APPROVAL SHEET

Title of Dissertation: Purpose in life mediating the relationship between depression and heavy drinking in post-treatment among individuals with alcohol use disorders

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ABSTRACT

Title of Document: PURPOSE IN LIFE MEDIATING THE RELATIONSHIP BETWEEN DEPRESSION AND HEAVY DRINKING IN POST-TREATMENT AMONG INDIVIDUALS WITH ALCOHOL USE DISORDERS

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Doctor of Philosophy, 2019

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Depression has long been associated with the development of alcohol use disorders (AUD) and implicated throughout the recovery process. By better understanding the mechanisms that help to explain this relationship, the treatment field can more effectively promote quality of life and prevent relapse independent of the treatment-type employed. Purpose in life (PIL) has been established as a mediating factor that protects against other health disorders and has been significantly related to both depression and alcohol use outcomes separately. The primary goal of this study was to consider purpose in life as a partial mediator in the relationship between depression and heavy alcohol drinking among outpatient alcohol use disorder patients across a one-year post-treatment period. Estimating indirect effects attributed to purpose in life over time in this relationship was assessed using a longitudinal analysis known as latent difference score (LDS) modeling.

Purpose in life (month 3) longitudinally mediated the relation between depression (month 0) and drinking outcomes at month 12 (i.e. drinks per drinking day, percent heavy drinking days). This was anchored by strong correlations between depression and PIL (maximum r = -.70). Depression change scores measured during the treatment course (baseline to 3 months) also served as a significant predictor of post-treatment alcohol use outcomes, improving upon the prediction of depression measured only at baseline. However, contrary to a priori hypotheses, the use of variables measured at one time interval (status scores) primarily led to higher estimates of indirect effects compared to inclusion of variables created from difference scores between two time intervals (change scores).

The results of this study further support the dynamic link between depression and problematic drinking throughout the treatment process. Clinicians are encouraged to include *measurement-based care* for depression in their practice to promote treatment retention and strengthen relapse prevention. Purpose in life seems to serve as a protective factor between depression and future heavy alcohol consumption and may be considered one of a number of mechanisms in taking a contextual-behavioral approach to alcohol use disorder recovery.

PURPOSE IN LIFE MEDIATING THE RELATIONSHIP BETWEEN DEPRESSION AND HEAVY DRINKING IN POST-TREATMENT AMONG INDIVIDUALS WITH ALCOHOL USE DISORDERS

By

Daniel James Knoblach

Dissertation submitted to the Faculty of the Graduate School of the
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Dedication

This dissertation project is dedicated to my father, Lloyd Joseph Knoblach (1944-2000), who taught me to never give up and modeled the importance of fatherhood.

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Chapter 1: Introduction

Depression has long been linked with problematic alcohol use. Research that seeks to explain this relationship between depression and alcohol may better inform the integration of treatments for each. Purpose in life (PIL) is historically considered an important element of healthy psychological adjustment, and is a key principle of Viktor Frankl's (1963) *logotherapy*. This positive psychology factor has been found to be inversely associated with depression and problematic alcohol use independently. While PIL has been found to be a key mediator in improving other health outcomes, very little research has considered the possible role of PIL in explaining the relationship between depression and problematic drinking.

This study considered the possible mediating role purpose in life (PIL) has between depression and the heavy drinking of alcohol. These three factors are known to change dynamically, and longitudinal data was used in an attempt to capture a broader view of their relationships over time. Project Match, the large multisite alcohol treatment trial conducted in the 1990s involving hundreds of alcohol-abusing adults, was the data set used to investigate proposed relationships over time, given that it included these three factors over four time-points, and its inherent statistical power. With the recent advent of increasingly sophisticated statistical models, such as latent difference score (LDS) modeling, the objective of this study was to estimate the indirect effect of PIL as a mediator between depression and heavy drinking over time.

Global Burden of Problematic Alcohol Use

The harmful use of alcohol continues to be a major health concern globally. Problematic alcohol use has been identified as a causal factor in more than 200 diseases and other injuries, making alcohol misuse the fifth leading risk factor for premature death and disability worldwide (World Health Organization, 2015), and the first among people aged 15-49 (Lim, et al., 2013). In the United States, 26.9% of adults reported binge drinking (BAC $\geq$ 0.08 g/dL) and 7.0% engaged in heavy alcohol use (more than 5 binge drinking days) *in the past month* (National Survey on Drug Use and Health, 2015). While 1.3 million adults received specialized treatment for alcohol use disorders in the U.S. in 2015, this represented approximately 8.3% of adults who were estimated to need treatment (National Institute on Alcohol Abuse and Alcoholism, 2015). In addition to high prevalence rates, heavy alcohol use is generally known to be highly comorbid with other mental health conditions (Shivani, Goldsmith, & Anthenelli, 2002) and significantly reduces all forms of quality of life (Donavan, Mattson, Cisler, Longabaugh, & Zweben, 2005.) It is evident that harmful alcohol use persists as a detriment to not only individuals, but also to their families, and to our communities at large.

Alcohol Use Disorders (AUD) and Depression

Comorbidity between alcohol use disorders and major depression has been high in several epidemiology reports (Fein, 2015). For example, Grant et al. (2004) found the 12-month prevalence rate of major depression disorder among respondents with an alcohol use disorder to be about 14%. In a recent epidemiology meta-analysis, Boden and Fergusson (2011) concluded that the presence of either disorder doubled the risk of having the second disorder, and that associations between disorders were evident even

when factors that influence both conditions are controlled. The co-occurrence of depression and AUD is more common with White Americans and older adults. Although women are more likely to show higher levels of depressive symptoms combined with problematic drinking, gender did not demonstrate a moderating effect between depression and alcohol use (Conner, Pinquart, & Gamble, 2009). Alcohol use disorders more often begin at a later age compared to co-occurring psychological disorders, like depression, and psychological disorders are better predictors of later alcohol dependence than alcohol abuse (Kessler et al., 1997). In a review by Sullivan, Fiellin, and O'Connor (2005), in which 35 studies were considered involving clinical patients with current major depressive disorder, the median prevalence of current alcohol problems (16%) and lifetime alcohol problems (30%) were nearly twice as great compared to the problematic drinking rates of the general population. Specific populations, such as U.S. veterans, are at even greater risk for comorbidity. Veterans with a life-time AUD were substantially more likely to have current or life-time mood and anxiety disorders, compared to veterans without an AUD (ORs equaled 2.6 and 4.1, respectively, Fuehrlein, et al., 2016). In the recent National Health and Resilience Veterans Study (NHRVS) study of 3157 veterans aged 21 an older, life-time diagnosis of major depressive disorder independently predicted past year AUD, along with younger age, male sex, and unpartnered marital status (Fuehrlein, et al., 2016).

Both AUD and MDD disorders lead to health care problems when considered independently, but when combined the problems are often compounded. For example, the presence of depression has an impact on the course of AUD treatment and recovery. Depressive symptoms are associated with higher treatment drop-out rates and shorter

time to first drink after a period of abstinence (Gamble, et al., 2010). However, when people with a depressive diagnosis actually engage in AUD treatment, their treatment participation was found to be higher (Conner, Pinquart, & Gamble, 2009), and their baseline readiness to change scores were significantly higher (Shields & Hufford, 2005) compared to non-depressed AUD clients. In clinical trials involving alcohol dependence and depression, most participants improved their report of depressive symptoms significantly and substantially for about the first six weeks of treatment, and then much more gradually thereafter (Pettinati, et al., 2010). Ilgen and Moos (2005) found that among the 10% of outpatient Project Match participants who actually deteriorated with drinking outcomes in the three months following treatment, baseline depression measured with the Beck Depression Inventory (BDI) was a significant, independent predictor, suggesting the need for a higher level of services or increase in protective factors for this sub-population experiencing more depressive symptoms.

Conversely, the presence of alcohol problems has also been linked to worse depression course outcomes, poorer social functioning and health care utilization, and higher suicide risk (Sullivan, Fiellin, & O'Connor, 2005). The process of recovery from co-occurring mental health and addiction disorders should also consider other outcomes, such as scores on quality of life. In a review of 42 studies, Levola, Aalto, Holopainen, Cieza, and Pitkanen (2015) found that alcohol dependence negatively impacted all domains of health-related quality of life, and the presence of depression significantly lowered these levels even more. These co-occurring conditions were also associated with other problematic health behaviors like smoking (Friend & Pagano, 2007). For all these reasons, researchers have recommended that integrated treatments consider the interplay

between depression and AUD at assessment, treatment planning, and into follow-up care (Connolly et al., 2013).

The bidirectional relationship between AUDs and depression has also been evaluated over time. In Conner, Pinquart and Gamble's (2009) meta-analysis involving 74 studies, depression was found to be concurrently associated with alcohol use and impairment at several testing points. However, effect sizes were small, and the association was not always found. Overall, depression predicted future alcohol use, and was associated with an earlier age of onset of AUD. In another study involving Project Match data, baseline depression predicted lower abstinence rates and higher rates of increased drinking intensity at 12 months post-treatment, but not after controlling for depression *at post-treatment*, which is a better predictor of post-treatment relapse (Gamble, et al., 2010).

Problematic alcohol use is capable of prompting experiences of depression. Alcohol, especially when consumed in heavy amounts, can chemically induce symptoms of depression, which should be differentiated from non-alcohol induced depression (Schukit, 2006). Alcohol-induced depression often resolves during early abstinence (Schukit, 2006), and has been found to be more prevalent with females (Karpyak, et al., 2016). Both alcohol-induced depression (hazard ratio = 4.7) and *independent major depression* (hazard ratio = 2.3) significantly predicted later relapse (Samet, et al., 2013). Cravings for alcohol seem to be a major part of this positive feedback cycle, where alcohol can provide rewarding properties and compile a method of reducing stress reactivity (even if short-lived), and obsessive thoughts related to temptation craving (Karpyak, et al., 2016).

Witkiewitz and Villarroel (2009) helped summarize the dynamic relationship between alcohol use and depression over time using a newer longitudinal model with Project Match data. They found that at each 3-month testing period, up to 12 months following treatment, changes in drinking were significantly associated with current and prior changes in negative affect (depression and anger), and changes in negative affect followed prior changes in drinking. Consistent with the parameters of the analyses, independence between the two processes could not be assumed, with effect sizes varying at different time points between .13 (small) and .33 (medium). Those participants with the highest levels of negative affect over time, analyzed both between treatment-end and 6 months, and 6 months to 12 months, had the highest probability of heavy and frequent drinking, with a near-zero probability of moderate, healthy drinking levels. Conversely, the "non-drinking" group predicted a greater probability of decreased negative affect over the same time periods. Finally, when considered separately, higher levels of depression, and not anger, increased the probability of future heavy drinking. The researchers concluded that heavy drinking and problematic affect regulation form a positive feedback loop, where increasing levels of depression move toward a "bifurcation point", similar to a threshold, that eventually results in heavy drinking. These sophisticated feedback loops seem to develop at a young age. In a recent study involving adolescents (N = 273) in a school aged treatment program, "drinking to cope" was found to significantly explain the indirect effects between depressive and AUD symptoms. The authors concluded that *affective dysregulation* is the trait that precedes negative affect in adolescents, and can result in drinking to cope behaviors, which can ultimately result in later patterns of unhealthy heavy drinking (Stewart, Arlt, Felleman, Athenour, and Arger, 2015). The

dual-diagnosis treatment field works to identify factors that may help to buffer affect dysregulation when present.

Importance in Investigating Mechanisms of Behavior Change

Recently the Substance Abuse and Mental Health Services Administration (SAMHSA) summarized epidemiological studies to show that, on average, 58% of individuals with lifetime chronic substance dependence achieve sustained recovery (Sheedy & Whitter, 2009). Although recovery from behavioral health conditions like depression and alcohol use disorders is clearly possible, researchers are less sure about *how* people make these healthy changes. After decades of clinical trials comparing effective addiction treatments against each other, direct comparisons failed to show differences in effectiveness, even though they had different underlying theories and mechanisms. In recent years, addiction treatment research has attempted to better understand *how* treatments lead to behavior change (Longbaugh & Magill, 2011).

This new focus on mechanisms research can be broken down into *active ingredients of treatment*, such as a therapeutic skill or process, and *mechanisms of behavior change* (MOBC), such as an event or process occurring within the individual that is associated with subsequent change (Longbaugh, 2013). While people in active recovery probably change for different reasons using different mechanisms, it is also likely that personal mechanisms and processes change in type and amount at different points during a recovery attempt. Cognitive and behavioral examples of personal processes have been summarized by the Transtheoretical Model's *Processes of Change* (Prochaska & DiClemente, 1992). Given the fact that personal processes change over time, models that can identify mechanism factors, such as in this study, can offer a better

understanding for how recovery works (Magill, Kiluk, McCrady, Tonigan, & Longabaugh, 2015). By learning more about what MOBC factors are involved in recovery, and what strategies and processes tend to work for whom, we can better target alcohol use disorders and improve outcomes, independent of the type of treatment (Roos, Maisto, & Witkiewitz, 2017). A primary goal of this research study was to consider purpose in life (PIL) as a possible MOBC factor that helps to explain the problematic relationship between depression and alcohol use.

Purpose in Life as an Important Construct in the Recovery Process

Regarding nomenclature, past research has equated *purpose in life* (PIL) with *meaning in life* (MIL). This convention will be followed for the remainder of this background section. However, others have identified differences, considering "purpose" as making future-oriented goals, and MIL as more of an assessment of the present (Martela Steger, 2016). Viktor Frankl (1963) also described purpose, a necessary element in his theory of an individual's growth, in terms of lifespan, rather than merely an assessment of the present moment. Frankl believed that finding meaning in one's everyday life was primary to an individual's motivational force, especially when searching outside of oneself and seeking connection externally: "It denotes the fact that being human always points, and is directed, to something, or someone, other than oneself—be it a meaning to fulfill or another human being to encounter," (Frankl, 1984, p. 115). In the development of the *Meaning in Life Questionnaire: Presence of Meaning Scale (MLQ-P)*, "meaning" was defined as "the sense made of, and significance felt regarding, the nature of one's being and existence" (Steger et al., 2006, p. 81), perhaps being more mindful of the present moment compared to PIL. In the past year,

Martela and Steger (2016) have developed a comprehensive theoretical overview integrating past research and arguing for a framework where meaning includes a) coherence; a sense of comprehensibility and one's life making sense, b) purpose; a sense of core goals, aims, and direction in life, and c) significance; the inherent value of having a life worth living. The authors suggest that meaning and purpose should no longer be considered separately, and future research should attempt to look at these subfactors with more specificity.

In the current recovery literature for both substance use and mental health disorders, purpose in life has been an important factor in intentional behavioral change. In their summary of 354 semi-structured interviews of New York City residents in maintained recovery from substance dependence, White, Laudet, and Becker (2006) used the term *life meaning and purpose* to describe the common experience among interviewees of redefining their identity and developing hope for their future goals. This common experience, whether framed in religious, spiritual, or in secular terms, was termed a form of *recovery capital*, a known predictor of sustained recovery and life satisfaction (Laudet & White, 2008). In related research with individuals in maintained recovery, purpose in life was also associated with both hope (McCoy, 2009) and AA affiliation (Galanter, 2007). Mental health researchers have also identified purpose in life as an important ingredient to personal recovery. In their narrative synthesis approach with descriptions of personal recovery from mental health disorders (N = 97 manuscripts), Leamy, Bird, Le Boutillier, Williams, and Slade (2011) labeled *meaning in life* as a necessary recovery process, along with connectedness, hope and optimism, identity, and empowerment to form the acronym *CHIME*. Finally, SAMHSA's (2012)

initiative of integrating recovery efforts named "purpose" in its working definition of recovery that included finding meaningful daily activities.

Purpose in Life (PIL) Related to Research Aims

Although PIL often has been discussed as an important factor in recovery, surprisingly few quantitative studies have focused on this construct as a mechanism of change in alcohol treatment research (Roos, Kirouac, Pearson, Fink, & Witkiewitz, 2015), and even fewer include PIL in the study of co-occurring AUD and depression. In one underpowered study with a low sample size, PIL was found to be a significant contributor to AA involvement in stepwise regression, but did not meet Baron and Kenny's (1986) mediation criteria between AA involvement and long-term sobriety (Oakes, 2008). In another study of inpatient AUD patients with depression in Athens, Greece, nonparametric correlational analyses measured the association between meaning of life separately with depression and alcohol use at treatment initiation. Alcohol use scores (via AUDIT) correlated significantly with both *existential vacuum* (t_b = -.19, p < .01) and *goal seeking* (t_b = -.15, p < .01), both sub factors of a meaning in life measure. The authors added that Western-trained academics have historically avoided meaning in life in the study of depression and alcohol use disorders given its relation to a spiritual dimension and academics beliefs in "logical positivism" (Kleftaras & Katsogianni, 2012).

Following this study, Pearson, Brown, Bravo, and Witkiewitz (2015) used structural equation modeling with cross-sectional data of 1277 college students who had never attempted mindfulness exercises. The study focused on the potential for PIL, considered as a factor to quantify *value clarification*, as a partial mediator between trait mindfulness and three health outcomes: depressive symptoms, anxiety symptoms, and

alcohol-related problems. PIL, measured with the Life Engagement Test, demonstrated significant indirect effects ($p < .05$) in the relationship between trait mindfulness (β=.16), and both depressive symptoms (β = -.31) and alcohol related problems (β = -.12). PIL was not a significant mediator for anxiety. *Decentering*, known as shifting a perspective through mindfulness, including watching one's thoughts and emotions in a non-judgmental way (Pearson et al., 2015), was also significantly linked in the model between trait mindfulness and purpose in life (β = .31, β = .40, respectively). As a result, decentering was believed to serve as a *meta-mechanism* factor, one that may mobilize other factors of positive change more directly associated with overall well-being (Pearson et al., 2015).

Purpose in life (PIL) has been examined in AUD treatment research and is included in this study's aims. Starting with the development of the Purpose in Life Test, Crumbaugh (1964) observed that participants, described as inpatient alcoholics, scored much lower on PIL (M = 85.4, SD = 19.4, N = 38) than the non-clinical sample (M = 112.4, SD = 14.1, N = 805). Additionally, a review of longitudinal studies found purpose in life to increase consistently over the course of treatment, showing gains for individuals engaged in a broad range of treatments (Hart and Carey, 2014.) Meaning in life has also been found to be an important consideration in post-treatment recovery, and has been significantly correlated with three types of quality of life among residential AUD clients 2 years post-treatment: personal functioning (r = .38, $p < .01$), interpersonal functioning (r = .26, $p < .05$), and societal functioning (r = .24, $p < .05$) (Hart & Singh, 2009). While PIL is an important element within the AUD recovery context, more research is necessary to specifically explore how PIL may be a part of the process.

PIL as a possible mediator between depression and alcohol in AUD recovery

The current study's hypothesis is that purpose in life (PIL) is a significant partial mediator in the relationship between depression and alcohol use outcomes across time. Since the literature is limited to studies focusing directly on the specific relationship among these factors, related research is examined below. First, purpose in life was a significant mediator in other health outcomes research, and the literature is summarized below. Second, mediational arguments are supported by establishing the relationship between the potential mediator and the direct predictor, and then independently with outcome variables (Longbaugh, 2013). Thus, significant relationships between PIL and depression, and then PIL with alcohol outcomes, are examined. Finally, a longitudinal mediation model is proposed that considers the associations between these three factors throughout the course of treatment and time of follow-up.

PIL as a significant mediator in other health outcome research

Purpose in life (PIL), and its related constructs, has been related to overall wellness, and may mitigate health disorder severity. For example, meaning in life mediated the relationship between religious behaviors and measures of well-being (Steger and Frazier, 2005), and is negatively associated with experiential avoidance and emotion suppression, which are known factors in the maintenance of psychological distress (Kashdan, Barrios, Forsyth, & Steger, 2006). PIL's role as a mediator also extends to protecting against drug dependence and suicide risk. In a study involving adolescents, Harlow, Newcomb, and Bentler (1986) found that PIL mediated the relationship between

depression and suicide ideation for males, and mediated the relationship between depression and substance use among females. In a later study among active military and veterans with both depression and PTSD, meaning in life mediated the relationship for both depression and PTSD, and suicidal risk (Sinclair, Bryan, & Bryan, 2016). Meaning in life has also mediated the relationship between physical symptoms related to disabling diseases like cancer and psychological distress (Simonelli, Fowler, Maxwell, & Andersen, 2008; Park, Edmondson, Fenster, & Blank, 2008). Further, PIL was also a relevant factor for heathy aging, as PIL scores independently predicted levels of allostatic load 10 years later among U.S. middle-aged adults (Zilioli, Slatcher, Ong, & Gruenewald, 2015). Finally, PIL buffered against depression in older age, as meaning in life mediated the relationship between "activity and social interest" and depression among Korean retirees (Kim, Park, & Hogge, 2015).

PIL and depression

PIL has consistently been shown to be related inversely to depression, both with general health care outcomes and among people with AUDs. Zika and Chamberlin (1992) demonstrated that PIL scores correlated moderately well with depression both for non-clinical mothers (r = -.44) and for the elderly (r = -.64). This contrasted with positive associations for measures of psychological well-being [Mental Health Inventory, among mothers (r = .74), and the elderly (r = .74)]. In another study using step-wise regression analysis with college students (Molasso, 2006), PIL was positively associated with "behaviorally-activating" events, engaging activities, such as spending time with friends, studying, exercising, and attending social events, and was negatively associated

with passive, non-behaviorally-activating events, such as frequently watching television or playing video games.

PIL was also strongly correlated with depression in other behavioral health populations. For example, in an inpatient psychiatric sample, PIL scores were strongly associated with depression (r = -.76), and significantly mediated the association between satisfaction in life and suicide ideation, while moderating the relationship between depression and suicide ideation (Heisel & Flett, 2004). Presence of meaning in life has been strongly associated with depression among smokers as well (r = -.59, p < .001, Konkoly Thege, Bachner, Martos, & Kushnir, 2009; r = -.60, p < .001, Steger, Mann, Michels, & Cooper, 2009). Specific to the latter study, both experience of meaning in life, and the propensity to seek deeper meaning in life interacted to predict perceived health, above and beyond depression.

PIL has also shown significant associations with depression among AUD clients. In a clinical trial involving alcohol-dependent outpatient participants, PIL was correlated negatively with depressive symptoms (r = -.65, p < .01, Krentzman, Cranford, & Robinson, 2015). Additionally, in their extensive review of the use of PIL with alcohol and drug treatment studies, Hart and Carey (2014) cited one study (Gomes & Hart, 2009) that found a negative correlation between a three item MIL/PIL index and depression (r = -.55, p < .05) among inpatients with problematic drinking. More specifically, depressive symptoms correlated significantly with all sub factors of meaning in life within the Life Attitude Profile (e.g. *goal seeking*, *personal meaning*) among inpatient AUD patients with depressive symptomology. Correlations of subscale scores ranged in strength from *existential vacuum* (t_b = .17, p < .05) to *life purpose* (t_b = -.39, p < .01) (Klefarus &

Katsogianni, 2012). Finally, in a subsample of the Project Match data (*N*=414), baseline purpose in life correlated moderately with baseline depression (r = -.61, p < .001, Krentzman, Farkas, and Townsend, 2010).

PIL and alcohol outcomes

There have been several studies showing the significant relationship between PIL and alcohol outcomes. In an initial pilot study, PIL was found to significantly improve after a short three-week inpatient treatment program among alcohol abusing adults (t = 3.21, p < 0.01, Jacobson, 1977). Similar trends were observed in post-treatment AUD recovery, where PIL scores increased with age and each later stage of recovery (short-term = 3-12 months, mid-term = 13-47 months, long-term = longer than 47 months, Junior, 2006). PIL scores were also associated with drinking intensity levels, both concurrently and predictive of future drinking. Among 364 participants who met criteria for alcohol dependence, baseline PIL was significantly associated with baseline drinking intensity (drinks per drinking day) (r = -.20, p < .01, Cranford, Krentzman Mowbray, & Robinson, 2014). Stewart, Hudson, and Connors (2006) analyzed the full Project Match data set (*N*=1709) with a regression model that compared all available PIL scores (baseline, post-treatment, 3 months and 6 months post-treatment) to drinks per drinking day across the same time-period, and found that PIL scores independently predicted changes in drinks per drinking day over the entire 15 months of the study ($\beta = -0.48$, p < 0.001). PIL scores also improved over time. Interestingly, an examination of PIL and alcohol outcomes by race showed group differences in a small subset of Project Match data (N = 414), with Black participants having higher baseline PIL than White participants. Additionally, race moderated the relationship between PIL and alcohol

outcomes where PIL served as a stronger protective factor for Black participants compared to White participants; this interaction effect was not true for religiousness (Krentzman, Farkas, & Townsend, 2010).

Some studies have examined the relationship between PIL and drinking outcomes across different time points. For example, C*hange in PIL* has also been tested as a factor, from baseline to six months later, and was a significant predictor of *absence of heavy drinking days* at six months (*AOR* = 1.03, $p < .05$, $N = 123$) in an alcohol treatment-seeking sample, controlling for AA involvement and gender (Robinson, Cranford, Webb, & Brower, 2007). Later, linear and logistic regression analyses were used with a different treatment-seeking sample (N = 364). Baseline to six month changes in PIL significantly predicted alcohol use outcomes at nine months; specifically, percent days abstinent ($b = .30$, $p = .02$) and mean days since last drink ($b = 1.73$, $p = .002$), as well as the percent of heavy drinking days (*OR* = 0.97, $p = .009$), after controlling for baseline AA involvement and drinking. There was no statistical significance for drinks per drinking day (*OR* = 0.98, $p = .06$) (Robinson, Krentzman, Webb, & Brower, 2011). Although the authors acknowledge that the effect sizes across studies were modest, they note the consistency of the significance of their findings, and suggest that PIL, and related "spiritual and religious" concepts, play a role in recovery and should be further studied. Finally, in a related study, purpose in life deterred AUD individuals from remaining in a high-risk drinking trajectory (Cranford, Krentzman, Mowbray, & Robinson, 2014).

Two recent studies have examined long-term changes in PIL over time, and the longitudinal relationship of PIL with AUD outcomes or related factors. Working with the

same treatment-seeking sample above, Krentzman, Cranford, & Robinson (2015) extended the analysis of PIL from baseline to 2.5 years with 6 month intervals, and predicted three change trajectories retroactively as a function of remission status at the study end (based on met DSM-IV criteria; full remission = 0 criteria, partial remission = 1-2 criteria, no remission = 3+). Consistent with other studies, baseline PIL was higher among those reporting full and partial remission compared to no remission. PIL increased over time for each group, and this increase was greatest for the full remission group, followed by the partial remission group, with mean scores similar to non-clinical population norms (Krentzman, Cranford, and Robinson, 2015). While PIL scores started to increase right after baseline, growth continued past early recovery and into the maintenance stage.

In a related study, Roos, Kirouac, Pearson, Fink, and Witkiewitz (2015) used the full Project Match data set over 15 months to examine the longitudinal associations between PIL and temptation to drink (TTD), measured by the urge subscale within the Alcohol Abstinence Self-Efficacy Scale (AASE-T) (DiClemente, Carbonari, Montgomery, & Hughes, 1994). Through parallel process latent growth curve analysis, an inverse relationship was established between PIL and TTD across all time intervals, and these results were independent of treatment type. Consistent with the previous study (Krentzman, Farkas, & Townsend, 2010), PIL scores were also found to increase initially in months 0 to 3, but the growth rate actually accelerated after treatment, and maintained this higher rate until the last follow-up interview at 15 months. Additionally, PIL and TTD slopes and intercepts were significantly correlated with all three drinking outcomes (drinks per drinking day, percent drinking days, and drinker inventory of consequences),

in the expected directions. The authors proposed that for AUD individuals, low PIL scores could be viewed as a deprivation of healthy reinforcers, which can lead to increased strength of alcohol cues and craving, and then to an increase in TTD.

Possible PIL relationship with readiness to change (RTC)

Both research teams of the past two studies concluded that PIL may be related to an individual's values, and to the meaningful activities that are consistent with this worldview. It seems that for many, redefining values and committing to purposeful behaviors, leads people to pursue other rewarding life goals unrelated to alcohol use, and, thus, may be a mechanism of recovery (White, Laudet, & Becker, 2006; Best, et al., 2012). Given its process-orientation, PIL may strengthen critical motivational factors that carry an individual through the stages of change (Krentzman, Cranford, & Robinson, 2015). Miller and Rollnick (2012) discuss this topic in their description of the effectiveness of *Motivational Interviewing,* believing that "encouraging greater life purpose and meaning may be one of the primary mechanisms". Interestingly, both PIL and an important indicator of motivation, *motivational readiness*, have had significant associations with improved alcohol outcomes over time (Project Match Research Group, 1997, Gaume, Bertholet, and Daeppen, 2017). Recent literature has not investigated possible associations between PIL and motivational factors, such as motivational readiness or RTC. It may be that PIL can be considered a distal factor related to motivation, one that is useful particularly in anchoring relapse-prevention efforts (Center for Substance Abuse Treatment, 2006). Given the increased rate of PIL scores after treatment, and the observation that depression levels decrease at a greater rate earlier during treatment, PIL may be a factor that helps crystalize the *recovery capital* that

begins in early recovery with an increase in motivation to change and a decreasing level of depression.

Advances in Longitudinal Mediational Analysis

To better understand the relationship between depression, drinking outcomes, and purpose in life over time, longitudinal mediation analyses are necessary. Since the advent of latent growth modeling (LGM) curves, we can now test for mediational relationships longitudinally. Using a recent specialized version called latent difference score (LDS) modeling, mediation analysis can now be conducted with difference scores, in addition to status scores (measured at one time), for each variable serving as statistical parameters. In this type of modeling, changes can be examined for each factor with each time wave, rather than only relying on the starting point or constant slope for the entire trajectory that LGM provides to assess relationships among variables. From the use of this new longitudinal mediation approach, indirect effects can be better inferred over time in successive fashion. Having a model with this type of temporal precedence can strengthen claims of both mediation over time, as well as directionality between factors, compared to previous modeling.

Given that the MOBC factors related to positive outcomes are always changing throughout the recovery process, the use of change scores may be preferred over status scores as statistical parameters in studies of longitudinal mediation (Grimm, An, McArdle, Zonderman, & Resnick, 2012). Throughout the natural sciences and developmental psychology, there are many instances of dynamic interactions among factors, where the change in one factor can trigger the change in other factors. The synthesis of several successive changes may be necessary to push toward a multifaceted

outcome such as recovery. This study model is an example of dynamic interactions, where a decrease in depression may be considered a fundamental factor related to intentional behavioral change, and a factor, such as purpose in life, may be necessary to maintain and even enhance recovery efforts for the long-term. The use of latent difference score modeling is better equipped to detect this dynamic interplay of changes compared to previous statistical models.

Research Aims/Hypotheses

The study's primary purpose was to evaluate the role of purpose in life (PIL) as a mediating mechanism between depression and two alcohol outcomes, *Percent days of heavy drinking* (PDHD) and *Drinks per drinking day* (DDD). Depression was chosen to be the initial predictor based on previous research where depression at baseline and treatment end significantly predicted alcohol intake post-treatment (see Gamble, et al., 2010). PIL was found to increase to its highest rates after treatment, or, at minimum, maintain its initial gains (Roos, Kirouac, Pearson, Fink, and Witkiewitz, 2015, Krentzman, Cranford, and Robinson, 2015), and was, therefore, considered sequentially after reported depressive symptoms. The study included drinking outcomes that occurred after assessments of depression and purpose in life, toward the end of the study where about half of the participants were engaging in heavy drinking at both 12 and 15 months (Cisler and Zweben, 1999).

Therefore, this study uniquely examines decreases in depression symptoms as a predictor of increases in PIL scores, which are expected to precede observed changes in later alcohol outcomes post-treatment. In addition to the previous research suggesting this order of successive factors in a longitudinal manner, it is also believed to be intuitive.

In the early stages of AUD treatment, with an expected reduction in problematic drinking, depression symptoms are suspected to alleviate parallel to improvements in basic primary physiological needs summarized with Maslow's (1943) *Hierarchy of Needs* (e.g. better sleep, nutrition, perhaps improved environmental conditions). These improvements are also occurring concurrently with a reduced consumption of alcohol, a known physiological depressant. Following an outpatient treatment episode (i.e. 3 months), and after more basic needs have been met, the individual in recovery may become more aware of motivators that have greater meaning for them. Purpose in life could be an example of this type of "contextual motivator" where the individual seeks a greater sense of esteem and experiences an internal push to actualize a believed purpose. It is hypothesized that these higher level factors are believed to help sustain recovery throughout post-treatment and long after short-term needs have been met.

This broader theory of the relationship between depression, purpose in life, and AUD recovery will be tested specifically within a latent difference score (LDS) model. This longitudinal model includes assessing change scores for each factor, status scores at single time points, and a combination of both. Table 1 outlines the eight proposed paths for the indirect effects of the mediator on the relation between the predictor and outcome. Another step is to examine the strength of the relationship between PIL and Readiness to Change-RTC (at baseline) at treatment initiation. If the relationship is significant, RTC will be controlled for in the mediation analysis.

Table 1

Indirect Effect Paths for the Latent Difference Score Mediation Model using Outpatient Project Match Data

Path Number	Predictor	Mediator	Outcome
1	BDI_0	PIL_3	ALC_{12}
2	BDI_0	PIL_{3-9}	ALC_{12}
3	BDI_{0-3}	PIL_3	ALC_{12}
4	BDI_{0-3}	PIL_{3-9}	ALC_{12}
5	BDI_0	PIL_3	ALC_{12-15}
6	BDI_0	PIL_{3-9}	ALC_{12-15}
7	BDI_{0-3}	PIL_3	ALC_{12-15}
8	BDI_{0-3}	PIL_{3-9}	ALC_{12-15}

Note: Alcohol measures at 12 and 15 months ask participants for self-report data during a 90-day window retroactively.

Subscripts indicate the timing of assessment, in months after baseline. The analysis of each path result in an estimation of fit for indirect effects in the model, with a corresponding 95% confidence interval. When zero is not included in the confidence interval the indirect effect is interpreted as significant.

Specifically, this research study aimed to answer the following empirical questions:

1. Does purpose in life serve as a significant partial mediator, measured in terms of an indirect effect, in the relationship between depression and each alcohol outcome (PDHD, DDD) during the 15-month interval of Project Match data?

2. Does the use of change scores for the predictor and mediator have a different level of power in predicting drinking outcomes (PDHD and DDD) compared to the use of status scores (obtained at a single time point)?

Hypotheses

1. It is hypothesized that purpose in life (PIL) partially mediates, as evidenced by significant indirect effects, the relationship between depression and both alcohol outcomes (PDHD, DDD) over the study's course of 15 months.

   The hypothesis for this longitudinal mediational analysis assumes that decreases in depressive symptoms between months 0 to 3 predict changes in PIL between months 3 to 9, which, in turn, predicts decreases in average drinking outcomes, measured at months 12 and 15 (Drinking outcomes are based on retroactive self-reporting for the past 90-day window). *Please refer to Table 1 for a complete description of the eight possible paths of indirect effects analyzed in the LDS model. Paths will be analyzed by comparing the indirect effect estimates and bootstrap confidence intervals.*

   - Hypothesis 1 is represented by model path #8 in Table 1.

2. It is hypothesized that change scores for depression between months 0 and 3 are stronger predictors of PIL compared to status scores for depression, measured only at month 0.

   - Specifically, it is expected that depression serves as a stronger predictor in model paths 3, 4, 7 and 8 compared to model paths 1, 2, 5, and 6.

3. It is hypothesized that change scores in PIL between months 3 and 9 are stronger predictors of both drinking outcomes (PHDD, DDD) compared to status scores for PIL, measured only at month 3.

    - Specifically, it is expected that PIL serves as a stronger predictor in model paths 2, 4, 6, and 8 compared to model paths 1, 3, 5, and 7.

Chapter 2: Method

Study Approval/Data Use Permission

Prior to carrying out this secondary study using Project Match data, permission was obtained from the University of Connecticut, Department of Community Medicine and Health Care. The data use agreement was shared with the University of Maryland, Baltimore County's Institutional Review Board (IRB), along with a summary of the study, and the IRB application was approved.

Project Match

The following study was a secondary analysis using Project Match data. Project Match was a large-scale, multi-site alcohol treatment study conducted over a two-year period between 1994 and 1996. The study's primary objective was to assess for fit between a variety of client characteristics and the type of treatment received (Project Match Research Group, 1997). Participating clients were randomly assigned to one of three 12-week individual treatments: Cognitive Behavioral Coping Skills Therapy (12 sessions), Twelve-Step Facilitation Therapy (12 sessions), and Motivational Enhancement-Therapy (4 sessions). Clients were then followed-up for one year post-treatment. Project Match included two parallel but independent studies: an "outpatient"

study, which recruited participants from the community and outpatient treatment centers, and an "aftercare study", which recruited participants who had just finished a residential or intensive day hospital treatment. For the purposes of this secondary analysis, only outpatient study data was analyzed. This decision was made in part due to this sample having a greater range of drinking outcomes compared to the aftercare participants. In Project MATCH, aftercare participants had better drinking outcomes, and less variance, because they had experienced an inpatient treatment experience before Project MATCH participation (Krentzman, et al., 2010). The outpatient study consisted of five outpatient clinics, located in Albuquerque, NM, Buffalo, NY, Farmington, CT, Milwaukee, WI, and West Haven, CT.

Participants

Project Match inclusion criteria consisted of a current DSM-III-R diagnosis of alcohol abuse or dependence, alcohol as the primary substance of abuse, active drinking during the 3 months prior to study recruitment, and a minimum age of 18 and a sixth-grade reading level. Exclusion criteria included current dependence on drugs, intravenous drug use in the 6 months prior to recruitment, acute psychosis/danger to self or others/organic impairment, unstable housing, or concurrent involvement in another formal alcohol treatment or probationary activity (Longabaugh & Wirtz, 2001). Table 2 shows completion rates by measure at different follow-up waves for the original Project Match outpatient data set.

For this secondary analysis, additional exclusionary criteria were applied and are summarized in Figure 1. The outpatient study originally recruited 952 eligible participants. For this type of growth trajectory analysis, all cases needed baseline data

with every measure to serve as the y-intercept; 75 cases did not meet this criterion and were excluded. Additionally, since growth models ideally include at least three measures per individual (one at baseline and at least two at follow-up) (Curran, Obeidat, & Losardo, 2010), 84 cases were excluded because they had less than 2 follow up data points on each measure. The remaining data set analyzed included 793 cases.

Table 2

Completion Rates by Measure at Time Waves for Project Match Outpatient Participants (N = 952) (Number, Percentage)

Time wave	BDI	PIL	Form 90 (Alcohol outcomes)	URICA (RTC)
Baseline	896 (94.1%)	932 (97.9%)	952 (100%)	946 (99.4%)
3 months	898 (94.3%)	868 (91.2%)	921 (96.7%)	
9 months	819 (86.0%)	822 (86.3%)	896 (94.1%)	
15 months	825 (86.7%)	835 (87.7%)	871 (91.5%)	

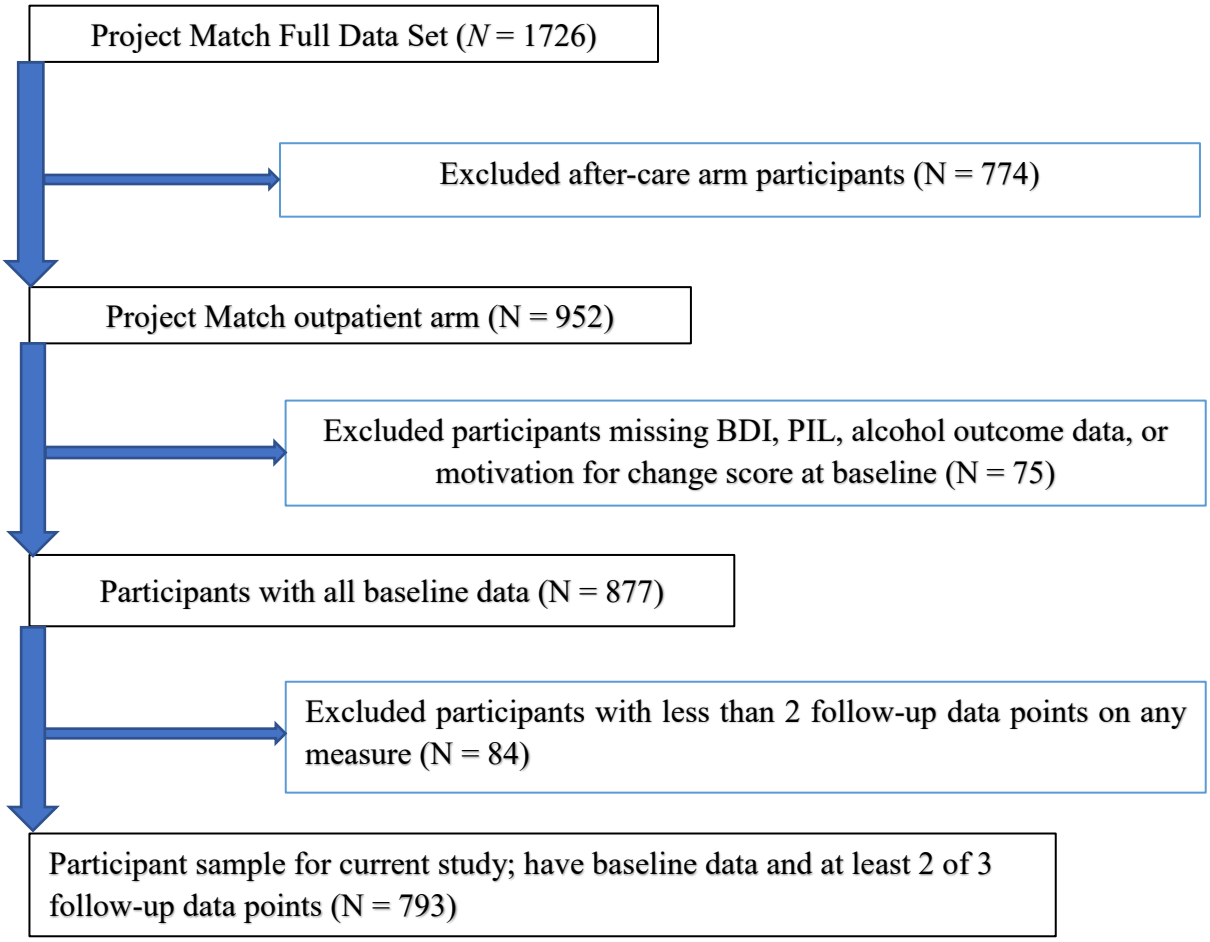

Figure 1: Participant inclusion and exclusion for secondary analysis of Project Match data

Measures

Depression

The Beck Depression Inventory (BDI, Beck, Steer, & Garbin, 1961) was used to measure depression symptom severity. The BDI is a 21-item Likert-type measure that asks participants to respond on a scale of 0 to 3 on how much each statement describes the way they have been feeling during the past two weeks, including the day of testing.

Total scores range from 0 to 63. The standard cut-off scores for the original BDI are interpreted in the following way: 0-9: minimal depression, 10-18: mild depression, 19-29: moderate depression, and 30-63: severe depression. The BDI has a long history of use with a wide range of populations, and is a reliable and valid way of measuring depression severity among alcohol use disorders (Brown, Evans, Miller, Burgess, & Mueller, 1997). In a 25-year anniversary review paper assessing its psychometric properties, the BDI has shown high internal consistency (r = .92) and high test-retest reliability (r = .93, Beck, Steer, & Garbin, 1988). Studies of concurrent validity were also high with a psychiatric population; average correlations were r = .72 and r = .73 with clinical ratings and the Hamilton Psychiatric Rating Scale for Depression, respectively. Participants completed the BDI at baseline, 3 months (end of treatment), 9 months and 15 months to make up the trajectory over time. Regarding the LDS model shown in Table 1, BDI scores at baseline and 3 months will be emphasized.

Purpose in life

The Purpose in Life Test (PIL, Crumbaugh & Maholick 1964) was used in Project Match to measure "purpose in life." This 20 item self-report measure attempts to quantify Viktor Frankl's (1963) ideas of meaning in life according to logotherapy. Presently, it is the most widely used scale to measure meaning and purpose in life (Garcia-Alandete, Martínez, Nohales, Valero, & Lozano, 2016). Each item is rated on a separate seven-point differential scale (e.g. In life I have… 1: no goals or aims at all — 7: very clear goals and aims). The total score is calculated by summing items, creating a range of 20 to 140, with higher scores suggesting a stronger identification with "purpose in life". The PIL developers suggest the following interpretation: scores of 113 and

above equate to high purpose, 92-112 reflect moderate levels of purpose, and scores 92 and below suggest a lower life purpose. These cut-off scores correspond with the original tested means from a "normal" (112.42) and "patient" (92.60) population (overall M = 106.47, SD = 18.94, N = 1151, Crumbaugh & Henrion, 1988).

Since its inception, several psychometric evaluations have been conducted. A latent variable approach (Harlow, Newcomb, & Bentler, 1987) was conducted on a slightly revised edition (PIL-R) with 722 healthy young adults, and four factors were identified: 1) lack of purpose, 2) positive purpose, 3) motivation for meaning, and 4) existential confusion. However, over the years several other factor models have been suggested, ranging from a single primary factor model to complex multi-factorial models. Because of these varied factor analysis results, and its general attempt to include several broad concepts (i.e. suicidality, goal-making, worldview, boredom), its structural validity has at times been questioned (Garcia-Alandete, Martínez, Nohales, Valero, & Lozano, 2016). Despite this factor variability with other populations, the PIL was found to have a single factor among treatment and non-treatment problematic drinkers after dropping three items deemed unrelated (Marsh, Smith, Piek, & Saunders, 2003). The current study worked with participant total PIL scores, comprised from all 20 test items, since it was not possible to drop individual items deemed unrelated. Historically, the PIL has shown high internal consistency, specifically with a problematic drinking population (α = .88, N = 154, Robinson, Cranford, Webb, & Brower, 2007). However, without individual item scores in this Project Match data set, item consistency was not able to be measured. Research participants in Project Match completed the PIL at recruitment, end of treatment (3 months), 9 months and 15 months to make up the trajectory. Regarding the

LDS models shown in Table 1, PIL scores at 3 months and 9 months were selected as the key measures.

Drinking outcomes: Form 90

In Project Match, drinking outcomes were calculated using Form 90 (Miller, 1996). This measure includes a timeline follow-back method that obtains self-reported, daily estimation drinking data to form summary alcohol use variables. Participants were asked retrospectively about their drinking habits 90 days prior to each interview, starting at intake, and at each subsequent 3-month follow-up, creating a continuous daily drinking record trajectory extending to 15 months after baseline interview. To enhance recall, participants were assisted with a calendar to identify repeated patterns, and were anchored to specific events in the participant's life (e.g. birthdays, holidays, anniversaries). Form 90 has demonstrated excellent test-retest reliability from its use in Project MATCH, across different interviews and sites, and for both *drinks per drinking day* (r = 0.88 to 0.93) and *percent heavy drinking days* (r = 0.92 to 0.97, Tonigan, Miller, & Brown, 1997). Analysis of Project MATCH data established strong concurrent validity between Form 90 self-reports and a frequency item on the Alcohol Use Disorders Identification Test (AUDIT) (r = 0.67 for outpatient participants, Miller, 1996). Overall, the validity of daily estimation procedures has exceeded quantity/frequency measures given the greater amount of data obtained (Del Boca & Darkes, 2003), and has correlated with biological markers during detoxification treatment admissions (*gamma-glutamyl transferase*, r = 0.37, Scheurich, et al., 2005).

The summary alcohol use outcomes chosen for this study were *percent heavy drinking days* (PHDD), considered by NIAAA to be an "optimal" measure in alcohol

treatment efficacy trials (Sobell, Sobell, Connors, & Agrawal, 2003), as well as *drinks per drinking day* (DDD), a commonly used measure in past Project MATCH research. Heavy drinking days were defined as 5 or more standard drinks per day for males, and 4 or more standard drinks per day for females, consistent with current National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2004) guidelines. The outcomes used were also more sensitive to measure improvement (i.e. reduction) over time compared to abstinence outcomes, and allowed for capturing drinking within healthy limits. Regarding the LDS model shown in Table 1, drinking outcome data was selected at 12 months and 15 months. For PHDD, this equated to the percent heavy drinking days over a 90-day window prior to each reporting interval at 12 and 15 months. For DDD, this equated to the average number of drinks per drinking day over the same 90-day intervals.

Readiness to change (RTC)

An important covariate to consider was baseline motivation for change, a factor found to predict drinking outcomes and to have shared variance with other potential predictors of behavior change (Project Match Research Group, 1997). In Project Match, motivation was measured using the University of Rhode Island Change Assessment-Alcohol version (URICA-A), a 28-item self-report measure that contains four 7-item subscales: a) precontemplation, b) contemplation, c) action, and d) maintenance. Each item is rated on a Likert Scale ranging from 1 (strongly disagree) to 5 (strongly agree). A composite score for readiness to change (RTC), a measure of motivation for change, was calculated by summing the mean scores of contemplation, action, and maintenance, and subtracting the mean pre-contemplation score, creating a range of scores from -2 to +14. Internal consistency has been demonstrated for each of the subscales, evidenced by

acceptable to good Cronbach's alpha coefficients ranging between 0.75 to 0.86 for the outpatient Project Match study (DiClemente, Carbonari, Zweben, Morrel, & Lee, 2001). Further, the factor structure of the URICA has been supported by confirmatory factor analysis, and was correlated with addiction severity measures at baseline (Field, Adinoff, Harris, Ball, & Carroll, 2009).

Data Analysis Plan: Contextual Background for Study's Longitudinal Mediation Model

Introduction to latent difference score modeling

Latent Difference Score (LDS) modeling is a longitudinal design that is a specialized type of latent growth modeling (LGM). In comparison to cross-sectional studies, longitudinal models in general allow for detecting meaningful differences in the patterns of individual change over time (McArdle, 2009). In LDS, the model includes differences between waves of observation in an attempt to demonstrate *temporal precedence* to better support causal conclusions. Specifically, change scores measured across testing intervals can be thought of as unique model parameters, independent of the accumulated changes from the initial starting point (Reeve, Paul, & Butterworth, 2015). In this way, LDS can be considered an improvement from its parent model Latent Growth Curve Modeling (LGM), which requires changes to occur systematically (i.e. linear or quadratic) across all time intervals to obtain the best model curve fit. Therefore, for variables where the trajectory of change may be expected to differ from one interval to the next, LDS is the preferential model (Selig & Preacher, 2009). In this proposed analysis, rates of change for each factor are expected to change at different intervals, such as when comparing within-treatment to post-treatment changes. LDS offers more flexibility and availability to detect these specific events of change compared to other

longitudinal models. For these reasons, LDS was chosen as the best modeling program to analyze this study's mediation relationships.

LDS in the context of latent growth modeling

Latent difference score (LDS) modeling can be considered an extension of latent growth modeling (LGM), where the emphasis is placed on modeling several latent change scores between waves, compared to merely using one change parameter estimate to account for the entire time span (Grimm, An, McArdle, Zonderman, & Resnick, 2012). Both LDS and LGM stem from the logic of structural equation modeling (SEM) where latent scores are separated from the random error of measurement (Reeve, Paul, & Butterworth, 2015). Latent growth analyses in general can describe group level information by accounting for factor means, while also accounting for individual differences through the measurement of variances. The strengths of SEM statistical methodology include the ability to test the adequacy of a hypothesized growth form, including fixed and time-varying covariates, while incorporating growth into the model of several constructs simultaneously (Duncan & Duncan, 2004). In both LDS and LGM analyses, multi-wave data offer the advantage of increasing the precision of the parameter estimates, while offering the opportunity to test for nonlinearity.

To better contextualize LDS, it may be helpful to introduce fundamental LGM principles. Similar to LDS, LGM is able to account for intra-individual change while also summarizing differences between individual changes (Selig & Preacher, 2009). LGM differentiates these by identifying two latent factors, an *intercept* and a *slope*. The intercept represents a constant for each individual across time, the point where the growth line intersects with the vertical axis. When taking all individual trajectories together, the

collective y-intercept serves as the group's intercept mean (M_i) at the initial data point, with a corresponding deviance statistic (D_i). The second latent factor, slope, summarizes the rate of change in the individual's trajectory from initial to last observation. A group mean slope (M_s) and deviance (D_s) can also be calculated to describe the whole sample. LGM allows the user to choose slope loadings, which are usually selected according to the time scale, or can be altered to fit nonlinear trajectories. Shifting the slope loadings affects the interpretation of the intercept factor mean and variance as well (Duncan & Duncan, 2009).

The development of LDS from its LGM foundation has allowed for longitudinal analysis to overcome the inference limitations of previous models (Reeve, Paul, & Butterworth, 2015). In the LDS model, change is specified with each successive wave, and is not restricted to fitting a curve in latent growth models like LGM. This gives LDS an advantage as being more informative across time, and less restrictive compared to the requirements involved in fitting a curve to a growth model. Broken down by specific parameters, the latent intercept term in LDS affects each time point, and the effect of each latent slope is accumulated over subsequent time points. Because change scores between adjacent time points are explicit model parameters, the error variance associated with the previous test occasion is considered a constant and is removed from the change parameter, resulting in interpretation that is independent from each time wave (McArdle, 2009). This is a relative advantage compared to LGM, in which the change model accumulates from beginning to end, and error variance follows throughout the overall time span.

LDS within a mediation model

Longitudinal models can also be used to test hypotheses related to mediation. Latent difference score (LDS) models offer flexibility for modeling changes sequentially, and can examine the dynamic relationships with multiple variables over time (Grimm, An, McArdle, Zonderman, & Resnick, 2012). In these ways, LDS can be viewed as an important recent extension of LGM in terms of mechanism research, as it has more opportunity to establish the causal sequence between two variables over time, and therefore is a good match for testing longitudinal mediation (Selig & Preacher, 2009).

The application of any mediational analysis includes describing mediation (M) as the *indirect effect* of X on Y, and the product of a and b (*ab*, see figure 2). Total effects of X on Y are equal to the sum of the indirect effects, and the direct effects (path c') remaining once M is in the model. The value of M is often operationalized by the product of b_{xm} and b_{my} coefficients. The direct effect b_{xy} is also usually calculated and considered in comparison with indirect effects (Preacher & Hayes, 2008). Traditionally, the *causal steps strategy*, popularized by Baron and Kenny (1986), has been utilized to test mediation with several criteria needing to be met. For example, when the mediator is added to the model and the direct effect is found to no longer be statistically significant, full mediation occurs; and when the direct effect is reduced, compared to the absence of the mediator, partial mediation occurs. Causal steps analysis also requires that indirect effects are demonstrated with each product coefficient (b_{xm} and b_{my}) being significant independently (Selig & Preacher, 2009.)

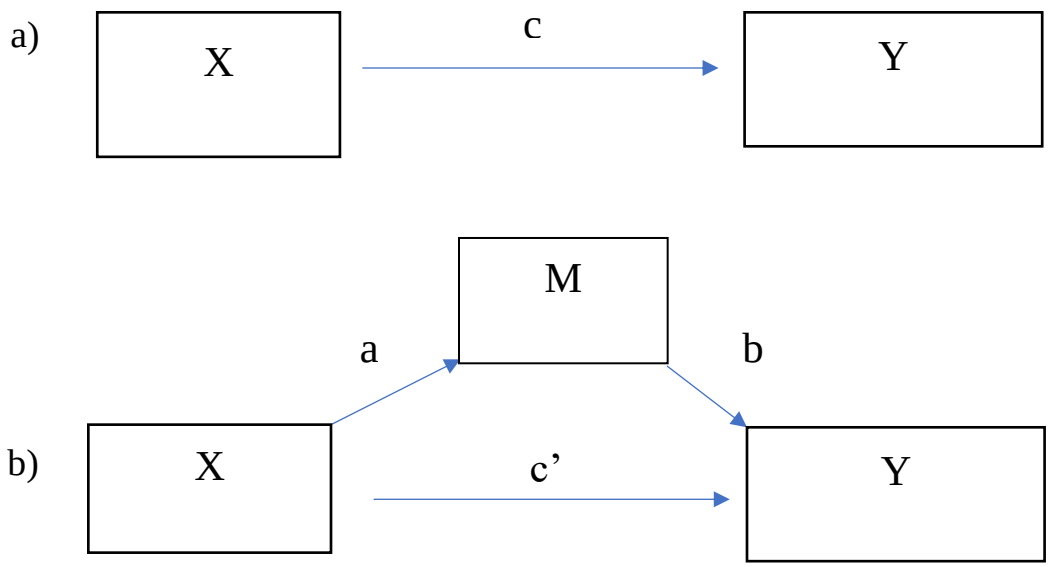

Figure 2: Schematic of the direct effects of X on Y, and of a mediation design. a) Direct effects of X on Y, b) Mediation design, X is hypothesized to exert an indirect effect on Y at least in a significant part through M. c' is equal to c – ab.

Over the past decade, many analysts now consider Baron and Kenny's causal step criteria to be too restrictive. Following several simulation tests, the causal step approach offered the lowest power and highest type II error of all attempted approaches (Preacher and Hayes, 2008). A noted limitation of the causal step strategy is that mediation tests were inferred by logic only, without the opportunity to quantify the indirect effects when they are present. Additionally, if even one of the criteria has not been met, the test for mediation would be discredited. Contemporary statisticians have also disagreed with the required criteria that each product coefficient (i.e. b_{xm} or b_{my}) is independently statistically significant, as it is feasible for indirect effects to be significant without each path being significant (Hayes, 2009). Alternative methods have been suggested that are less restrictive and offer more power in detecting mediation.

One of these new approaches for testing mediation hypotheses is called bootstrapping, or the use of bootstrap confidence intervals (BCI). BCI works by selecting a random number of cases from the original sample, with replacement, and forms a bootstrap sample where indirect effects can be estimated (MacKinnon, Fairchild, and Fritz, 2007). This procedure is repeated several thousand times, preferably 10,000. The total number of estimated indirect effects are then sorted from low to high, an overall indirect effect estimate is calculated, and a confidence interval can be created using a percentile method.

Therefore, using the bootstrapping method, the sampling distribution of the indirect effects can be estimated and tested with the estimated confidence intervals (e.g. 95%). In this way, hypotheses concerning mediation were analyzed using an inferential method. This method was an improvement from Sobel's Normal Theory Approach test (Sobel, 1982), which also tested the significance of the ab indirect coefficient product but required samples to assume normality. Bootstrapping is an asymptotic approach where normal samples are not required (Preacher and Hayes, 2008). Using this approach served an important purpose for the present study given that each baseline variable (e.g. BDI, PIL, DDD, PHDD) possessed a non-normal distribution (Shapiro – Wilk Normality Test of Normality: $p < .001$ in each case). A weakness of the bootstrapping method is that it is limited with small samples, but this was not a concern with this study's Project Match outpatient sub-sample (N=793). Specifically, Fritz and MacKinnon (2007) offered empirical estimates of sample sizes required to reach .8 power. At the most extreme condition, when both *a* and *b* mediation paths are small effects (i.e. equal to 0.14), the statisticians approximated minimum sample sizes (N = 558 for percentile bootstrap, N =

462 for bias-corrected bootstrap) to reach the .8 power level. The Project Match outpatient sample appeared to be sufficiently powered to detect mediation effects when present. Another suggested limitation of bootstrapping is that deviant observations have the potential to reappear multiple times in the resampling technique (Preacher and Hayes, 2008). Overall, bootstrapping has gained popularity in the statistical field for more than a decade and was the best-matched statistical method for measuring mediation in this study.

Data Analysis Model

An initial analysis was conducted to examine relationships between variables used to estimate indirect effects. Baseline readiness to change (RTC) was included with each table to assess degree of covariance (see Tables 5 and 6). If the relationship with purpose in life (PIL) was found to be meaningfully significant over time, RTC would be controlled for in the mediational analysis. Additionally, Repeated Measure Analysis of Variance (RM ANOVA) assessed for change across time among the variable means in the primary study models.

A latent difference score (LDS) mediation model tested for indirect effects of purpose in life on the relationship between depression and drinking outcomes over time. The model was tested twice using a different drinking outcome each time, one model for percent heavy drinking days and another for drinks per drinking day. A schematic summary of the proposed data analysis model can be found in Figure 3. The model shows the 15 direct effects (shown in brackets) that were calculated among status and change scores across time waves between the baseline and 15-month

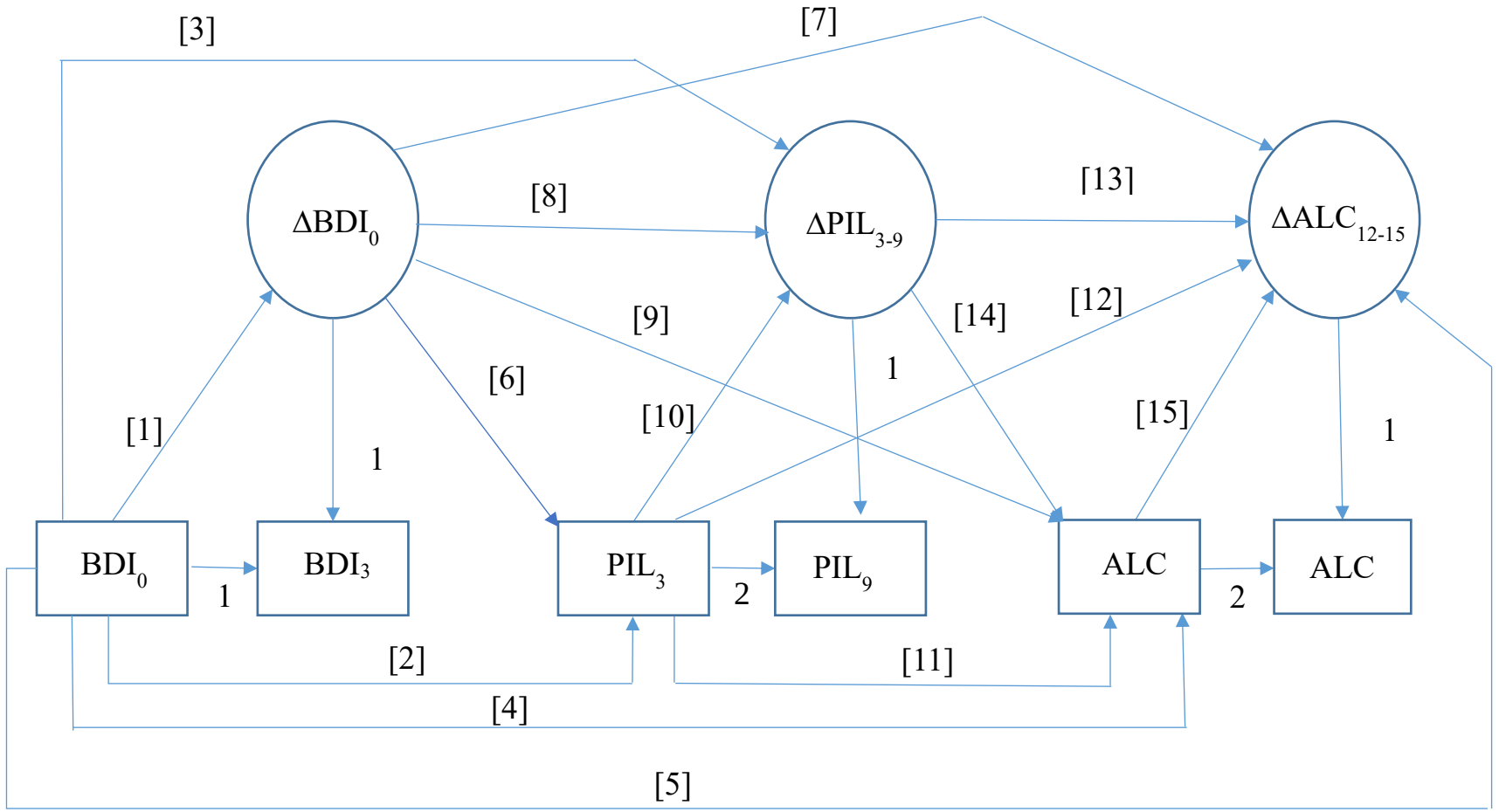

Figure 3: Latent difference score mediation model for Project Match outpatient participants, baseline to 15 months. Subscripts indicate time wave, measured in months after baseline. Model includes alcohol outcome (ALC), which was assessed twice, once using *drinks per drinking day*, and another using *percent heavy drinking days*. Factor loadings are noted where appropriate. Direct effect coefficients tested are in brackets.

follow-up. *Factor loadings*, which are essentially model multipliers chosen by the researcher, were also indicated in the model. This was assigned to 1 for depression change scores, since only three months of time had elapsed. The factor loadings for purpose in life and alcohol outcomes were assigned factor loadings of 2, since the time elapsed for each were twice as long compared to the time of depression measurement. (PIL change score data was measured from 3 to 9 months, and alcohol outcomes were measured from 9 to 15 months of self-reported drinking across the previous 90-day windows.)

Testing for mediation in this model included *change scores*, the measurement between two variables across successive time points, and single *status scores*, as the latent variables. Additionally, a sequential process was an important element of the LDS criteria, where the predictor X (depression) must precede the mediator M (purpose in life), which must proceed the outcome Y (drinking outcome) (Selig & Preacher, 2009). This focus on using both change and status scores, along with requiring sequential intervals, led to eight selected paths for the analysis of indirect effects. These are identified in Table 1. For simplicity, each construct is shown as only measured at the two time points that were represented in the working model, resulting in a total of nine latent variables. Using these methods allowed for an assessment of the hypotheses stated earlier. Each path of indirect effect was analyzed by both indirect effect estimates for effect size and bootstrapping confidence intervals for statistical significance.

The statistical software chosen to test this longitudinal mediational model was Mplus version 8 (Muthen and Muthen, 1998-2017.) Mplus estimated the parameters of the hypothesized model by using a maximum-likelihood method, and provided effect

estimates and bias-correcting bootstrap confidence intervals for the model parameters (Selig and Preacher, 2009). The analysis of each path resulted in an estimation of fit for indirect effects in the model, with a corresponding 95% confidence interval. When zero was not included in the confidence interval the indirect effect was interpreted as being significant.

When analyzing longitudinal data using Mplus, growth models were estimated with partially missing data (Curran, Obeidat, and Losardo, 2010). Values did not need to be imputed, but rather used data that were available to estimate the model using full information maximum likelihood estimations (FIMLE). When using FIMLE, longitudinal data can be non-normal, as was the case in this study, and can include individually-varying times of observations, changing slopes across time, and data *missing at random* (Muthen and Muthen, 1998-2017). A complete syntax script was used to run the proposed latent difference score (LDS) mediation model through Mplus (Preacher 2010-2017) and can be found in the Appendix.

There remains much to be learned about the recovery process from Alcohol Use Disorders, especially from early recovery and treatment-end to maintained abstinence. This study aimed to add to our understanding of the mechanisms of behavior change involved during this critical time to help crystalize important factors in recovery. It seems clear that the reemergence of depression during the recovery process places individuals at risk for relapse. Purpose in life may be a positive, protective factor that can help mitigate this risk in post-treatment recovery and has already been shown to be associated with depression and drinking outcomes independently. By learning more

about these possible mediating relationships over time, we hope to better train providers how to prioritize recovery factors to ultimately increase the quality of life of their clients.

Chapter 3: Results

The number of eligible participants in this secondary analysis of Project Match outpatient participants decreased from 952 to 793 following the use of additional exclusionary criteria (refer to Figure 1). A comparison of descriptive statistics for baseline demographic factors between the included subset and those who were excluded is presented in Table 3. The included subset (N = 793) had the following descriptive statistics: the average age was 38.7 (SD = 10.8), mostly male (72.4%), White (80.3%, Hispanic, 14.5%, Black 5.7%), and single (66.3%). About half of the outpatient participants (51.1%) were currently employed, averaged 13.4 years of formal education (SD = 2.1), and almost half had prior formal alcohol treatment (46.3%, not including detox-only episodes). Finally, about one third (30.9%) of the included participants had a previous lifetime Axis I diagnosis not related to a substance use disorder. A comparison test was conducted between included (N = 793) and excluded outpatient participants (N = 159) for these same demographic variables; all were found not to be statistically different, with the exception of marital status, as significantly more excluded outpatient participants were married (37.1%) compared to included participants (33.7%, $X^2 = 21.8$, $p < .001$).

Table 3
Demographic Characteristics between Included and Excluded Participants

		Included	Excluded	*p* value
N		793	159	
Age (*SD*)		38.7 (10.8)	39.9 (10.5)	.174
Gender* (% Female)		27.6 %	28.3%	.734
Ethnicity* (%)	White	80.3%	78.6%	.631
	Black	5.7%	5.7%	
	Hispanic	14.5%	11.6%	
	Other	2.4%	1.3%	
% Currently Married		33.7%	37.1%	< .001
Years of Education at baseline (*SD*)		13.4 (2.1)	13.5 (2.1)	.584
% Six Months Continuous Employment		51.1%	51.0%	.862
Lifetime Axis I diagnosis, non SUD		30.9 %	21.4%	.132
Previous Alcohol treatment (excluding detox-only)		46.3%	42.1%	.339
Drinks per Drinking Day (*SD*) (90 days prior to treatment)		13.5 (8.1)	13.4 (7.7)	.875

Note: * indicates Chi-squared test of equivalence

Changes in BDI and PIL Means over Time

Table 4 shows the change in Latent Difference Score (LDS) model variable mean scores for included participants ($N = 793$) over the study's time intervals. Repeated Measure ANOVA analyses assessed for change across time. Depression (BDI) mean scores significantly changed overall [$F(2.89, 1936.38) = 58.28$, $p < .001$] over the course of the study. Degrees of freedom were non-whole numbers after using the Huynh-Feldt correction for the violation of the sphericity assumption. Post-hoc tests

revealed a significant decrease ($p < .001$) in BDI scores between the time participants started the study (baseline $M = 9.81$, $SD = 7.92$) to the time that the treatment intervention ended (3 months, $M = 6.87$, $SD = 7.18$). This decrease in BDI scores after baseline was maintained until the end of the study. Regarding clinical significance, baseline mean BDI scores were near the mild to minimal depression cutoff and decreased into the minimal category starting at 3 months, although variance was high at each time interval indicating a wide range of scores in the sample. Purpose in life (PIL) mean scores also changed significantly over the course of the study [F (2.85, 1939.51) = 118.65, $p < .001$.] Again, degrees of freedom were non-whole numbers after using the Huynh-Feldt correction for the violation of the sphericity assumption. Post-hoc tests revealed a significant increase ($p < .001$) between baseline ($M = 94.95$, $SD = 18.32$) and the time the treatment intervention ended (3 months, $M = 103.81$, $SD = 17.93$). These changes in PIL scores were maintained at each post-treatment time interval, remaining relatively unchanged after three months. The change in PIL scores could be interpreted as increasing from low-moderate to moderate; again, with significant variance in the distribution. Figure 4 illustrates the comparison of change between BDI and PIL scores over time, highlighting their inverse relationship during the course of treatment.

Table 4
Latent Difference Score (LDS) Model Variables over Measured Intervals (M, SD)

	Potential Range	BL	3 months	9 months	12 months	15 months
BDI	0 – 45	9.81 (7.92)[a]	6.87 (7.18)[b]	7.10 (7.43)[b]		6.96 (7.58)[b]
PIL	20-140	94.95 (18.32)[a]	103.81 (17.93)[b]	103.86 (18.61)[b]		104.19 (18.06)[b]
DDD	0-60	13.51 (8.06)[a]	3.93 (5.40)[b]	5.13 (4.95)[c]	4.98 (5.38)[c]	4.96 (5.38)[c]
PHDD (%)	0-100	58 (31)[a]	14 (23)[b]	17 (24)[c]	18 (28)[c]	19 (28)[c]
RTC	-2 to +14	10.47 (1.74)				

Note: Means in the same row that do not share superscripts differ at $p < .05$.
BDI clinical scale (Beck et al., 1988): 0-9, minimal depression, 10-18 mild, 19-29 moderate, and 30-63 severe.
PIL clinical scale (Crumbaugh & Henrion, 1988): < 92: low, 92-112 moderate, 113-140 high.

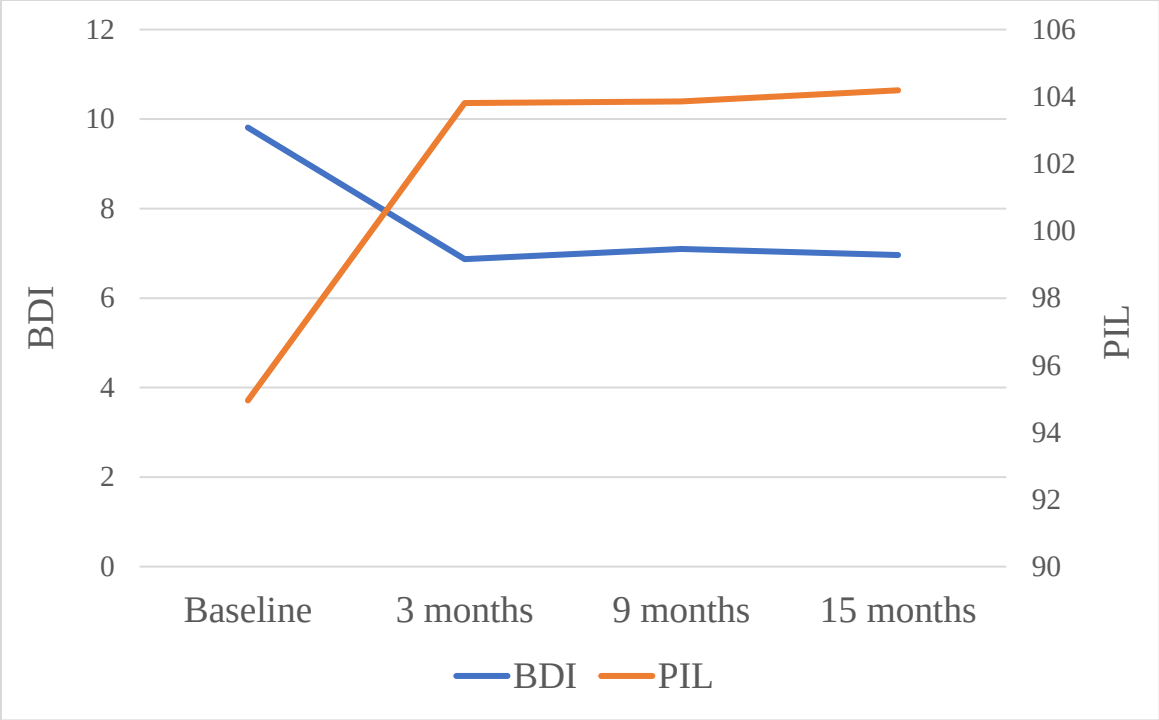

Figure 4: Means of Beck Depression Inventory (BDI) and Purpose in Life (PIL) at study intervals. The treatment course of study occurred between baseline and 3 months.

Comparison of Drinking Outcome Type over Time

Regarding drinking outcomes, both Drinks per Drinking Day (DDD) and Percent Heavy Drinking Days (PHDD) were observed to significantly change between baseline and study's end at 15 months [F (2.49, 1864.41) = 531.01, $p < .001$] and [F (2.74, 2140.55) = 692.01, $p < .001$], respectively. Degrees of freedom were non-whole numbers after using the Huynh-Feldt correction for the violation of the sphericity assumption. Both DDD and PHDD showed significant decreases with Pairwise Comparisons between baseline and 3 months ($p < .001$), with small increases initially after post-treatment (3-months to 9-months, $p < .001$ and $p = .001$ respectively). Drinking outcomes remained

relatively unchanged between 9 months and study's end at 15 months. Figure 5 shows the parallel nature of the drinking outcome trajectories over time.

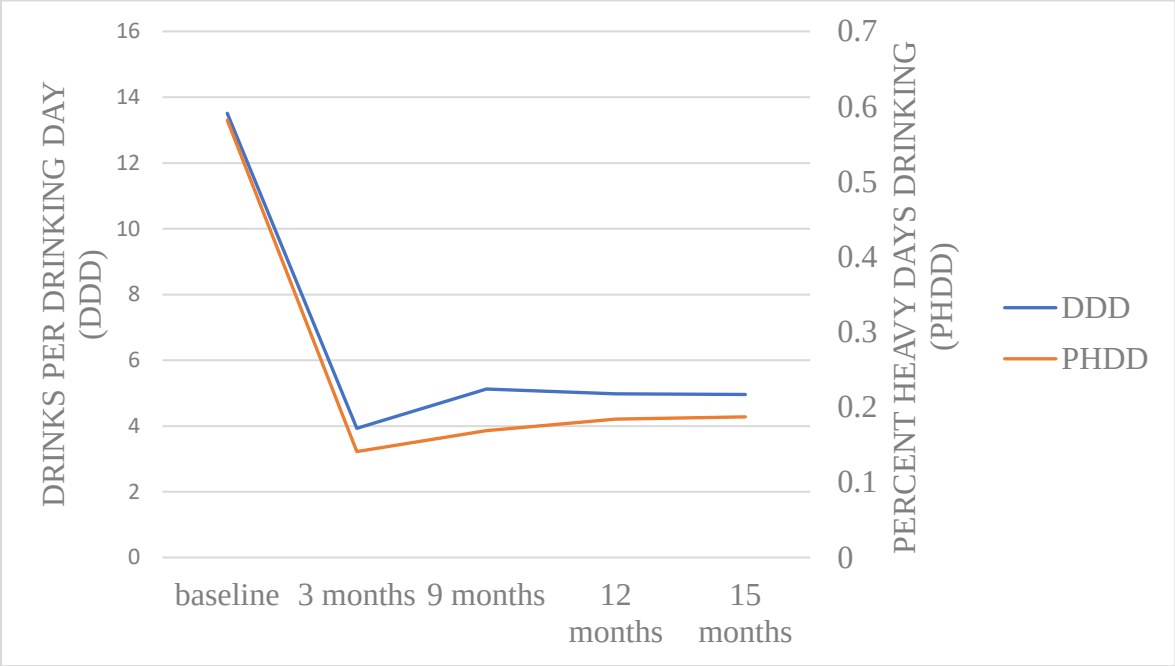

Figure 5: Drinking outcome means over time by type.
Note: Treatment duration occurred between baseline and 3 months.

Correlation Matrix

All variables examined in the LDS analyses were correlated at each study time interval. Correlations that include drinks per drinking day (DDD) as the outcome are found in Table 5, and correlations that include percent heavy drinking days (PHDD) are in Table 6. BDI scores and PIL scores formed statistically significant negative associations at each study interval, with the highest correlations observed at corresponding time points, starting at baseline (r = -.55, R^2 = .30 , p < .001), and reaching their highest correlation at months 9 and 15 (r = -.70, R^2 = .49 , p < .001 at each). These can be interpreted as demonstrating large effect sizes.

Table 5
Correlations Using Drinks per Drinking Day (DDD) as Drinking Outcome (N = 793)

	BDI_{BL}	BDI_3	BDI_9	BDI_{15}	PIL_{BL}	PIL_3	PIL_9	PIL_{15}	DDD_{BL}	DDD_3	DDD_9	DDD_{12}	DDD_{15}	RTC_{BL}
BDI_{BL}	9.8/ 7.9										.			
BDI_3	.58**	6.9/ 7.2												
BDI_9	.54**	.62**	7.1/ 7.4											
BDI_{15}	.50**	.60**	.62**	7.0/ 7.6										
PIL_{BL}	-.55**	-.41**	-.36**	-.34**	95.0/ 18.3									
PIL_3	-.44**	-.66**	-.47**	-.45**	.60**	103.8/ 17.9								
PIL_9	-.45**	-.51**	-.70**	-.48**	.62**	.70**	103.9/ 18.6							
PIL_{15}	-.44**	-.49**	-.51**	-.70**	.57**	.66**	.74**	104.2/ 18.1						
DDD_{BL}	.12*	.09*	.09*	.10*	-.16**	-.04	-.07*	-.09*	13.5/ 8.1					
DDD_3	.08*	.21**	.14**	.14**	-.13**	-.22**	-.16**	-.20**	.26**	3.9/ 5.4				
DDD_9	.07*	.23**	.24**	.19**	-.12**	-.26**	-.26**	-.24**	.28**	.66**	5.1/ 5.0			
DDD_{12}	.09*	.22**	.29**	.28**	-.12**	-.22**	-.27**	-.28**	.28**	.48**	.71	5.0/ 5.4		
DDD_{15}	.07*	.20**	.21**	.29**	-.09*	-.21**	-.23**	-.32**	.29**	.43**	.64	.78**	5.0/ 5.4	
RTC_{BL}	.10**	-.01	.01	-.02	.05	.14**	.14**	.13**	.12**	-.10**	-.11**	-.11**	-.11**	10.5/ 1.7

Note: Diagonals show *Mean* /*Standard Deviation;*
** Correlation is significant at the 0.01 level (2 tailed). * Correlation is significant at the 0.05 level (2 tailed).

Table 6

Correlations Using Percent Heavy Drinking Days (PHDD) as Drinking Outcome (*N* = 793)

	BDI_{BL}	BDI_{3}	BDI_{9}	BDI_{15}	PIL_{BL}	PIL_{3}	PIL_{9}	PIL_{15}	$PHDD_{BL}$	$PHDD_{3}$	$PHDD_{9}$	$PHDD_{12}$	$PHDD_{15}$	RTC_{BL}
BDI_{BL}	9.8/ 7.9													
BDI_{3}	.58**	6.9/ 7.2												
BDI_{9}	.54**	.62**	7.1/ 7.4											
BDI_{15}	.50**	.60**	.62**	7.0/ 7.6										
PIL_{BL}	-.55**	-.41**	-.36**	-.34**	95.0/ 18.3									
PIL_{3}	-.44**	-.66**	-.47**	-.45**	.60**	103.8/ 17.9								
PIL_{9}	-.45**	-.51**	-.70**	-.48**	.62**	.70**	103.0/ 18.6							
PIL_{15}	-.44**	-.49**	-.51**	-.70**	.57**	.66**	.74**	104.2/ 18.1						
$PHDD_{BL}$	.10**	.13**	.12**	.13**	-.09*	-.09**	-.07	-.09**	.58/ .31					
$PHDD_{3}$	.12**	.28**	.22**	.23**	-.12**	-.27**	-.21**	-.25**	.26**	.14/ .23				
$PHDD_{9}$	.10**	.26**	.31**	.24**	-.09*	-.25**	-.27**	-.26**	.28**	.66**	.10/ .24			
$PHDD_{12}$	.09*	.20**	.32**	.27**	-.06	-.18**	-.26**	-.26**	.28**	.48**	.71**	.18/ .28		
$PHDD_{15}$	.08*	.22**	.25**	.32**	-.02	-.17**	-.21**	-.28**	.29**	.43**	.64**	.78**	.19/ .28	
RTC_{BL}	.10**	-.01	.01	-.02	.05	.14**	.14**	.13**	-.02	-.12**	-.12**	-.12**	-.13**	10.5/ 1.7

Note: Diagonals show *Mean* /*Standard Deviation;*

** Correlation is significant at the 0.01 level (2 tailed). * Correlation is significant at the 0.05 level (2 tailed).

PIL also demonstrated significant relationships with both drinking outcomes. Strongest associations were found with PHDD and PIL at 3 months and 9 months (r = -.27, p < .001 at each). DDD and PIL correlations were strongest when both were measured at the study's end at 15 months (r = -.32, p < .001). However, even at their highest associations, the relationship between PIL and drinking outcomes still accounted for only about 10 percent of the unique variance. Interestingly, PIL and drinking variable correlations were lowest at baseline levels (PHDD: r = -.09, p < .05, DDD: r = -.16, p < .001), which is interpreted as small effect sizes and shared variance before treatment began. As expected from the previous literature summary, BDI was a consistent predictor of drinking outcomes (e.g. PHDD: ranging from r = .10, p < .001 at baseline to r = .32, p < .001 at later study intervals), with approximately similar magnitudes as PIL and drinking outcomes at corresponding time intervals. Overall, these reported correlational results are consistent with previous research that showed that PIL demonstrated its largest associations with other study variables at post-treatment intervals. However, compared to previous studies (e.g. Roos et al., 2015) that showed an increase in PIL mean scores between 3 and 9 months using the full Project Match data set (N = 1726), in this outpatient-participant only analysis, PIL scores remained at the same level during the following 3 months.

The study design also examined the strength of main study variables with the baseline Readiness to Change (RTC). Interestingly, baseline RTC did not have statistically significant associations with depression at 3 months and at later time intervals, nor at baseline with purpose in life. While the associations were primarily statistically significant, these correlations remained relatively small for each study

variable, reaching maximum associations of less than $r = .15$. Therefore, it was not necessary to control for RTC in the Latent Difference Score longitudinal mediation models.

Latent Difference Score Mediation Models

The latent difference score (LDS) mediation models involving two different alcohol outcomes are shown in Figure 6 [drinks per drinking day (DDD)] and Figure 7 [percent heavy drinking days (PHDD)]. In each model, 15 direct effect estimates can be analyzed, and the results are shown with standardized estimates to allow for equivalent comparisons using the same metric. In an effort to make the models as parsimonious as possible, different model runs were attempted with one variable set to zero at a time until coefficients that were consistently non-significant were identified and set to zero. If a coefficient was non-significant but trending (p approximately equal to .1), it remained in the model. Direct effects that were calculated in the final analyses and are presented in the figures. Factor loadings were set to equal 2 between 3 months and 9 months, and again between 9 months and 15 months, reflective of time intervals being twice as long as the first 3-month time interval. Both theoretical models were assessed in relation to their "goodness of fit." Starting with the LDS model using DDD drinking outcomes, a good model of fit was determined, evidenced by various Mplus indices [(X^2 (4) = 4.14, p = .39), RMSEA = .007, CFI = 1.000]. A good model of fit was also found for the LDS model involving PHDD drinking outcomes [(X^2 (3) = 0.46, p = .92), RMSEA < .001, CFI = 1.000]. In other research involving model-fit tests with goodness of fit values similar to above (i.e. RMSEA is approximately equal to zero and CFI is approximately equal to one), statisticians have suggested that this outcome is common whenever the chi-square

statistic is approximately equal to or less than the degrees of freedom, which is exemplified here (Gu, Thomas, & Chen, 2017).

Direct Effects

Following the bootstrap analysis based on 1000 samples, the majority of direct effect coefficients in the model were statistically significant in both the DDD-outcome model (11/15, see Figure 6) and the PHDD-outcome model (10/15, see Figure 7). Coefficients involving only change scores were not significant in each model, contrary to what was hypothesized. When status score variables (e.g. PIL at 3 months) were strongly correlated with other status variables, their coefficients were also significant, and more often served as better predictors compared to change scores. This was exemplified by the variable BDI, in which coefficients at a single time point, such as at baseline, demonstrated stronger predictive value for both PIL and the change in PIL compared to BDI change score coefficients (i.e. between baseline and 3 months.) This was observed in both models; again, in contrast to what was expected.

However, one exception to this pattern involved BDI change scores between baseline and 3 months, which significantly predicted both drinking outcomes at 12 months, and also predicted PHDD change scores significantly between 12 months and 15 months (see figure 7). Conversely, BDI direct coefficients at baseline were non-significant predictors of these same drinking outcomes. In this example, the results were consistent with what was hypothesized.

Concerning PIL and PIL change scores as predictors, both PIL status score coefficients at 3 months and PIL change score coefficients between 3 and 9 months, were statistically significant when predicting both drinking status score outcomes at 12

months. PIL status score coefficients at 3 months exhibited slightly higher predictive values of drinking outcomes compared to PIL change scores (i.e. 3 months to 9 months), contrary to what was hypothesized.

Finally, direct coefficients were considered between status scores and their complementary change scores (e.g. BDI and change in BDI). For each drinking outcome, measured standardized coefficients were large and inverse, representing the largest predictive values within the analysis. This might be understood by noting times of high variable scores at a single time point (i.e. PIL at 3 months) corresponding with lower change scores over time, probably due to a ceiling effect in potential growth. Conversely, low variable scores at a single time point were probably matched with higher change scores, given the greater potential for change over time.

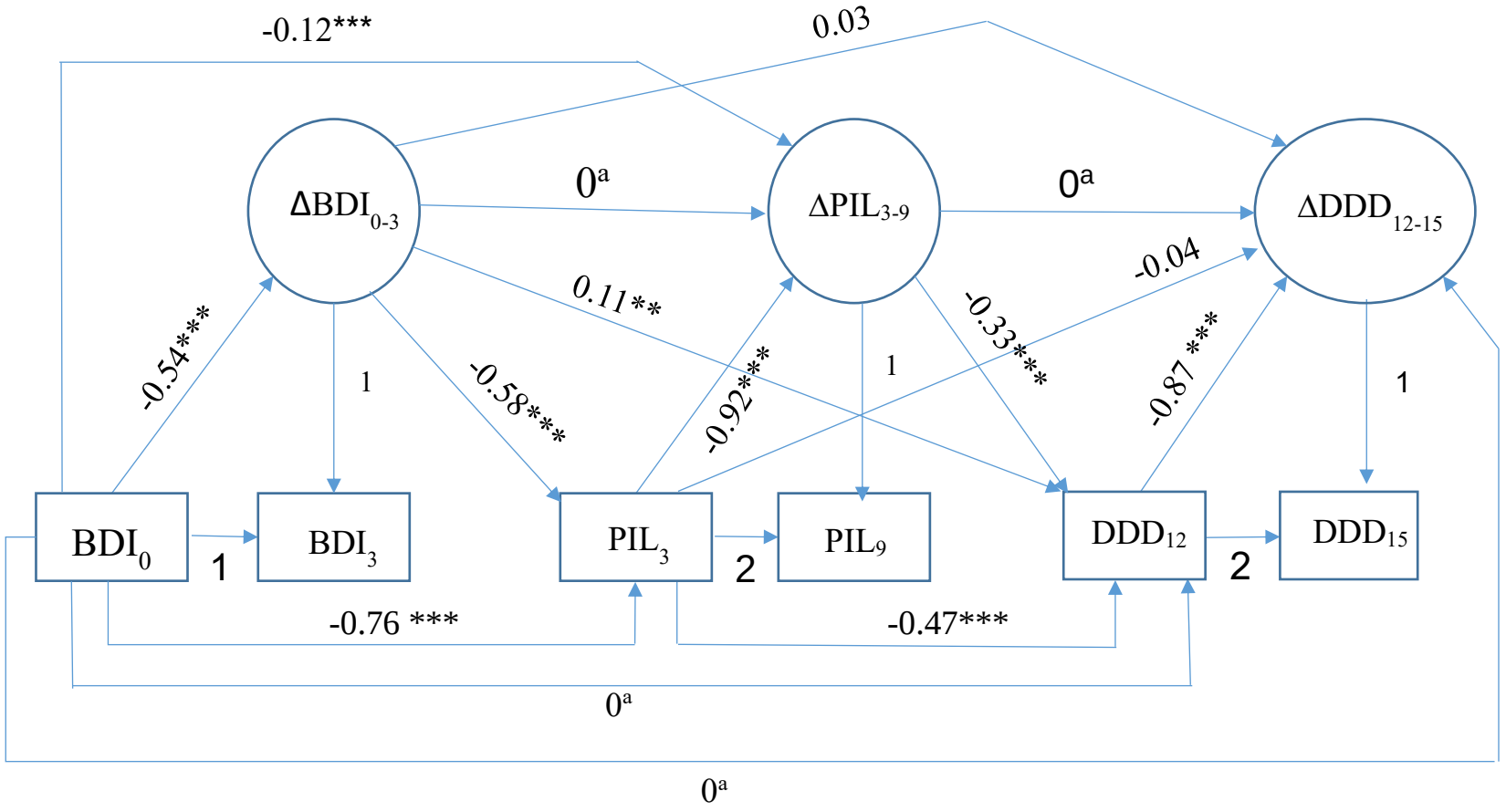

Figure 6: Latent difference score mediation model with drinks per drinking day (DDD) serving as drinking outcome. Direct effects shown as standardized estimates.

*p <.05, **p < .01, ***p < .001.

0^a = these coefficients were determined to be non-significant and then zeroed out in this final model.

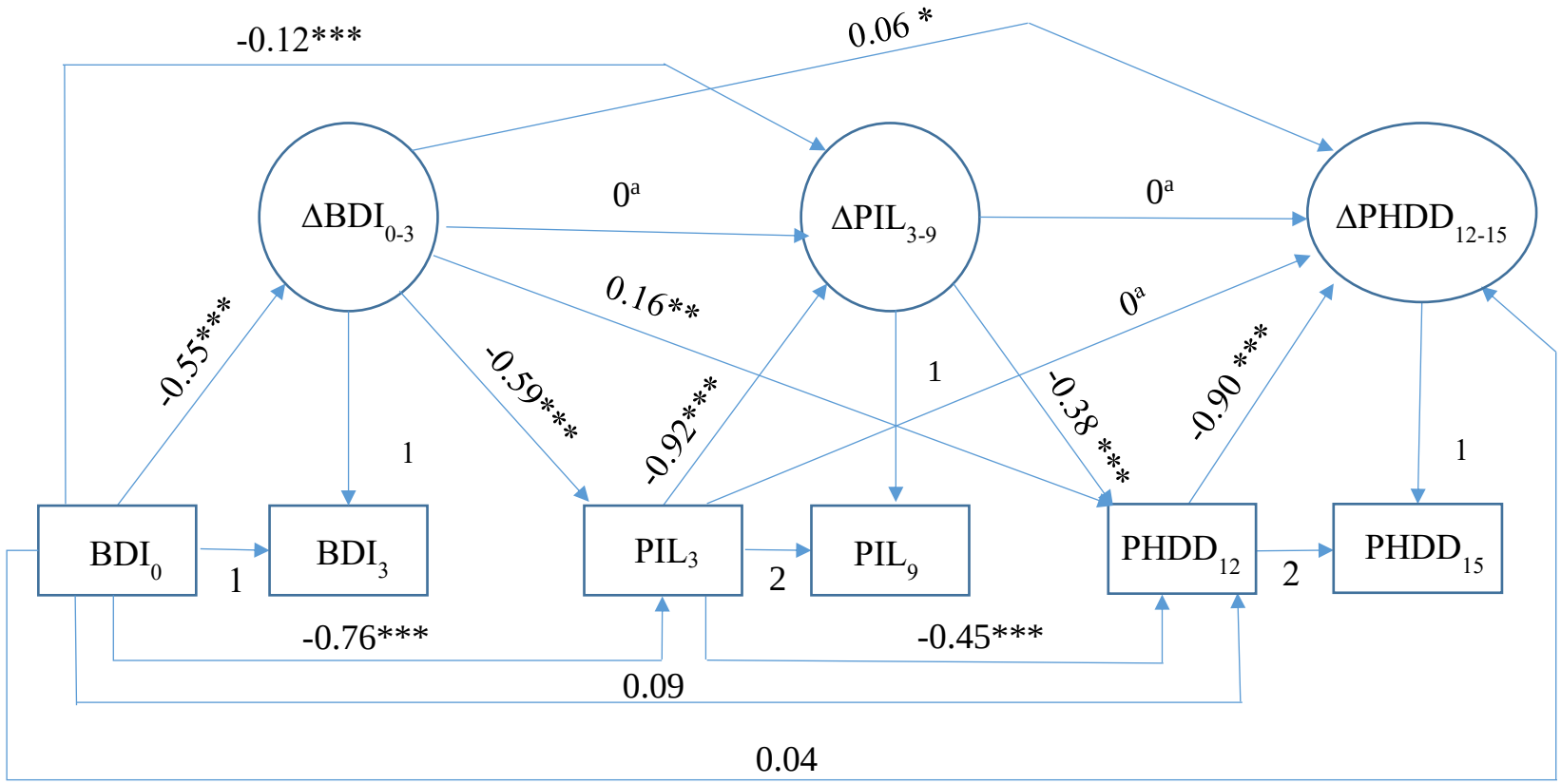

Figure 7: Latent difference score mediation model with percent heavy drinking days (PHDD) as drinking outcome. Direct effects shown as standardized estimates.
*p <.05, **p < .01, ***p < .001.
0^a = these coefficients were determined to be non-significant and then zeroed out in this model.

Indirect Effects

The advantages of testing for longitudinal mediation through Latent Difference Score (LDS) modeling included the opportunity to quantify indirect effects. Considering the eight possible mediation paths in Table 1, it was hypothesized that paths with change score variables would better capture mediation estimates compared to paths with status score variables. The two longitudinal mediation models were assessed using bootstrap analyses. During the initial analysis trial, one variable was set to zero creating the minimal one degree of freedom. In an effort to approximate the most parsimonious models possible, successive models were run, each time having a different variable set to zero. After several iterations, coefficients that were consistently found to produce negligible direct effect were set to zero. In models where the paths now contained a zeroed-out coefficient, the resulting indirect effect in the model also automatically defaulted to zero measured indirect effect. This process resulted in a different number of defaulted paths for each of the models run. In each model, indirect effects were interpreted as a unit increase in the predictor predicting a unit change in the mediator, which predicts a unit change in the outcome.

Results of the indirect effect estimates for longitudinal mediation, with drinks per drinking day (DDD) serving as the outcome, are summarized in Table 7. Path numbers are arranged in successive order from largest standardized effect estimates to smallest standardized effect estimates. In this model purpose in life demonstrated significant longitudinal mediation between depression as a predictor and DDD as the outcome, consistent with previous expectations. However, path number 1, measured from the use of only variables at single time points (e.g. BDI at baseline, PIL at 3 months) resulted in

Table 7

Indirect Effect Estimates for the Latent Difference Score Mediation Model: Drinks per Drinking Day (DDD) as Alcohol Outcome

Path Number	Predictor	Mediator	Outcome	Standardized Estimate	95% Bootstrap Confidence Interval	Two-tailed *p* value
1	BDI_0	PIL_3	DDD_{12}	0.356	[0.248, 0.476]	<.001
3	BDI_{0-3}	PIL_3	DDD_{12}	0.273	[0.188, 0.365]	<.001
2	BDI_0	PIL_{3-9}	DDD_{12}	0.038	[0.016, 0.067]	.003
5	BDI_0	PIL_3	DDD_{12-15}	0.033	[-0.001,0.067]	.067
7	BDI_{0-3}	PIL_3	DDD_{12-15}	0.025	[-0.001, 0.054]	.073
4	BDI_{0-3}	PIL_{3-9}	DDD_{12}	0^a		
6	BDI_0	PIL_{3-9}	DDD_{12-15}	0^a		
8	BDI_{0-3}	PIL_{3-9}	DDD_{12-15}	0^a		

Note: 0^a: Coefficients that were "zeroed out" before conducting model estimation led to zero indirect effect in the present model.

the largest estimate ratio, contrary to what was hypothesized [standardized estimate = 0.356, $p < .001$]. Path number 3, which included one change score variable (BDI_{0-3}) and two scores measured at a single point (PIL_3 and DDD_{12}) resulted in a slightly lower mediation estimate [standardized estimate = 0.273, $p < .001$]. One other path estimate, again involving one change score (PIL_{3-9}), resulted in a statistically significant estimate (path number 2, standardized estimate = 0.038, $p = .003$.) Two other paths, numbers 5 and 7, involving variables with small direct coefficients, produced indirect effect estimates that were non-significant but trending. Finally, paths 4, 6, and 8, involving at least two change score variables, resulted in zero indirect effects after at least one of their variables were "zeroed out" prior to the running of the final model. These outcomes were again contrary to what was initially hypothesized.

Table 8 outlines the indirect effect estimates results for longitudinal mediation with Percent Heavy Days Drinking (PHDD) serving as the alcohol outcome. Again, purpose in life demonstrated significant longitudinal mediation, this time with PDDD as the outcome. Similar to the previous model, the use of only status variables (measured at single time points, Path 1) resulted in the largest standardized estimated effects (= 0.339, $p < .001$). Path numbers 2 (standardized estimate = 0.262, $p < .001$) and 3 (standardized estimate = 0.045, $p < .001$), still containing a majority of variables at a single time point, continued to demonstrate statistically significant indirect effects, although this time with somewhat less magnitude. In this model with PHDD as the drinking outcome, fewer indirect effect paths showed statistical significance, or even trending toward significance. The remaining paths (numbers 4,5,6,7, and 8) possessed at least one variable with negligible direct effect in initial model runs, therefore their coefficients were zeroed out

in the final run, resulting in zero indirect effect. These results involving PHDD did not support the initial hypothesis made to an even greater degree than the previous model. With both models, paths using change scores for BDI and PIL did lead to significant indirect effects, consistent with the hypotheses, but only when serving as the single change score within the path (paths 2 and 3).

Table 8

Indirect Effect Estimates for the Latent Difference Score Mediation Model: Percent Heavy Drinking Days (PHDD) as Alcohol Outcome

Path Number	Predictor	Mediator	Outcome	Standardized Estimate	95% Bootstrap Confidence Interval	Two-tailed p value
1	BDI_0	PIL_3	$PHDD_{12}$	0.339	[0.230, 0.459]	<.001
3	BDI_{0-3}	PIL_3	$PHDD_{12}$	0.262	[0.178, 0.354]	<.001
2	BDI_0	PIL_{3-9}	$PHDD_{12}$	0.045	[0.023, 0.072]	<.001
4	BDI_{0-3}	PIL_{3-9}	$PHDD_{12}$	0[a]		
5	BDI_{0-3}	PIL_3	$PHDD_{12-15}$	0[a]		
6	BDI_{0-3}	PIL_{3-9}	$PHDD_{12-15}$	0[a]		
7	BDI_0	PIL_{3-9}	$PHDD_{12-15}$	0[a]		
8	BDI_{0-3}	PIL_{3-9}	$PHDD_{12-15}$	0[a]		

Note: 0[a]: Coefficients that were "zeroed out" before conducting model estimation led to zero indirect effect in the present model.

Chapter 4: Discussion

Findings

The overall purpose of the current study using Project Match data was to investigate whether *purpose in life* was a partial mediator in the relationship between depression and alcohol use outcomes. Based on the observed trajectories of these three factors from previous longitudinal analyses, it was further hypothesized that the use of change scores (i.e. beginning to end of treatment, or end of treatment to later post treatment period) would possess greater power in detecting indirect effects compared to the traditional use of variable scores at a single time point (i.e. at baseline, or at end of treatment.) Latent difference score modeling was employed to examine these questions given its flexibility to use an individual's change scores over time as key factors in the model. This type of analysis also capitalizes on the benefit of observing instances of temporal precedence in attempting to make cause and effect inferences.

The results demonstrated that purpose in life was a significant, longitudinal partial mediator in the relationship between depression and both drinking outcomes [i.e. *drinks per drinking day (DDD)* and *percent heavy days drinking (PHDD).*] This indirect effect seemed to be driven by the strong inverse correlations between purpose in life and depression that were found at each of the study intervals that had both variables present. Additionally, purpose in life and depression both demonstrated significant correlations with post treatment drinking outcomes. However, these associations were interpreted as small in their effect sizes.

Despite the finding of significant indirect effects involving purpose in life as a mediator between depression and alcohol outcomes, when change scores between two different assessment periods were used, they produced inferior model predictions compared to the use of status scores; contrary to what was hypothesized. Specifically, depression assessed at baseline, purpose in life at 3 months, and drinking outcomes at 12 months led to the strongest measure of indirect effects in modeling both alcohol outcomes (DDD and PHDD.) While other paths involving indirect effect estimates resulted in statistical significance, such as the use of depression change scores from baseline to treatment end (i.e. path 3), or purpose in life from end of treatment to 9 months (i.e. path 2), in each case models that used a change score variable in the path diminished the overall effect compared to the exclusive use of status scores at the three different time points. Contrary to what was expected, when change scores were exclusively used in the models (path 8), coefficients were zeroed out leading to zero indirect effects in both models. Other paths involving change score variables (paths 4 through 7) were also not statistically significant, contrary to the original hypothesis.

Some of the results from this current secondary analysis differed from other studies involving purpose in life (PIL) that had used Project Match data. In one previous study involving the entire participant pool (e.g. outpatient and aftercare, $N = 1726$), PIL was observed to increase at a greater rate post-treatment compared to within-treatment (Roos et al, 2015). However, in the current study, which selected only a subset of outpatient participants ($N = 793$), PIL averages increased until treatment end and then stayed constant until the end of the study (see Table 4, and Figures 4 and 5). This study's participant pool, consisting of only outpatient participants, was inherently different from

the full sample that included 774 aftercare participants. Outpatient participants were significantly younger, more residentially stable, and less dependent on alcohol at the start of the study compared to their Aftercare counterparts (Project Match Research Group, 1997). However, following treatment, aftercare participants also experienced more sustained abstinence compared to the outpatient group, at a time when their purpose in life scores were also increasing. These observations suggest that Project Match's two treatment populations were significantly different from each other, and in some ways could be considered as having participated in two different clinical trials. In addition to the observed lack of change in PIL reported post-treatment with the current outpatient group, drinking outcomes also stayed relatively stable during the study's 12 to 15 month period. The minimal variance at this critical interval would also factor into poor indirect effect model prediction.

The current study also led to significant findings related to direct effects involving depression, purpose in life, and both DDD and PHDD drinking outcomes. Consistent with study hypotheses, depression change scores (baseline to 3 months) outperformed depression status scores (taken at baseline) in the prediction of later status drinking outcomes at 12 months. However, contrary to what was hypothesized, depression scores at baseline outperformed depression change scores (baseline to 3 months) in the prediction of both types of purpose in life scores (i.e. PIL at 3 months or PIL 3 months to 9 months). Similarly, purpose in life (PIL) when used as a predictor at treatment end (3 months) slightly outperformed PIL change scores (between 3 months and 9 months) in the prediction of alcohol outcomes at 12 months. Neither PIL taken at treatment end, nor

the use of its change scores, had significantly predicted later alcohol change scores (measured between 12 months and 15 months).

To summarize, the study's main hypothesis that purpose in life serves as a partial, longitudinal mediator between depression and alcohol outcomes was partially supported. However, contrary to specific hypotheses made involving the Latent Difference Score (LDS) model, the use of variables at one time interval (status scores) clearly led to higher estimates of indirect effects compared to any inclusion of variables made from difference scores between two time intervals (change scores). The study's results also examined direct effects among study variables, and found several instances of significant prediction within two longitudinal models. Among these identified direct effects, depression change scores measured during the treatment course (baseline to 3 months) served as a significant predictor of post-treatment alcohol use outcomes, improving upon the prediction of depression measured only at baseline. However, when considering depressive variables predicting purpose in life, or purpose in life variables predicting alcohol use outcomes, using variables measured at one time point usually proved to be superior at prediction compared to the use of change variables that included difference scores across time.

Limitations

There were several limitations to consider in the current study. Given this study was a secondary analysis of established Project Match data, time intervals were already set. This allowed for only one possible time sequence (from baseline to 15 months) that included data that could involve the three factors juxtaposed together across time, satisfying LDS criterion. With the inclusion of predictor (depression, baseline to 3

months) and mediator (3 months to 9 months) data, the alcohol outcome data to be analyzed in the model reflected self-reported drinking from 9 months to 15 months. At this time interval, the data showed very little variance in alcohol outcomes between time points; the greatest change having already occurred during the time of treatment (baseline to 3 months). Similarly, the purpose in life data showed very little variance between 3 to 9 months. Therefore, any proposed path of indirect effects involving alcohol *change scores* or purpose in life *change scores* resulted in non-significant results. Future studies involving change scores in an LDS model would require careful selection for the length of time intervals and critical timing of successive factors to coincide with believed sensitive periods of change within a longitudinal model.

A second limitation with the current findings is the possibility that a different sequence of factors also could have produced similar significant indirect effects. Depression and purpose in life demonstrated strong inverse relationships at all time points, as well as sharing small but significant relationships with both alcohol outcomes. Considering the existence of these relationships, and observing significant change in both during treatment, purpose in life could have also preceded depression in the model. This alternative path was not tested, and a comparison of the relative strengths of mediation cannot be made.

Another element to consider when interpreting results is the importance of timing of factors within the models. According to the aggregated means found in Table 4, all model factors demonstrated their greatest change during the treatment period between baseline and 3 months. This contrasted with other studies that found continued growth in purpose in life throughout later study time intervals (Krentzman, et al, 2015, Roos et al.,

2015). In this study involving only outpatient alcohol use disordered participants, correlations between model factors showed their strongest relationships at 3 months compared to baseline (see Tables 6 and 7). The combination of these observations suggest that mediation found in this study may be more time-dependent, capturing global personal changes at end of treatment (3 months), and less dependent on the specific variables that were chosen as predictor and mediator.

A final possible limitation of the current study centers around needing more precision with psychometric properties of the Purpose in Life (PIL) Test. While many studies have confirmed the PIL test's high internal consistency, there have been varied results around its structural validity (Garcia-Alandete, et. al., 2016). With the PIL test including topic areas as diverse as considered retirement activities, views on freedom of choice, and the presence of boredom and suicidal ideation, more than a dozen studies have been conducted proposing factor models ranging from one to four identified factors (Garcia-Alandete, et. al., 2016). After the Project Match study, Marsh et al., 2003 concluded that PIL was a unidimensional model after testing the measure with a combined social and treatment drinker population. However, this resulted after dropping three items deemed unrelated. In developing a Spanish PIL test version, Garcia-Alandete et al., 2016 found that a reduced 10 item version resulted in two primary factors: Sense of Meaning in Life, and Goals and Purpose in Life. These results were found after testing a Spanish undergraduate population. In a future study involving primarily eating-disordered women, the original 20-item PIL test demonstrated robust construct validity, again as unidimensional involving a clinical population (Garcia-Alandete, Marco, & Perez, 2017). These results highlight that PIL psychometrics are probably sensitive to

different populations, and future studies involving the PIL test should be mindful about how construct validity may vary based on type of clinical problem, severity, and demographic factors such as age, race, and gender.

Clinical Implications and Future Directions

Latent difference score (LDS) modeling

This study used latent difference score (LDS) modeling to observe individual change over the course of the clinical trial. Compared to past longitudinal designs, researchers have noted the strength of this approach as offering better flexibility in detecting change across time, especially when an individual's rate of change is believed to differ from one study interval to the next (Bryan, et al., 2015). With change being specified in terms of adjacent time points, LDS does not require fitting a curve across all time intervals of the study, a requirement that was common with previous longitudinal models; change in factors actually become explicit parameters in the model (Reeve, et al., 2015). Observing difference scores between factors across distinct, successive time intervals allow for inference into temporal precedence and the ability to suggest causal relationships (Zuromski, Cero, & White, 2017).

These unique features within LDS carry potential to clarify change processes occurring during substance use disorder recovery. When individuals enter the action stage of recovery, such as in a formal treatment setting, several mechanism factors are changing quickly and often in relation to changes in other factors. After decades of process research concerning the intentional change process, we believe these factors include self-regulation, self-efficacy, and distress tolerance, among many (DiClemente, 2018). LDS modeling has the power to evaluate future hypotheses about the temporal

precedence and magnitude of effects among known change factors, to lead to a better understanding of how the change of one factor can trigger the changes in successive factors. More longitudinal studies using complex process modeling (e.g. mediated moderation and moderated mediation, Preacher & Hayes, 2008) can help the addiction treatment field better understand the critical timing, order, and magnitude of effects among these factor changes to better understand the overall mechanisms of behavior change in the recovery process.

Future directions regarding purpose in life

Future research directions should also consider how purpose in life and mitigated depression relate to this complex recovery process. The protective role that purpose in life served in the current study has recently been broadened to research involving wellbeing in general. In an analysis from the *English Longitudinal Study of Ageing* (Mean age = 65, Steptoe, Deaton, & Stone, 2015), *sense of purpose and meaning in life* were related to longer longevity, with all other factors controlled. The researchers concluded that health care systems need to be as concerned with "positive psychological states" as they are with illness and disability. This study has recently been supported by a systematic review (Martin-Maria, et al., 2017) that found *subjective well-being*, in which sense of purpose and meaning in life were primary elements of the working definition, to be associated with lower mortality rates within general populations. In contemporary behavioral health treatment, an emphasis on purpose in life fits nicely with context-behavioral approaches. Using acceptance and commitment therapy (ACT) as the context, for example, the client's recommitment to living life according to identified personal values can anchor healthy behavior changes, such as abstaining from heavy drinking.

Given this frame of reference, Pearson et al. (2015) used purpose in life as a measure of values clarification in their study model, and found that it was a significant mediator between trait mindfulness (self-reported everyday experiences) and both depression symptoms / alcohol use problems among college students. Inferring from the results of this study, purpose in life, like values clarification in acceptance and commitment therapy, may be an important transdiagnostic factor in the treatment of complicated, multifaceted dual-diagnosis cases similar to those involved in the current study. Purpose in life may operate as a part of a change mechanism through which incremental, committed actions later increase and ultimately lead to intentional behavioral change.

The results of this study, combined with similar research conducted within the decade, suggest that purpose in life (PIL) may be one of many *mechanisms of change* (Kazdin, 2007) identified in recovery from alcohol use disorders. This study adds to our understanding of the factors involved in the relationship between depression and heavy drinking outcomes, a common dual-diagnosis condition. Purpose in life, as well as decreases in depression, exemplify important variables that providers can monitor throughout the course of treatment. By emphasizing a therapeutic discussion with the client around enhancing a purpose in life identity, providers can offer treatment that is strength-based and deepens the recovery treatment plan compared to a traditional abstinence-only approach (Best, et al., 2012).

More research is necessary to consider how positive psychological factors like purpose in life (PIL) are involved in personal change, both during the treatment process, as well as in post-treatment. In a recent meta-analysis on the use of ACT for substance use disorders, ACT was found to be effective during the treatment course, but also

demonstrated incremental advantages compared to *active treatment elements* in relapse prevention measures at follow-up (Lee et al., 2015). The authors interpreted these results by noting that the fundamental goals of ACT are not only to reduce substance use, but also to improve overall levels of functioning by emphasizing the living of a meaningful, valued life. To better bridge our understanding between context (i.e. PIL), and behavior (drinking outcomes), another recent study found that *self-control* and *abstinence self-efficacy* were significant mediators between the association of purpose in life and alcohol self-regulation failure (Song, Jo, & Won, 2018). The authors concluded that through these established mechanisms of change (self-control and self-efficacy), purpose in life, a more generalized factor, can exert indirect influences on alcohol self-regulation.

Addressing depression within integrated alcohol disorder treatment

The outcomes of the present study also underline the importance of declining depression during the treatment period to the overall recovery process from alcohol use disorders. Depression was also found to decrease significantly during the same treatment period that heavy drinking rates also decreased. This finding was consistent with previous longitudinal research that found that heavy drinking and depressive symptoms are dynamically linked over time both during treatment course (Conner et al., 2008) and throughout post-treatment (Witkiewitz and Villarroel, 2009). Past research also concluded that co-occurring depression is associated with higher rates of treatment drop-out and shorter time to first drink after a period of abstinence (Gamble, et al., 2010). This literature, along with the outcomes from this study, suggest the importance of clinical practice that prioritizes measurement-based care for depression (i.e. *process monitoring*) throughout treatment, including the measurement and delivery of feedback regarding

self-reported depressive symptoms and other related factors related to recovery maintenance and relapse prevention (Goodman, McKay, & DePhilippis, 2013).

Large health care organizations have also considered new creative changes to clinical programming that better address dual-diagnosed conditions like depressive and alcohol use disorders with more positive psychology programming. The Veterans Health Administration, the nation's largest health care system, has recently promoted an initiative known as *Whole Health for Life* (Taylor, et al., 2019) that promotes complementary and integrated care for veterans' general wellness, independent of health care specialization. Considerations for purpose in life and decreasing states of depression are inherent within the *Personal Development* component of its wellness model. More research is necessary to address the relative effectiveness of this and similar initiatives that stress wellness over disease to an individual's perceived purpose in life and depression.

Conclusions

The current longitudinal study involving Project Match data underlined the strength of association between purpose in life and depression in an alcohol disordered population. Anchored by this correlation, purpose in life was found to be a longitudinal mediator between depression, measured at entry into treatment, and two different alcohol-use outcomes post treatment. In one instance, change scores of depression, measured between the start and end of treatment, showed stronger direct effects with future alcohol outcomes compared to depression measured only at baseline. However, contrary to a priori hypotheses made, depression and purpose in life primarily demonstrated more predictive power of alcohol outcomes when measured at single time

points, that is, baseline depression and end of treatment purpose in life. Although the inclusion of change scores primarily did not enhance the current mediation model, the use of latent difference score (LDS) modeling offers promise to evaluate future hypotheses about the temporal precedence and magnitude of effects among known change factors. Throughout the course of 15 months, depression, purpose in life, and both alcohol outcomes demonstrated greatest change over the 3-month treatment course.

Combining the results from this study with recent research showing associations between purpose in life and overall wellbeing and longevity, clinicians are invited to discuss purpose in life with their clients as part of an effective context-behavioral care approach. Additionally, considering the observed dynamic link between depression and heavy alcohol use, dual-diagnosed treatment should include process monitoring among all individuals who struggle with similar co-occurring conditions to promote better treatment retention and strengthen relapse prevention. The dual-diagnosis research field could also benefit from more longitudinal, mechanisms of change studies to improve our understanding of how diminished depression and increased purpose in life is related to other known recovery factors targeting the goal of improved quality of life.

Appendix

Sample *MPLUS* script used for the estimation of indirect effects using latent difference score modeling: Drinks per drinking day (DDD) used in this example.

INPUT INSTRUCTIONS:

```
TITLE:  DISSERTATION LDS
DATA:  FILE IS mp.18.ddd.dat;
VARIABLE:  NAMES ARE

bdi bdi03
pil03 pil09
dddmo12 dddmo15;

MISSING ARE ALL (-99);

ANALYSIS:  BOOTSTRAP=1000

MODEL:
BDI03 ON BDI @1;
BDIDIFF BY BDI03 @1;
BDIDIFF ON BDI*;

BDI*; BDI03@0; BDIDIFF*;

PIL09 ON PIL03@2;
PILDIFF BY PIL09@1;
PILDIFF ON PIL03*;

PIL03*; PIL09@0; PILDIFF*;

DDDMO15 ON DDDMO12@2;
DDDDIFF BY DDDMO15@1;
DDDDIFF ON DDDMO12*;

DDDMO12*; DDDMO15@0; DDDDIFF*;

PIL03 ON BDI BDIDIFF;
PILDIFF ON BDI;
PILDIFF ON BDIDIFF@0;
DDDMO12 ON BDIDIFF PIL03 PILDIFF;
DDDMO12 ON BDI@0;
DDDDIFF ON BDI@0;
DDDDIFF ON PILDIFF@0;
DDDDIFF ON BDIDIFF PIL03;
```

MODEL INDIRECT:

DDDMO12 IND BDI;
DDDMO12 IND BDIDIFF;
DDDDIFF IND BDI;
DDDDIFF IND BDIDIFF;

OUTPUT: STANDARDIZED CINTERVAL (BOOTSTRAP);

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