ordered training framework, interspersing training and testing blocks, that has been demonstrated to be a highly efficient procedure for yielding reliable equivalence relations (Fienup, Wright, & Fields, 2015). The stimuli utilized in the training sessions included cocaine-related words (*ROCK*, *COKE*, *HIT*; denoted as A stimuli above), nonsense syllables (*ZID*, *YIM*, *VEK*; denoted as B stimuli above), and words indicating negative consequences of cocaine use (*CRASH*, *PARANOID*, *LONELY*; denoted as C stimuli above). The cocaine-related words and negative-consequence words were those rated to be the most highly associated with cocaine use during a semantic stimulus generation and rating assessment protocol in a sample of more than 400 treatment-seeking cocaine users (Carpenter, Schreiber, Church, & McDowell, 2006). Word assignment denoted by the numbers 1, 2, and 3 within each class of stimuli [Class A (1, 2, 3) = cocaine words; Class B (1, 2, 3) =

nonsense syllables; Class C (1, 2, 3) = negative consequences] was randomly generated for each participant.

The MTS procedure was administered during a 2.5-hr session prior to beginning treatment. There were four phases: (a) familiarization, (b) training with continuous feedback, (c) training with intermittent feedback, and (d) testing. Testing was conducted to probe for the derived relations of symmetry, transitivity, and the emergence of three, three-member (e.g., A = B = C) stimulus equivalence classes. Table 1 presents the STC protocol, which includes the sequence of training and testing blocks, the percentage of trials within each training block that provided instructive feedback following a response (i.e., correct or wrong), the performance criterion used to define mastery of the block and allow the participant to move to the next block of trials, and the specific relations trained and/or tested within each block (e.g., AB, a training item; BA, a probe for derived symmetry relations). Participants were instructed they would earn money based on their performance before beginning the training in order to maintain their motivation during the task. However, all reimbursement was randomly selected from a range of $18 to $20 dollars and was presented after all testing phases were completed or at the end of the training session. Participants were asked to interact with the training procedures until they either demonstrated the emergence of equivalence or the training was ended based on predefined exit criteria (see below). The training session was ended if a participant failed to reach either termination point during the allotted 2.5-hr time period.

The training and testing sequence was the same for all participants. As noted in Table 1, AB (cocaine words → nonsense syllables) relations were trained first (Blocks 1 and 2) and the emergence of symmetrical relations (BA; nonsense syllables → cocaine words) was tested (Block 3). Second, BC relations (nonsense syllables → negative consequences) were trained (Blocks 4 and 5) and the emergence of symmetry relations (Block 6) was assessed with CB tests (negative consequences → nonsense syllables). After testing with BA and CB together (Block 7, all symmetry relations) the emergence of transitive relations (AC; cocaine words → negative consequences) was tested (Block 8). The emergence of equivalence relations (Block 9) was assessed with CA tests (negative consequences → cocaine words). Finally, Block 10 included a mixed test to further probe for the emergence of the derived symmetry, transitivity, and equivalence relations. The mastery criterion for all training blocks (1, 2, 4, and 5) was 100% accuracy. The first AB training block included feedback on 100% of the trials and was repeated until the mastery criterion was reached. The feedback consisted of presenting the words *CORRECT* or *WRONG* on the screen after each choice. Thereafter, the percentage of trials presenting performance feedback was reduced (100% to 75% to 25% to 0%) over successive training trials as long as 100% correct performance was retained. Performance below the mastery level resulted in the readministration of the 100% feedback block. The same feedback sequence was used for training the BC relations. No performance feedback was provided during the testing blocks. Mastery criterion for the test blocks was demonstrating no more than one choice error. Failure to reach mastery criterion after 6 presentations of any training or testing block terminated the training session at that point and the participant was classified as not deriving equivalence relations.

Treatment outcome.—Cocaine use was defined as the proportion of weeks during treatment that it occurred (number of weeks cocaine use was indicated/total number of weeks in treatment). Cocaine use was assessed with a modified time-line followback assessment covering all days between clinic visits. Self-reports were confirmed with urine samples. Urine samples were scheduled to be collected at treatment visits. Abbott/MDTX was used to score urines as positive or negative for cocaine using standard National Institute on Drug Abuse cutoffs. If a participant reported using cocaine (regardless of urine results) or the participant reported no cocaine use but the urine sample was cocaine positive it was scored as a cocaine use week. A week was scored as an abstinence week if the urine sample was negative and/or no cocaine use was reported. This variable was normally distributed.

Analyses.—Sample sizes varied by analysis because not all participants completed all measures. They are noted in each analysis section. Overall, 90% of those enrolled in the study participated in the equivalence training and 77% had their sessions recorded and coded. Four sets of analyses were conducted. First, parametric (i.e., *t* tests, chi-square) statistical tests were used to characterize differences on the demographic, substance use, cognitive performance, strength of participant talk, and treatment response measures between participants deriving equivalence relations ($n = 32$) and participants who did not ($n = 43$). Second, ICCs (i.e., Shrout & Fleiss, 1979) were calculated to assess the agreement between each coder's averaged strength values for the preparatory (i.e., DARN) and the commitment utterance categories in the 1st and 10th deciles. Third, the relationship between the magnitude of change in the preparatory and commitment utterance categories and the percentage of weeks in which cocaine use occurred were tested in separate multivariate linear regression models. Following the procedures utilized in other investigations (Aharonovich et al., 2008; Amrhein et al., 2003; Walker et al., 2011), a maximum likelihood estimation procedure (Little & Rubin, 1987) was used to estimate and impute strength values for the DARN and Commitment categories that did not have a representative utterance occur in a decile (1 through 10). Estimation procedures were conducted blind to the outcome of the MTS training, study retention, drug use outcomes, and participant demographics. Fourth, as an exploratory procedure, a stepwise regression model was used to test the relative predictive strength of the DARN and Commitment categories by including both categories in a single model and applying a statistical selection criterion to identify the variables most predictive of cocaine use.

Baseline drug use (i.e., the amount of money, in dollars, spent per use episode), therapist, the frequency of DARN-C speech in the 1st and 10th deciles of a session, WAIS–III vocabulary scores, and the average strength ratings in the 1st and 10th deciles for the speech category of interest were entered as covariates in each regression model. The specific parameters of interest in each analysis were the 10th decile regression weights for the specific utterance category being tested (i.e., DARN and C), performance on the MTS task (0 = no equivalence relations demonstrated; 1 = equivalence relations demonstrated), and their interaction. Although all therapists ($n = 11$) operated within the standardized treatment protocol, analyses indicated two therapists were significantly associated with treatment outcome (i.e., one with significantly better outcome and one with significantly worse outcome). Thus, dummy codes for the two therapists were included in the regression model. The interaction

term assessed the potential moderating effect of equivalence training performance on the relationship between the magnitude of change in language strength (10th decile parameter) and treatment response.

Results

Derived Relations

Seventy-five participants began the MTS training procedure. There were no differences between the 75 participants initiating the training and the 8 who did not in terms of demographic characteristics, drug use history, treatment response, cognitive functioning, the strength of utterances in the beginning and the end of the session, or change in the strength of speech for the preparatory or commitment language categories. On average, the participants completed 319 (*SD* = 130.5) AB (i.e., cocaine word → nonsense syllable) training trials and 167 (*SD* = 98.1) BC training trials (i.e., nonsense syllable → negative consequence). Approximately 5% (*n* = 4) of the participants failed to make it past the AB and BC training trials.

Of the 75 participants initiating the training, 32 (43%) met the mastery criterion (i.e., 98% correct) during the block of mixed test probes indicating the derived relations of equivalence (i.e., the derivation of 3, three-member equivalence classes that included nonsense syllables, cocaine-related words, and negative-consequence words); 43 (57%) failed to demonstrate derived equivalence during the procedure. For example, when shown a negative-consequence word (e.g., *LONELY*) they did not consistently relate the word to the cocaine word (e.g., *COKE*; i.e., C → A). Among the 43 individuals who did not demonstrate equivalence relationships, less than half (*n* = 20) reliably derived symmetry relations (e.g., B → A; B → C). Table 2 presents demographic, cocaine use, utterance strength, and cognitive performance measures across the two MTS performance groups. There were no significant differences between participants deriving equivalence relations and those who did not on most measures. However, participants deriving equivalence relations demonstrated significantly stronger vocabulary scores, reported more days of cocaine use in the month before treatment, and were more likely to demonstrate derived symmetry and transitivity with fewer training trials. Although the average strength of preparatory (DARN) and commitment language increased from the beginning to the end of the session, they each were statistically equivalent in the 1st and 10th deciles across both groups.

Strength of Participant Language (DARN-C)

Sixty-four participants had their initial counseling sessions audiotaped and coded. There were no significant differences between participants who had their counseling sessions coded relative to those who did not on demographic, MTS performance, and drug use measures. The primary reason for not having psycholinguistic coding completed was the discontinuation of study participation prior to the first counseling session. Reliability estimates for the strength of the coded utterances in the 1st and 10th deciles varied within the good to fair range (Cicchetti, 1994) for a majority of the speech categories ($ICC_{(2,1)}$ Commitment = 0.71; Composite DARN = 0.54; individual DARN categories Reasons = 0.59, Desire = 0.54; and Ability = 0.45). The reliability estimate for the Need utterance

category was in the poor range ($ICC_{(2,1)}$ = 0.33). The low reliability estimate was primarily due to a low frequency of need statements in the 1st and 10th deciles.

Changes in the Strength of Client Speech and Treatment Response

Table 3 presents the predictive relationships between the percentage of weeks in which cocaine use occurred during treatment and the average strength of DARN and Commitment utterances in the first and tenth deciles, equivalence training outcome (derived relations demonstrated vs. not demonstrated), and the interaction between changes in the strength of a language category and equivalence training outcome. Results of the multiple regression analyses yielded nonsignificant associations between the magnitude of change in the strength of DARN utterances and cocaine use during treatment. Furthermore, demonstrating derived equivalence relations was not directly associated with cocaine use during treatment nor did it moderate the associations between cocaine use and changes in the strength of DARN talk.

The results of the regression analysis including the commitment utterances indicated a significant interaction between changes in the strength of commitment language by the end of the session (10th decile) and equivalence performance (see Table 3). As seen in Figure 1, *a greater* increase in the strength of commitment language was associated with less cocaine use over the course of treatment among individuals demonstrating equivalence relations, $b = -17.3$ ($SE = 6.8$); $t = -2.56$; $p < .02$. Among participants who did not demonstrate equivalence, the relationship between changes in the strength of commitment language and cocaine use was not reliable, $b = -4.1$ ($SE = 6.9$); $t = -0.59$; $p < .57$. The exploratory stepwise multiple regression analysis that included the DARN and Commitment utterance categories simultaneously further supported the findings of the individual regression models. Specifically, the commitment language by equivalence performance interaction term was retained ($t = -3.29$; $p \leq .003$) along with baseline drug use, therapist assignment, and the strength of commitment language in the 1st decile, final model, $F(4, 60) = 7.42$; $p \leq .001$; multiple $R^2 = .39$.

Discussion

This study examined the relationships between deriving equivalence relations, shifts in the strength of in-session preparatory and commitment language, and treatment response. There were three findings of note. First, only a minority (43%) of cocaine-dependent participants who were seeking treatment derived equivalence relations. Second, contrary to our hypothesis, deriving equivalence relations was not directly associated with treatment outcome. However, it did impact how increases in the strength of commitment language in favor of change related to treatment response. Specifically, among participants who derived equivalence relations, increases in the strength of commitment language in favor of change predicted less cocaine use. Among participants who did not derive equivalence relations, a change in the strength of commitment language was not associated with cocaine use. Third, a change in the strength of preparatory (i.e., DARN) language was not related to treatment outcome nor did it interact with performance on the equivalence task to predict cocaine use.

Characterizing Derived Relational Responding Among Cocaine Users

This was one of the first investigations to examine derived relational responding among illicit substance users seeking to change their drug use. Participants deriving equivalence relations were similar to those who did not in terms of demographic characteristics, comorbid psychiatric disorders, substance use, cognitive functioning, and the average strength of DARN-C language in the beginning and at the end of a counseling session. However, participants who derived equivalence relations demonstrated stronger vocabulary skills. This later finding is consistent with previous research that has supported a link between deriving relations and verbal fluency (O'Hora et al., 2005) and further supports the hypothesis that deriving relations is an important aspect of human language. In addition, this study employed a STC training protocol. The STC protocol has been demonstrated to be more efficient in establishing equivalence classes and has yielded less intersubject variability in performance relative to other training frameworks (Adams & Fields, 1993). Despite the more favorable training protocol, only a minority of the participants demonstrated derived equivalence (n = 30; 43%). This finding is consistent with a growing body of evidence indicating a significant link between cocaine use and poorer performance on higher order cognitive functioning tasks (Aharonovich et al., 2006) and other relational measures (Vadhan et al., 2008). However, it is unclear if the use of cocaine-related or negatively valenced words impacted participants' performance in this study. Evidence suggests the use of emotionally relevant stimuli can have both inhibitory (Plaud, 1995) and facilitative (Adcock et al., 2010) effects on the formation of equivalence classes. Although this study did not evaluate if either process affected performance, employing stimuli that were neutral to cocaine use may have yielded different results.

Deriving Equivalence Relations and Treatment Response

We hypothesized that deriving equivalence relations would be directly associated with treatment outcome. The results did not support this hypothesis. This finding is inconsistent with a previous study that demonstrated a direct relationship between performance on a different relational assessment procedure and treatment outcome (Carpenter et al., 2012). However, some methodological issues may have contributed to the observed discrepancy. This study focused on the behavioral process of training and deriving relations in an experimental setting rather than directly assessing an individual's preestablished verbal relations or their unique learning history regarding the consequences of their cocaine use. The content of the verbal stimuli used in the present study focused on cocaine-related words and negative consequences, although the selection of these stimuli were based on aggregate ratings among cocaine users seeking treatment. Because the stimuli were not individualized to each participant, it is possible that the relations being assessed were not necessarily linked to an individual's specific learning history with cocaine. Thus, the potential utility of the task to directly predict treatment response may have been diminished. Designing relational assessment procedures that are customized to an individual's learning history and implemented in applied settings (e.g., Levin, Hayes, & Waltz, 2010) may offer a more powerful measure for assessing the effect of this process on individual behavior change. Furthermore, evidence suggests that contextual cues can influence the types of relations that are brought to bear on a given situation. Thus, deriving equivalence relations between cocaine and negative consequences in the context of a training session may not have direct

relevance to the specific relations that are brought to bear on cocaine use in other situations. A more precise specification of the contextual cues that give rise to relational responses, which can alter the probability of drug use for an individual may help increase the utility of the relations that are specifically reinforced during a counseling session.

Deriving Equivalence Relations and Changes in the Strength of Client Speech

We tested the hypothesis that demonstrating derived equivalence relations would influence the relationship between the way participants talk about their substance use during a cognitive– behavioral intervention for cocaine dependence and their drug use during treatment. Consistent with our hypothesis, performance on the relational training procedure affected how changes in the strength of participant speech related to treatment response. Specifically, an increase in the strength of commitment language in favor of change during an early counseling session was associated with less cocaine use among participants demonstrating derived equivalence relations. The moderating effect remained after accounting for differences in the frequency of all talk (i.e., DARN-C) in favor of change, verbal performance, and baseline substance use. It is important to note, that the average strength of commitment language at the beginning and at the end of the counseling session, as well as the magnitude of change in the strength of commitment language over the course of a session, were not statistically different between those who derived equivalence and those who did not. Thus, from the perspective of a listener, how clients talk about their substance use may not always identify those more likely to change. However, the present findings suggest the functional relationship between shifts in commitment language strength and behavior change may differ based on an individual's relational repertoire. Moreover, although an increase in the strength of commitment language in favor of change has been associated with other cognitive performance measures and treatment retention among cocaine-dependent participants (Aharonovich et al., 2008), in this sample, the other measures of cognitive performance (e.g., WCST) were not related to changes in the participants' language or treatment outcome. Instead, demonstrating a relational repertoire that included deriving equivalence appeared to be a specific factor in determining who may be more likely to decrease their cocaine use following discussions that increase the strength of commitment language.

The equivalence relations derived in this study involved nonsense words, cocaine words, and negative-consequence words. Verbally relating drug use to negative consequences has predicted less cocaine use (Rohsenow, Sirota, Martin, & Monti, 2004) and can reduce the strength of cravings for other substances (Kober, Kross, Mischel, Hart, & Ochsner, 2010). Verbally making the negative consequences of drug use more present in the moment may also be one important counseling technique for altering a client's situational preference for drugs and increasing the strength of commitment language during a counseling session (Amrhein et al., 2003). It has been proposed that derived relations may serve an important role in evaluative conditioning, one process by which preferences can be altered based on the pairing of stimuli (Hughes, De Houwer, & Barnes-Holmes, 2015, November). From this perspective a learning history that facilitates the development of a relational repertoire can serve as a key distal factor by which proximal events (e.g., clinical discussions) can influence situational preferences and likings. Extending this conceptualization to clinical

interactions for substance misuse, a learning history that gives rise to a behavioral repertoire of relational responding, may be an important historical prerequisite that provides a context by which the specific content of client language during a counseling session comes to influence motivational states and other verbal content (e.g., commitment language) related to making change. The present findings provide initial empirical support for bringing the conceptual framework of derived relational responding to bear on the content analysis of in-session client speech to extend our understanding of how client and counselor verbal interactions may come influence substance misuse (Christopher & Dougher, 2009). The results further invite the need for a more precise specification of both the contextual parameters in a counseling session (e.g., the content of therapist language) and the individual learning histories that give rise to relational repertoires, which together can set occasion for changes in the strength of client speech to affect motivational states and influence substance use in the natural ecology.

Disaggregating Commitment and Preparatory Language

This study was one of the few investigations to assess the extent to which shifts in the strength of participant speech favoring change across preparatory and commitment utterance categories (i.e., DARN and C) were related to treatment response. We hypothesized that increases in the strength of both preparatory and commitment language in favor of change would be related to a decrease in cocaine use. Cocaine use was not directly related to changes in the strength of the preparatory (i.e., DARN) language nor was it associated with an interaction between preparatory language and performance on the equivalence task. The unique relationship between commitment language and drug use is consistent with Amrhein et al.'s (2003) findings. However, the present results differ from other studies that utilized average strength ratings for preparatory and commitment language (e.g., Baer et al., 2008; Walker et al., 2011). The differential relationship between each language category and cocaine use lends support to a functional distinction between commitment language and other client utterances (Miller & Rollnick, 2013). Moreover, they further highlight the possibility that the effect of commitment language on drug use is dependent on other factors, such as a robust relational repertoire. It is important to note that the present results extend the prognostic significance of changes in the strength of commitment language to a cognitive– behavioral treatment platform for cocaine dependence, further suggesting that the strength of client speech may function as one trans-therapeutic mechanism of change.

Study Limitations and Summary

This study had several limitations. The relatively small sample size prohibited more extensive multivariate modeling of participant speech and derived relational responding. It may have also increased the chances of not detecting associations that did exist (i.e., Type II error). Participants were recruited from different pharmacotherapy treatment studies and many received placebo, which may have influenced treatment response in unknown ways. However, it is important to note all participants were assessed and recorded prior to beginning any study related medication and the results of the clinical trials did not demonstrate any significant effects for the studied medications (personal communications). Moreover, the counseling intervention was standard across all the treatment protocols, thus

minimizing the potential effect of different counseling approaches on client speech. The fair reliability ratings for the preparatory utterances (DARN), in part due to the low frequency of some of the categories (Need), may have mitigated finding an association with treatment outcome. Although this study directly trained several verbal relations, it did not directly test the transfer of consequential functions through the derived equivalence relations. Thus, the present study cannot directly address the extent to which the transfer of verbal consequences directly impacted the strength of commitment language. Human laboratory studies that establish the specific functions of the verbal stimuli used in the MTS procedure would be particularly powerful in this regard. Furthermore, the stimuli utilized in the MTS procedure were selected based on aggregated saliency ratings. Thus, they were not based on the unique learning history of each individual, which may have diminished the prognostic significance of the MTS task.

Despite the limitations, this preliminary study demonstrated that the strength of participants' commitment utterances in favor of change increased during a CBT based counseling session. However, only increases in the strength of commitment language among participants who derived equivalence relations predicted less cocaine use. These findings extend previous psycholinguistic studies by highlighting a potentially important behavioral process by which the content of client language may come to bear on clinically relevant behaviors. As such, the findings suggest augmenting counseling based interventions with training protocols that can help establish stronger relational repertoires (Luciano, Valdivia-Salas, Cabello-Luque, & Hernandez, 2009), may help improve outcomes among individuals who may not otherwise benefit from clinical discussions that strengthen their commitment language. They further highlight the potential utility of applying noninvasive data collection procedures to understand how characteristics of language and speech may track change and predict future relapse. Future investigations are needed to replicate the present findings and extend these analyses to other treatment modalities (i.e., supportive therapy, 12-step facilitation). To the extent the present findings are replicated, it stands to reason that the content and processes by which clients talk about their substance use may be important trans-therapeutic mechanisms by which psychosocial interventions influence change.

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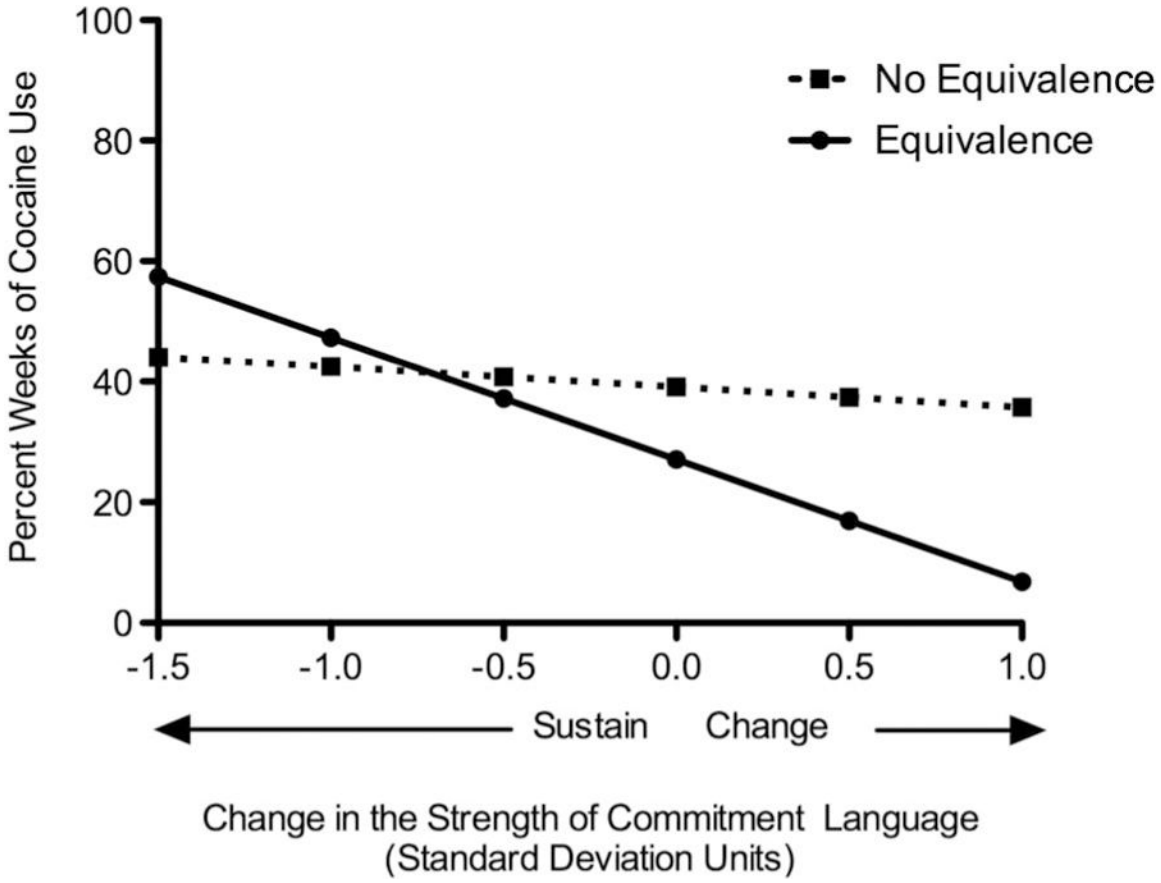

Figure 1.

The relationship between the magnitude of change in commitment language strength and cocaine use during treatment among cocaine-dependent participants who demonstrated and who did not demonstrate derived equivalence relations.

Table 1

The Sequence of Training and Derived Relation Probes During the Simple to Complex Training Procedure

Blocks (in order of training)	Percentage of trials providing feedback	Mastery criterion	Relations trained and/or tested within each block (no. times trials presented in each block)		
1. Train AB (24 trials)	100%	100% (24/24)	A1:B1 (8)	A2:B2 (8)	A3:B3 (8)
2. Train AB (36 trials; 12 trials per feedback level)	75%, 25%, 0%	100% (12/12)	A1:B1 (4)	A2:B2 (4)	A3:B3 (4)
3. BA symmetry test (48 Trials)	0%	98% (47/48)	B1:A1 (8)	B2:A2 (8)	B3:A3 8)
			A1:B1 (8)	A2:B2 (8)	A3:B3 (8)
4. Train BC (24 trials)	100%	100% (24/24)	A1:B1 (2)	A2:B2 (2)	A3:B3 (2)
			B1:C1 (6)	B2:C2 (6)	B3:C3 (6)
5. Train BC (72 trials; 24 trials per feedback level)	75%, 25%, 0%	100% (24/24)	A1:B1 (4)	A2:B2 (4)	A3:B3 (4)
			B1:C1 (4)	B2:C2 (4)	B3:C3 (4)
6. CB symmetry test (42 trials)	0%	98% (41/42)	C1:B1 (6)	C2:B2 (6)	C3:B3 (6)
			B1:C1 (4)	B2:C2 (4)	B3:C3 (4)
			A1:B1 (4)	A2:B2 (4)	A3:B3 (4)
7. Mixed BA and CB symmetry tests (66 trials)	0%	98% (65/66)	B1:A1 (4)	B2:A2 (4)	B3:A3 (4)
			C1:B1 (6)	C2:B2 (6)	C3:B3 (6)
			A1:B1 (6)	A2:B2 (6)	A3:B3 (6)
			B1:C1 (6)	B2:C2 (6)	B3:C3 (6)
8. AC transitivity test (48 trials)	0%	98% (47/48)	A1:C1 (8)	A2:C2 (8)	A3:C3 (8)
			A1:B1 (4)	A2:B2 (4)	A3:B3 (4)
			B1:C1 (4)	B2:C2 (4)	B3:C3 (4)
9. CA equivalence test (42 trials)	0%	98% (41/42)	C1:A1 (6)	C2:A2 (6)	C3:A3 (6)
			A1:B1 (4)	A2:B2 (4)	A3:B3 (4)
			B1:C1 (4)	B2:C2 (4)	B3:C3 (4)
10. Mixed tests (symmetry, transitivity, equivalence; 48 trials)	0%	98% (47/48)	C1:A1 (2)	C2:A2 (2)	C3:A3 (2)
			A1:C1 (2)	A2:C2 (2)	A3:C3 (2)
			B1:A1 (2)	B2:A2 (2)	B3:A3 (2)
			C1:B1 (2)	C2:B2 (2)	C3:B3 (2)
			A1:B1 (4)	A2:B2 (4)	A3:B3 (4)
			B1:C1 (4)	B2:C2 (4)	B3:C3 (4)

Note. For each block, the percentage of trials providing performance feedback, the criterion used to denote mastery of the relations, and the types and the number of items presented is noted. A stimuli were cocaine words (*COKE*, *ROCK*, *HIT*); B stimuli nonsense syllables (*ZID*, *YIM*, *VEK*), and C stimuli were negative consequence words (*CRASH*, *PARANOID*, *LONELY*).

Table 2

Demographic Characteristics, Drug Use History, Treatment Response, and Cognitive Performance Across the Two Equivalence Performance Groups

Variables	Equivalence (n = 32)	No equivalence (n = 43)	Test statistic
Age	41.8 (9.3)[c]	45.6 (6.8)	$t(55) = -1.96$; $p = .06$; $d = -.47$
Female	29.0% (n = 9)	18.2% (n = 8)	$\chi^2(1) = .94$; $p = .331$
Education (years)	13.6 (1.5)	13.0 (2.3)	$t(71) = -1.28$; $p = .206$; $d = .32$
Baseline depression (HAMD)	11.0 (7.4)	10.0 (6.7)	$t(61) = -.56$; $p = .576$; $d = .14$
Cocaine use			
Past month (days)	18.7 (8.6)	14.8 (7.7)*	$t(73) = -2.05$; $p = .044$; $d = .47$
Years regular use	15.9 (9.8)	19.4 (9.7)	$t(73) = 1.51$; $p = .135$; $d = -.40$
Per-use spending	$ 102.6 ($130.6)	$ 144.7 ($145.4)	$t(73) = 1.29$; $p = .202$; $d = -.30$
Average no. treatments	1.1 (1.3)	1.1 (1.4)	$t(72) = .24$; $p = .811$; $d = .06$
Other *DSM–IV* Axis I disorders[a]			
Depressive	15.6% (n = 5)	20.9% (n = 9)	Fisher's exact $p = .814$
Anxiety	12.5% (n = 4)	7.0% (n = 3)	
Substance-induced mood	21.9% (n = 7)	14.0% (n = 6)	
None	46.9% (n = 15)	58.1% (n = 25)	
Other substance use[b]			
Alcohol	65.6% (n = 21)	67.4% (n = 29)	$\chi^2(1) = .94$; $p = .331$
Cannabis	28.1% (n = 9)	32.6% (n = 14)	
Other	3.1% (n = 1)	2.3% (n = 1)	
WCST performance			
Learning to Learn	0.91 (5.7)	−2.10 (8.3)	$t(64) = -1.67$; $p = .100$; $d = .42$
% errors	88.4 (18.6)	87.0 (19.4)	$t(71) = -.30$; $p = .766$; $d = .07$
% nonperserverative errors	92.6 (11.9)	87.8 (13.1)	$t(71) = -1.62$; $p = .110$; $d = .38$
% preseverative error	91.3 (14.3)	91.6 (17.7)	$t(71) = -.07$; $p = .944$; $d = -.02$
WAIS–III vocabulary	10.4 (3.2)	8.4 (3.0)*	$t(72) = -2.68$; $p < .009$; $d = .63$
Equivalence training performance			
Number of baseline training Trials	380.8 (93.7)	558.8 (187.0)*	$t(58.1) = -5.20$; $p \leq .001$; $d = -1.20$
Derived symmetry	100% (n = 32)	45% (n = 20)*	$\chi^2(1) = 24.9$; $p \leq .009$

Variables	Equivalence (*n* = 32)	No equivalence (*n* = 43)	Test statistic
Derived transitivity	100% (*n* = 32)	16% (*n* = 7) *	$\chi^2(1) = 51.5$; $p < .001$
DARN-C (Strength)			
1st decile			
Preparatory (DARN)	0.31 (1.08)	0.40 (1.34)	$t(63) = -.30$; $p = .77$; $d = -.07$
Commitment	−0.83 (1.54)	−0.37 (1.84)	$t(63) = -1.08$; $p = .46$; $d = -.27$
10th decile			
Preparatory (DARN)	0.69 (1.55)	1.03 (1.39)	$t(63) = -.93$; $p = .36$; $d = -.23$
Commitment	1.45 (1.25)	1.34 (1.37)	$t(63) = .37$; $p = .72$; $d = .08$
Treatment response			
Treatment completer	64.5% (*n* = 20)	60.5% (*n* = 26)	$\chi^2(1) = .05$; $p = .51$
Proportion of sessions attended	0.63 (0.33)	0.65 (0.31)	$t(71) = .18$; $p \leq .86$; $d = -.04$
Proportion of treatment weeks cocaine use occurred	0.45 (0.35)	0.52 (0.39)	$t(70) = .77$; $p \leq .45$; $d = -.18$

Note. HAMD = Hamilton Depression Inventory; *DSM–IV* = *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.); WCST = Wisconsin Card Sorting Test; WAIS–III = Wechsler Adult Intelligence Scale—Third Edition; DARN = Desire, Ability, Reasons, Need; DARN-C = Desire, Ability, Reasons, Need, and Commitment statements.

[a]The contrast was having versus not having a comorbid *DSM–IV* Axis I Disorder across equivalence performance categories. The individual diagnostic categories are presented for descriptive purposes.

[b]The contrast was the presence versus the absence of other substance use across equivalence performance categories. Individual substance categories are presented for descriptive purposes.

[c]Standard deviations are presented in parentheses unless otherwise noted.

*Denotes significance at the a *priori* alpha 0.05.

Table 3

Parameter Estimates Quantifying the Relationship Between Changes in the Strength of Client Speech, Derived Equivalence Performance, Their Interaction, and Cocaine Use

Variable	Parameter (*SE*)	*t*-value	*p*-value
Preparatory utterances (DARN)			
DARN (1st decile)	−4.8 (4.8)	−0.98	<.33
DARN (10th decile)	−4.1 (7.2)	−0.58	<.57
Equivalence	−9.4 (9.8)	−0.96	<.34
DARN (10th) × Equivalence	3.5 (9.8)	0.35	<.73
$F(9, 55) = 1.47$, $p \leq .175$, multiple $R^2 = .21$			
Commitment utterances			
Commitment (1st decile)	−19.4 (4.6)	−4.18	<.01*
Commitment (10th decile)	−3.4 (5.7)	−0.60	<.55
Equivalence	−18.3 (8.7)	−2.11	<.04*
Commitment (10th) × Equivalence	−17.8 (8.0)	−2.22	<.03*
$F(9, 55) = 4.02$, $p \leq .001$, multiple $R^2 = .43$			

Note. All regression models included the covariates of amount of cocaine used per occasion, therapist assignment, frequency of all DARN-C talk in the first and tenth deciles, and vocabulary performance from the Wechsler Adult Intelligence Scale—Third Edition. DARN = Desire, Ability, Reasons, and Need statements.

*Denotes significance at the a *priori* alpha .05.