Using Text Message Reminders to Help Adolescents and Young Adults Remain Mindful of Their Commitment to Substance Use Behavior Change

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Abstract

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Substance use disorder is a major health and safety concern, and initiation of use typically occurs during adolescence or young adulthood. Early initiation of substance increases the likelihood that individuals will experience a variety of negative consequences due to substance use. Interventions have been developed to support adolescent and young adult substance use behavior change. Text messaging or short message service (SMS) are an inexpensive, reliable, and relatively simple way of reaching adolescents and young adults to support their substance use behavior change goals. This randomized controlled trial evaluated the feasibility, acceptability, and efficacy of four-weeks of SMS reminders designed to support adolescent substance use behavior change goals. Participants were randomly assigned to a self-selected message content intervention condition (self-selected), an other-selected message content intervention condition

(yoked-intervention), and a general health message content condition (control). Fifty-nine adolescents and young adults participated in the study. Overall, the SMS intervention was feasible and acceptable, although recruitment of eligible participants into the study was lower than expected. Participants' achieved their substance use goals at a relatively high rate, reported decreased alcohol and cannabis use, reported decreased negative substance use consequences, and reported increased self-efficacy. The pooled intervention condition demonstrated statistically significantly lesser levels of change relative to the control group, suggesting that messages focusing on co-occurring issues may be more relevant to adolescents and young adults with lower levels of motivation to change or less severe substance use problems.

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1.0.0 Introduction

Substance abuse in the United States causes an estimated $400-740 billion in costs related to crimes, lost work productivity, and health care per year (Goplerud, Hodge, & Benham, 2017; National Institute on Drug Abuse, 2017, 2018; U.S. Department of Justice: National Drug Intelligence Center, 2011). Substance use disorder (SUD) is a major health and safety concern that typically begins during adolescence or young adulthood (Substance Abuse and Mental Health Services Administration, 2018). Adolescence is the developmental period during which individuals go through some of the most rapid changes they will experience in their life and is followed by the major life transition to young adulthood (Casey & Jones, 2010; Lenz, 2001; Monti, Colby, & O'Leary, 2001; Schulenberg & Maggs, 2002). This time of change, maturation, and transition makes individuals especially susceptible to the initiation of substance use (SU) (Arain et al., 2013; Casey & Jones, 2010). Adolescent and young adult (AYA) SU can cause a variety of negative consequences, including hangover, assault, risky sexual behavior, sexual assault, impaired driving, legal involvement, health problems, suicide, and impaired cognitive functioning (Marshall, 2014; National Research Council and Institute of Medicine, 2004; Schwebel et al., 2018). AYA SU has also been correlated to a number of future consequences, including academic failure, relationship difficulties, physical illness, injuries, and impaired adult cognitive function (Allen, Rivier, & Lee, 2011; Lubman, Yücel, & Hall, 2007; Marshall, 2014; Milich et al., 2000). Early onset of SU increases the likelihood an individual will continue to abuse substances for an extended period of time (Johnston et al., 2017; Lubman et al., 2007; Marshall, 2014), and is associated with increased negative health outcomes over time (Casey & Jones, 2010; McGue et al., 2001; National Institute on Drug Abuse, 2014; Poudel & Gautam, 2017; Richmond-Rakerd, Slutske, & Wood, 2017). Because of the quantity and severity of

consequences associated with early initiation of substance use, the long-term consequences related to age of initiation, and the challenging nature of working with AYAs, numerous specialized interventions have been developed to target these populations (Dimeff, Baer, Kivlahan, & Marlatt, 1999; Marlatt et al., 1998; Monti et al., 2001).

1.1.0 Treatment Goals

Traditionally, the most commonly used approach to SUD treatment has been a 12-step model with a focus on SU abstinence (Bowen et al., 2009; Godley et al., 2007; Greenfield & Tonigan, 2013; Moos, 2007). More recently, SUD treatment approaches have broadened treatment goals to include others such as harm reduction, an approach that emphasizes reducing the negative consequences that individuals experience from substance use (Marlatt & Witkiewitz, 2002; Ritter & Cameron, 2006). The transtheoretical model of change (Prochaska & Norcross, 2001)—often referred to as the stages of change model—is a six-stage model of behavior change. Individuals do not necessarily go through the stages in a linear manner, although some do. Presented linearly, the six stages are pre-contemplation (no intention to take action toward change in the next six months), contemplation (intention to take action toward behavior change in the next six months), preparation (intention to take action toward behavior change in the next 30 days and beginning to take behavioral steps in this direction), action (changed overt behavior for less than six months), maintenance (changed overt behavior for more than six months), and termination (no temptation to relapse and 100% confidence in maintaining behavior change). From the transtheoretical perspective, sustained behavior change (e.g., abstinence or staying within new limits) occurs during the action stage, whereas harm reduction can begin to occur during the preparation stage (Prochaska & Norcross, 2001; Prochaska, Norcross, & DiClemente, 1994). Thus, the shift toward harm reduction outcomes

likely helps increase acceptability of SUD intervention options to a wider range of individuals (e.g., those who are not inclined to an abstinence or faith-based approach or those motivated by rapid progress in behavior change).

1.2.0 Relapse Rates

Individuals attempting to change their SU behavior often underestimate the difficulty in learning to control urges and the effort required to enact successful behavior change. They often have unrealistic expectations about SU behavior change, particularly with regard to the amount of effort required; speed and ease of change; and effects on other aspects of their lives—this is sometimes referred to as "false hope syndrome" (Polivy & Herman, 2002). False hope syndrome, lapse (resumption of SU after a period of SU behavior change), and relapse (return to baseline levels of SU and/or abandonment of the current change effort) are common occurrences (Larimer, Palmer, & Marlatt, 1999; Marlatt & George, 1984). The National Institute on Drug Abuse (NIDA) estimates relapse rates for individuals of all ages, post-SUD treatment, to be between 40 and 60% (National Institute on Drug Abuse, 2018). AYA relapse rates, while not as well researched, have been estimated to be between 50 and 90% (Breslin, Zack, & McMain, 2006; Connors, 2004; Dawson, Goldstein, & Grant, 2007; Godley et al., 2001; Moos & Moos, 2006). AYA time to relapse also has not been extensively researched. One prospective study of 59 adolescents receiving outpatient treatment found that the median time to relapse was approximately 54 days and that 66% of adolescents had relapsed within six months (Cornelius et al., 2003). A study of adolescents receiving inpatient treatment reported finding that 64% of adolescents relapse within three months (Chung & Maisto, 2006). The researchers did not measure average time to relapse in this study, however results appeared to indicate the period of highest risk for relapse is the first four to six weeks following treatment. Research on adult time

to relapse when their goal is abstinence is limited as well; 40-60% of adults receiving treatment for alcohol problems relapse within three months of termination of treatment, and 70-80% within 12 months (Hunt, Barnett, & Branch, 1971; Lowman, Allen, & Stout, 1996). For heroin users and smokers, approximately 60% relapse within three months of treatment termination and 75% relapse within 12 months (Hunt et al., 1971). Neither study on adult relapse rates reported results on average time to relapse.

Consistent findings of high relapse rates have led NIDA and the Institute of Medicine to label susceptibility to relapse as a defining feature of SUD (Breslin et al., 2006; Dennis & Scott, 2007; McLellan, Lewis, O'Brien, & Kleber, 2000). NIDA suggests that SUD relapses should be treated similarly as chronic illness relapses—relapse can occur and should be seen as an indicator that treatment needs to be adjusted or resumed (National Institute on Drug Abuse, 2018). Additionally, NIDA suggests recovery from SUD is a long-term process that frequently requires multiple courses of treatment. Relapse is a challenge that is especially problematic for AYAs.

1.3.0 Delay Discounting

When individuals decide to change their SU behavior, they are deciding to give up short-term benefits (e.g., increase pleasure, reduce pain, improve sleep onset) in order to obtain a long-term benefit (e.g., lead a healthier, safer, better life). This decision could be categorized as deferred gratification and is made particularly difficult in part by the psychological mechanism known as delay discounting, a phenomenon by which individuals mentally decrease the present value of a reward in correspondence with the delay of its receipt (Connors, 2004; Mischel, Shoda, & Rodriguez, 1989; Robles, Huang, Simpson, & McMillan, 2011; Steinberg et al., 2009). Research suggests individuals will more frequently select immediate rewards over delayed rewards (Connors, 2004). Future orientation, or the ability of an individual to imagine their

future life circumstances, is also being investigated for its role in the ability to delay gratification (Greene, 1986; Steinberg et al., 2009). Results suggest that adolescents, particularly those age 16 and younger, are more susceptible to engaging in delay discounting and have a lower level of future orientation (i.e., they think less about their future circumstances) than adults (Steinberg et al., 2009). Afterward, increased sensitivity and motivation for reward begins to decline throughout adolescence and young adulthood, presumably as affective processing system develops (Steinberg & Chein, 2015). There are individual differences, but in most cases, younger, especially still developing and impulsive, individuals prefer short-term immediate rewards to greater future rewards (Bickel, Odum, & Madden, 1999; Steinberg & Chein, 2015; Steinberg et al., 2009). It is likely the development process plays a role in this preference.

1.4.0 Brain Development

The human brain develops in a back-to-front direction, meaning that areas responsible for motor function are the first to mature while the areas dealing with rational decision-making, impulse control, and planning (prefrontal cortex) are among the last to develop (Amara & Cortés, 2007; Arain et al., 2013). The AYA brain is still maturing during ages 10-25 and development can be influenced by a variety of factors, including heredity and environment, nutrition, sleep, medication, and surgical intervention during childhood (Arain et al., 2013). Because the AYA brain is still developing, it is particularly vulnerable to the reinforcing properties of alcohol and other drugs, thus increasing the likelihood of escalating use, which then potentially interrupts the natural process of brain maturation and important processes of brain development (Arain et al., 2013; Casey & Jones, 2010; Lubman et al., 2007; Squeglia, Jacobus, & Tapert, 2009). Characteristics of an underdeveloped brain, such as poor impulse control and deficits in rational decision making, can not only contribute to the development of a SUD and relapse, but can also

be exacerbated by it (Bjork et al., 2004; Join Together Online, 2004). Repeated early exposure to alcohol intoxication (i.e., before completion of brain maturation and development) can cause memory deficits and has been associated with increases in dendritic spine size. These increases suggest a modification of brain functioning that may serve to stabilize addictive behavior (Carpenter-Hyland & Chandler, 2007; Sircar, Basak, & Sircar, 2009; Sircar & Sircar, 2005; Witt, 2010). Additionally, studies of hippocampal volume suggest that early adolescence may be a particularly high-risk time to begin SU and that continued alcohol use may compound the effect (De Bellis et al., 2000). Given the high rate of SU initiation at an early age and the negative consequences associated with it, adolescence and young adulthood are frequently selected times for intervention (National Institute on Drug Abuse, 2018).

1.5.0 Intervention Approaches for Adolescent and Young Adult Substance Use Disorder

Motivational interviewing (MI) and motivational enhancement therapy; 12-step facilitation treatment; cognitive-behavioral treatment; behavioral family counseling; and contingency management and community reinforcement approaches are five frequently utilized effective psychosocial treatments for SUD (Moos, 2007). Common components of these treatment approaches include support, goal-direction, and structure; stimulus control; an emphasis on rewards that compete with substance abuse; and attempts to enhance self-efficacy and coping skills (Moos, 2007). Many evidence-based AYA SUD providers or organizations providing treatment utilize these approaches. Behavioral therapies are the most commonly used forms of SUD treatment (National Institute on Drug Abuse, 2018). Relapse prevention with a focus on counter-conditioning and stimulus control is frequently incorporated in behavioral approaches (Connors, Donovan, & DiClemente, 2001; National Institute on Drug Abuse, 2018). In relapse prevention, the emphasis of treatment is on identifying and avoiding cues that could possibly

trigger resumption of SU; on learning alternative responses to behavioral cues; and learning coping skills. Examples of skills include ones that help individuals learn how to cope with or tolerate feelings and situations that trigger SU; how to challenge cognitions that encourage SU; and how to resist external pressure(s) to use (Connors et al., 2001; Cornelius-White, 2002; DiClemente, 2003; Prochaska et al., 1994). Group therapy is an increasingly used component of behavioral treatments for SUD and is frequently used with younger populations (Connors et al., 2001; National Institute on Drug Abuse, 2014, 2018). Group therapy has been found to have relatively comparable positive outcomes to individual therapy in general, and a meta-analytic study found that participants receiving group therapy for SUD were more likely to have positive outcomes than participants receiving individual therapy (McRoberts, Burlingame, & Hoag, 1998). Group therapy can help create a supportive environment for individuals; can let them know they are not alone—others share the same or similar problems—and they have support; and can help maintain long-term treatment goals (McRoberts et al., 1998; Moos, 2007; National Institute on Drug Abuse, 2018). Another important component of SUD treatment is continuing care or aftercare, a strategy used to help maintain healthy behavior change after treatment (Godley et al., 2007; Moos, 2007).

Given the high rates of SU relapse, it is important to consider other positive outcomes of treatment (e.g., self-efficacy) when assessing for intervention effectiveness.

1.6.0 Self-Efficacy

Social learning theory defines self-efficacy as an individual's belief in their ability to implement and maintain a specific behavior (Bandura, 1977; Bandura, 1977a). Across a variety of settings, self-efficacy has been found to be a strong predictor of coping behavior, level of performance, and perseverance in the face of difficult problems (e.g., work, academic, and

athletic performance) (Bandura & Locke, 2003). Efficacy beliefs were also found to strongly mediate the relation between prior and subsequent performance (Bandura & Locke, 2003). In the context of SUD treatment, self-efficacy (often referred to as abstinence self-efficacy) is a measure of the beliefs of individuals that they can reduce their amount of substance use, resist using when faced with external pressure to use, and maintain this change over time (Hall et al., 2014; Kadden & Litt, 2011; Moos, 2007). Increasing self-efficacy has been identified as one of the common components of effective SUD treatment (Moos, 2007). Individuals with necessary skills/support and high levels of self-efficacy are more likely to resist SU in high-risk situations or to use within their limits, while reliance on avoidance coping and lower levels of self-efficacy are more likely to lapse in high-risk situations (Moos, 2007). Furthermore, if an individual with high levels of self-efficacy has a lapse, they are more likely to view the situation as a temporary slip up and quickly regain control than an individual with lower levels of self-efficacy (Kadden & Litt, 2011; Moos, 2007).

1.6.1 Empirical Support of Self-Efficacy

A large body of research suggests higher levels of self-efficacy predict better treatment outcomes for both adults and adolescents, although the length and strength of the effects are not fully understood (Burleson & Kaminer, 2005; Hall et al., 2014; Kadden & Litt, 2011; Kavanagh, Sitharthan, & Sayer, 1996; Litt, Kadden, Kabela-Cormier, & Petry, 2008). Kavanagh et al. (1996) and Maisto, Connors, and Zywiak (2000) found that higher levels of post-treatment self-efficacy significantly predicted decreased alcohol consumption for periods of up to 12 months among an adult sample. However, Dolan, Martin, and Rohsenow (2008) found that among an adult sample, post-treatment self-efficacy level predicted drug use for only a three-month period and not after six months. In a study of step-down continuing care, self-efficacy levels were

associated with amount of SU after treatment as well as level of participation in continuing care (McKay et al., 2004). Self-efficacy levels during inpatient alcohol dependence treatment was found to predict likelihood of drinking, time to first drink, and time to relapse for one year post-treatment (Greenfield et al., 2000). Self-efficacy level after outpatient alcohol dependence treatment was found to be a predictor of time to relapse (Allsop, Saunders, & Phillips, 2000; Romo et al., 2009; Vielva & Iraurgi, 2001). These studies also found that individuals with high self-efficacy were more likely to maintain abstinence for six months. Adults in a SU aftercare program with higher self-efficacy levels reported fewer days of SU and reduced SU severity (e.g., lower levels of SU) in high-risk SU situations (Brown, Seraganian, Tremblay, & Annis, 2002). Untreated young adult binge drinkers with higher self-efficacy reported reductions in frequency of binge drinking episodes (Blume, Schmaling, & Marlatt, 2003).

A number of studies have compared the temporal effects of self-efficacy on SU outcomes. A study of post-residential SUD treatment patients found that a higher level of self-efficacy at discharge was the strongest predictor of one-year SU abstinence (Ilgen, McKellar, & Tiet, 2005). A longitudinal study compared individuals that achieved alcohol abstinence either naturally or with the help of treatment (both residential and outpatient). The study found higher self-efficacy predicted continued abstinence after as long as three years, while individuals with lower self-efficacy were more likely to relapse (Moos & Moos, 2006). Other studies have investigated the relative impact of self-efficacy level and having achieved SU abstinence. A study comparing different treatment methods for marijuana dependence found high self-efficacy after treatment was a better predictor of continued abstinence than coping skills change (pre- and post-treatment) and abstinence during treatment (Litt et al., 2008). A study of individuals attempting to quit smoking who completed daily measures assessing abstinence self-efficacy found self-

efficacy increased as individuals stopped smoking and maintained abstinence. (Gwaltney, Shiffman, Balabanis, & Paty, 2005). The study also found decreases in self-efficacy predicted relapse. Baer et al., (1986) found similar results among cigarette smokers attempting to quit, suggesting that self-efficacy in cigarette smokers predicted longer smoking abstinence even when previous abstinence was controlled for. In contrast, Wong et al., (2004) found that achieving abstinence during treatment was the primary mechanism of change rather than self-efficacy among cocaine users. The findings with regard to self-efficacy suggest that this outcome, as well as abstinence should be treatment targets, and change in one might lead to change in the other.

A handful of studies have found that self-efficacy has a negative relationship with SU abstinence (i.e., higher self-efficacy predicts worse outcomes) (Langenbucher, Sulesund, Chung, & Morgenstern, 1996; Mayer & Koeningsmark, 1992). Langenbucher et al., (1996) suggest their findings should be interpreted with caution given they were using a brief, modified version of the Situational Confidence Questionnaire that might limit its validity. Additionally, it may be that high baseline self-efficacy creates challenges in SUD treatment. Perhaps it makes individuals overconfident in their ability to change, making them susceptible to relapse and more likely to leave treatment before completion. While there is minimal research comparing the impact of changes in pre- and post-treatment levels of self-efficacy, findings regarding the beneficial impact of high self-efficacy post-treatment on future SU abstinence may point in this direction.

Given overall positive findings regarding the beneficial effects of self-efficacy on SU abstinence, it is surprising that there are few treatments designed to increase self-efficacy. In addition, self-efficacy findings in the SU field are typically elucidated via secondary analyses (e.g., self-efficacy is not the primary outcome variable). Two studies found greater levels of self-

efficacy after SUD relapse prevention treatment, however, it is unclear whether or not self-efficacy mediated the change in addictive behaviors (Brown et al., 2002; Stephens, Wertz, & Roffman, 1995). One study compared a SUD relapse prevention intervention to a social support intervention (Stephens et al., 1995). The other study was a relapse prevention aftercare study that increased self-efficacy during the aftercare portion of the study, but did not maintain the increase at follow-up (Brown et al., 2002). Cognitive-Behavioral Therapy (CBT) has been found to be more effective at increasing self-efficacy than Motivational Enhancement Therapy (MET) among a sample of alcohol dependent adults (DiClemente et al., 2001). Another study found that CBT and 12-step interventions improved self-efficacy (Finney, Noyes, Coutts, & Moos, 1998). Other studies have also found that treatment related activities such as active participation in setting goals, achieving behavioral goals, and greater participation in skills-building activities are associated with increased self-efficacy, and that self-efficacy is related to a positive treatment outcome (Borrelli & Mermelstein, 1994; Ilgen, McKellar, & Moos, 2007; Lozano & Stephens, 2010). However, Bandura identified four key sources of efficacy beliefs: performance attainments (e.g., successfully maintaining SU abstinence); observing the performance of others; verbal persuasion (e.g., trying to convince an individual that they have certain capabilities); and physiological states based on judgment of an individual's capabilities, strengths, and weakness (Bandura, 1986; Kadden & Litt, 2011).

1.7.0 Reminders and Prospective Memory

Remembering information learned in the past and that has no relevance to the future is classified as a retrospective memory, whereas remembering to do an activity in the future is classified as a prospective memory (Brewer et al., 2011; Guynn, McDaniel, & Einstein, 1998). Examples of prospective memory include remembering to take a medication or attend an

appointment. Although retrospective memory has been extensively researched, there is limited information regarding prospective memory and how to activate the underlying mechanism that prompts it (Guynn et al., 1998; McDaniel, Einstein, Graham, & Rall, 2004). Although limited, evidence suggests that event-based prospective memory (e.g., remembering to stop at the grocery store after seeing the grocery sign while driving home) is considered to be cognitively demanding, given the need to shift focus from an ongoing task to the prospective memory cue (Rummel, Wesslein, & Meiser, 2017). Additionally, interruptions during delays in prospective memory tasks have been found to distract from task completion (Schaper & Grundgeiger, 2018). There is some research that suggests external memory aids, such as paired imagery or reminders, may help enhance prospective memory although benefits of reminder interventions may not be sustained over time (Guynn et al., 1998; Insel, Einstein, Morrow, Koerner, & Hepworth, 2016; Wang & Pérez-Quiñones, 2014).

1.8.0 Reminders, Relapse Prevention, and Text (SMS) Messages

Reminders and motivational coaching (or prompts) are types of prospective memory aids that can help individuals remain mindful of their SU behavior change decision, the reasons for their decisions, and potential pitfalls that might occur between treatment sessions. These are relapse prevention strategies that can be applied in treating SUD (Prochaska et al., 1994). Prochaska et al., (1994) discuss the usefulness of alarm clocks and calendars in our daily life and compare them to stop signs at a busy intersection—they remind us how to respond next. In the context of SUD treatment, therapists and treatment or support group members may serve to remind individuals of their SU behavior change decisions during their meetings. A skilled therapist can help an individual remember why they have decided to make decisions (e.g., to stop

using drugs due to potential consequences) and what may get in the way of being to follow through on their decisions (e.g., invitations to parties).

Reminders have been used to help individuals accomplish their smoking cessation goals. Researchers compared a reminding device, a pharmacological nicotine control treatment, and a behavioral treatment. The reminder device ("Triggered Suggestion Device" [TSD]) was essentially a watch that beeped at certain times throughout the day to provide positive reinforcement and reminders to support behavior change (Grant et al., 2001). A CD recording was used to pair four distinct watch beeps with therapeutic goals to remind and reinforce the decision to quit smoking. Results indicated the TSD was nearly as effective as a pharmacological treatment and more effective than a behavioral smoking cessation treatment in smoking quit rate, smoking reduction, and treatment satisfaction. The researchers noted that high frequency contact—perhaps in this case embodied in the electronic reminders—had a strong positive influence in successful smoking cessation (Grant et al., 2001; Ockene, 1987).

However, AYAs today rarely use traditional alarm clocks, watches, or calendars. Instead, they use their smartphones or smartwatches as alarms, clocks, calendars, and modern communication devices (Madden et al., 2013; Nelson & Nelson, 2010). Importantly, use of technology is increasingly ubiquitous and not limited by individual factors such as age or socio-economic status (Menin, 2015). The Pew Research Center (2018) estimated that 100% of 18-29 year-olds own cellphones and that 94% of these individuals own smartphones. A study of 142 Hungarian young adults (ages 19-24) found that YAs seek proximity to their cellphone and become more anxious when separated from them (Konok, Gigler, Bereczky, & Miklósi, 2016). Estimates of adolescent cellphone ownership do not appear to have been measured as recently as those for older individuals and rates vary and are influenced by types of cellphone (e.g.,

cellphone versus smartphone). The Pew Research Center (2015) estimated 88% of teens owned cellphones and 73% of teens owned smartphones. One marketing company estimated teen cellphone ownership to be 78% in 2013 (Madden et al., 2013). More recently, several marketing companies have published estimates of adolescent (ages 12 to 17) smartphone ownership (84% in 2016) in the United States and age of receiving first smartphone (10.3 years in 2016) (Donovan, 2016; eMarketer, 2016). Given the lack of information available regarding how these estimates were made, it is worth comparing them to rates published in a report by a well-known Japanese mobile service provider that used a more methodologically rigorous approach to produce an estimate (GSMA and the Mobile Society Research Institute, 2014). They assessed 1,500 9 to 16-year-olds in seven western European countries and Japan and reported an estimated 69% of youth owned cellphones in 2014. Of teens who own cell-phones, 84% report having slept with their phone in their bed at least once, exemplifying the strong attachment that adolescents have for their phones (Kirst, 2008; Lenhart, Ling, Campbell, & Purcell, 2010). While estimates of cellphone ownership vary, it seems clear that a large proportion of AYAs in the U.S. own cellphones and are increasingly becoming attached to them.

AYAs send and receive text messages at an extraordinary rate—over six text messages per waking hour, over 100 messages per day, and over 3,300 messages per month (Cocotas, 2013; Smith, 2011; The Nielsen Company, 2010). As cellphone technology was first being used to provide or enhance SUD treatment, it was originally thought to be most effective with young people given their increased level of familiarity with the technology (Center for Substance Abuse Treatment, 2009). However, as cellphones and smartphones have become increasingly ubiquitous, technology-based SUD interventions have been found to be effective for individuals across an array of populations (Marsch, Carroll, & Kiluk, 2014). This suggests the importance

of using technology to provide treatment to people of all ages, and that young people in particular may be well-suited to engage with technology-based treatment approaches.

1.9.0 mHealth Research

Mobile Health (mHealth) is defined as the use of mobile computing and communication technologies in health care and public health (Berrouiguet, Baca-García, Brandt, Walter, & Courtet, 2016; Free et al., 2010). Research on text messaging falls under the umbrella of mHealth and has been primarily focused on two treatment strategies: interventions and reminders. The use of text messaging as a stand-alone intervention, as an adjunct to treatment, or as a reminder mechanism is largely driven by the ease, acceptability, and inexpensiveness of sending text messages (Schwebel & Larimer, 2018). Companies that send automated text messages typically charge a $1 monthly membership fee and less than $0.01 per message sent (and as little as $0.0005 depending on quantity of messages sent). A study conducted in India found that a national AIDS control text message reminder system could be implemented for between $1.27 and $1.57 per patient per year (Rodrigues, Bogg, Shet, Kumar, & De Costa, 2014). Text messages can be personalized, made interactive, and sent repeatedly. Messages can also be automated. They can be sent to individuals who may not have access to specific treatments in their vicinity. This is particularly important in developing countries where cellphones are the easiest and most common method of communication, and where the number of cellphones exceed the size of the population (Ben-Zeev et al., 2015; Free et al., 2010; International Telecommunication Union, 2017). However, this also is relevant in the United States. Underserved minority groups (who now use smartphones as their primary method for accessing the internet) and individuals living in rural parts of the United States (who often face a scarcity of services) can be more easily reached using cellular technology (Ben-Zeev et al., 2015;

Douthit, Kiv, Dwolatzky, & Biswas, 2015). To provide widespread help to individuals across varied and diverse socioeconomic and demographic groups, health promoting messages, including text message reminders, have been increasingly used in the mHealth field.

Initial mHealth reminder research in the medical field focused on appointment reminders and medical practice reminders. There is a body of research globally that has demonstrated the continued effectiveness of text message reminders as a tool for general health maintenance. A narrative review of mHealth reminder research found that medical practice reminders are the most commonly studied topic, followed closely by appointment reminders (Schwebel & Larimer, 2018). The review found that over 85% of appointment and medical practice reminder studies reported increased attendance and adherence. One such study investigated the effect of twice-monthly text message reminders to complete breast self-examination (BSE) on rate of BSE completion for women that had undergone breast cancer surgery (Chung et al., 2015). The study found that self-reported BSE adherence was statistically significantly higher for women receiving the reminder messages than for those that did not ($p < 0.001$). When the researchers controlled for group differences in education level, they found the reminders were the only significant predictor of BSE adherence ($p < 0.001$). Another study delivered supportive wellness-related text messages to mothers with young children and found an over 50% increase in physical activity (Fjeldsoe, Miller, Graves, Barnett, & Marshall, 2015).

Psychological research has also applied mHealth to behavioral intervention. For example, Cognitive-Behavioral Therapy (CBT) is an evidence-based treatment for depression that uses strategies such as behavioral skill building, cognitive restructuring, and homework to improve outcomes (Cuijpers et al., 2011; Hollon, 2003; Mausbach, Moore, Roesch, Cardenas, & Patterson, 2010). Text messages were found to supplement and enhance CBT through: reminding

individuals of appointments, delivering additional treatment content, and prompting the use of skills being taught in treatment (Berrouiguet et al., 2016). Text messages have also been used to try to direct the behavior of individuals who have trouble following through on certain behaviors. For example, individuals with schizophrenia who received text message reminders were found to display improved rates of task completion and completion of goal-directed behaviors (Pijnenborg et al., 2010; 2007). Text messages can similarly be applied to SUD treatment. Early studies of stand-alone text message interventions for smoking cessation demonstrated that text messaging is well-received by participants and moderately effective (despite a number of the studies not being sufficiently powered to report significant differences) (Free et al., 2009; Haug, Meyer, Schorr, Bauer, & John, 2009; Ybarra, Holtrop, Bağci Bosi, et al., 2013; Ybarra, Holtrop, Prescott, Rahbar, & Strong, 2013). A meta-analysis of smoking cessation interventions found a significant effect size with an odds-ratio of 1.37 (i.e., intervention condition participants were 37% more likely to remain abstinent than control condition participants) (Scott-Sheldon et al., 2016). A brief text message intervention for adolescents after a hazardous drinking related emergency department visit was found to decrease self-reported binge drinking and number of drinks consumed per day (Suffoletto et al., 2014). A brief text message aftercare study delivered daily self-monitoring texts, a daily wellness tip, and educational messages on the weekend to adolescents and young adults (ages 12-24) after discharge from inpatient SUD treatment (Gonzales, Ang, Murphy, Glik, & Anglin, 2014). The study found that individuals receiving the text messages were statistically significantly less likely to relapse over time (after 12-week intervention and 90-day follow-up; $p = 0.002$); text messages recipients reported experiencing significantly fewer and less severe substance use related problems ($p = 0.03$); and text message recipients were more likely to participate in other extracurricular recovery behaviors ($p = 0.03$).

However, not all research has found positive results. A pilot feasibility study using text messages to deliver normative feedback to heavy drinking college students found that although intervention condition participants experienced reductions in peak number of drinks, frequency of heavy episodic drinking, negative consequences, and injunctive norms relative to control condition, the overall condition-level differences in drinking behavior and norms were not statistically significant (Merrill, Boyle, Barnett, & Carey, 2018).

More recently, researchers have started to investigate the impact of mHealth reminders as an adjunct to treatment. One such study investigated the use of text message reminders as an adjunct to CBT for depression among an outpatient, adult Latino population (Aguilera, Bruehlman-Senecal, Demasi, & Avila, 2017). All participants received a 16-week manualized CBT treatment for depression. Participants in the text message adjunct condition received a daily mood rating prompt, a daily adjunct to treatment (e.g., based on CBT module), an optional daily medication reminder, a weekly reminder to attend psychotherapy, and a monthly opt-out message to cease message delivery. While participants reported an overall positive experience receiving the messages and indicated the messages helped them feel closer to the group, there was not a statistically significant symptomatic improvement ($p = 0.15$). However, due to the pilot nature of the trial and relatively small sample size, it is hard to reach any definitive conclusions about the messaging effectiveness.

Three meta-analyses reviewed the growing body of mHealth literature and have found promising results (Fjeldsoe, Marshall, & Miller, 2009; Head, Noar, Iannarino, & Grant Harrington, 2013; Mason, Ola, Zaharakis, & Zhang, 2015). Head et al., (2013) found a mean effect size of $d = 0.33$ which is a small to moderate effect size according to Cohen's guidelines (Cohen, 1988) and compares favorably to effect sizes reported in other health-promotion

intervention meta-analyses (print-based tailored behavior change intervention *d = 0.15* (Noar, Benac, & Harris, 2007), computer-delivered health interventions *d = 0.05-0.35* (Portnoy, Scott-Sheldon, Johnson, & Carey, 2008), computer-based HIV prevention *d = 0.26* (Noar, Black, & Pierce, 2009), and message framing health interventions *d = 0.17* (Gallagher & Updegraff, 2012)). Mason et al., (2015) investigated the effects of text message interventions whose goal was substance use prevention, reduction, or cessation among adolescents and young adults (age 12-29). They found a summary effect size of *d = 0.25* (also in the small to moderate range) indicating that, in general, text interventions have a positive effect on adolescents and young adults attempting to reduce substance use behavior. The early success of mHealth interventions have demonstrated its utility and value as a potential treatment-delivery method or adjunct to therapy. Fjeldsoe et al., (2012) argue for four primary applications of text messaging in health care: 1) enhancing health service provision, 2) distributing mass health education messages, 3) encouraging better disease self-management practices, and 4) delivering personalized health promotion interventions.

1.10.0 Study Rationale and Specific Aims

Although several studies apply text messaging as an alternative treatment delivery method, there is strong evidence regarding the importance of the patient-therapist relationship in psychotherapy outcomes (e.g., G. J. Connors, Carroll, DiClemente, Longabaugh, & Donovan, 1997; Krupnick et al., 1996; Lambert & Barley, 2001). However, text messaging may be of value in a simpler yet less-investigated context—as an adjunct to in-person therapy. The current study tested the effects of text-message reminders as an adjunct to SUD intervention in a sample of AYA drawn from SUD treatment agencies or SUD interventions for young adults who violated alcohol and drug policies on a college campus. The study was a randomized control trial (RCT)

that sought to combine different aspects of mHealth and SUD treatment by using text messages with varied supportive message content as reminders of the individuals' decisions to change their SU behavior. Aims of the study were to (1) test the feasibility and acceptability of text messages in supporting the commitment of AYAs to SU behavior change; and (2) investigate the relationship between control and intervention groups on the effects of the following on self-efficacy and relapse rates (a) content of the text messages and (b) self-selection versus assignment of messages. The first hypothesis was that text message reminders would be feasible (≥ 80% recruitment rate) and acceptable to AYA in SU interventions. I also hypothesized that receiving SU-related messages would predict statistically significantly better results at the end of the intervention (e.g., higher levels of self-efficacy and lower relapse rates in the intervention groups relative to attention control) (Hypothesis 2) and at follow-up (four weeks after the end of the intervention) (Hypothesis 3). Lastly, I hypothesized that self-selection of message content would predict statistically significantly better results than non-self-selection (Hypothesis 4).

2.0.0 Method

2.1.0 Focus Groups for Message Development

Prior to implementing the randomized control trial (RCT), five hour-long focus groups were conducted in order to help the research team finalize study design and text message content. The focus groups occurred at treatment agencies using The Seven Challenges program in a major metropolitan city in Washington State. The Seven Challenges is a manualized evidence-based cognitive-behavioral/problem solving therapy that includes a focus on relapse prevention and was listed in SAMHSA's National Registry of Evidence Based Programs and Practices (until the list was removed by SAMHSA). It is currently implemented at over 400 sites around the country and was specifically developed to treat adolescents with SU problems to motivate a decision and

commitment to change, and help support successful implementation of desired changes. Youth were invited to share their opinions about the study and were asked about specific facets of the study including message content, message timing, message frequency, and other details related to participation. The information provided helped inform the final message list that was used in the study as well as other factors such as message delivery times.

2.2.0 Main Study

2.2.1 Participants and Recruitment

AYAs ages 13-22 were recruited with support from two SU treatment providers, (1) outpatient treatment centers located throughout the United States that use The Seven Challenges and (2) providers of brief motivational interventions (BMI) for substance use at a large west-coast university that used the Brief Alcohol Screening and Intervention for College Students (BASICS) framework. Recruitment methods were similar. Both used flyers (either printed or projected via PowerPoint) with study contact information for AYAs to contact the research team via the study website, social media, email, or phone number (call/text). Participants recruited from the BASICS intervention were invited to provide contact information if they preferred the research team contact them. Participants were screened for eligibility either over the phone or online.

2.2.2 Measures

Assessment occurred at four times, (1) when participants signed up for the study (baseline), (2) after receiving two weeks of the reminder text message intervention (two weeks after baseline; during), (3) after receiving the full four weeks of reminder text messages (two weeks after during; post-treatment), and (4) four weeks after the end of reminder text messages (four weeks after post; follow-up) (See Figure 1 for study flowchart). The during-assessment was

selected to occur halfway through the intervention to assess the acceptability of messages over time and assess the primary constructs of interest (self-efficacy level and relapse status). The post-assessment was selected to occur at the end of the text messaging intervention and the primary constructs of interest were assessed at this time. The follow-up assessment was selected to occur four weeks after the end of the intervention to measure the possible long-term effects of the intervention after it was no longer being used. The primary constructs of interest were assessed at each time point. All assessments were completed online.

Eligibility. Assessment of eligibility occurred either online or over the phone. Participants had to be between 13 and 22 years old, have their own SMS-capable cellphone, and have a stated commitment to SU behavior change (e.g., had decided to set limits or abstain entirely).

Commitment to Substance Use Behavior Change. The Thoughts about Abstinence Scale (TAAS; Hall, Havassy, & Wasserman, 1990) was used to assess participant commitment, motivation, and self-efficacy to substance use behavior change. The measure was adapted to ask about substance use limits in addition to abstinence. The TAAS is a brief, four-item self-report measure that is adapted from Marlatt, Curry, and Gordon's work on smoking cessation (1988). TAAS scores have been found to predict smoking cessation treatment outcomes (Hall et al., 1990; Hendricks, Wood, Baker, Delucchi, & Hall, 2011). TAAS was administered at all four time points.

Self-Efficacy. The Drug Avoidance Self-Efficacy Scale (DASES; Martin, Wilkinson, & Poulos, 1995) is a 16-item self-report measure developed to be applicable across a range of drugs. It has been found to be a valid and reliable measure of self-efficacy ($\alpha = 0.91$) and is positively associated with other measures of self-efficacy (Martin et al., 1995). It was administered at all four time points.

Substance Use. The Adolescent Drug Involvement Scale (ADIS; Moberg & Hahn, 1991) is a 13-item self-report measure that was used to assess substance use behavior and substance use urges. The ADIS was developed to be administered to anyone reading at an 8th grade reading level. It has acceptable internal consistency ($\alpha = 0.85$) and is highly correlated with self-reported drug use frequency ($r = 0.72$) and with independent rating by clinical staff ($r = 0.75$) (Moberg & Hahn, 1991). It was administered at all four time points.

Stages of Change. The Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES; Miller & Tonigan, 1996) is a 19-item self-report measure designed to assess motivation to change substance use behavior. The SOCRATES has three subscales (Ambivalence, Recognition, and Taking Steps) that are scored separately and display acceptable to excellent internal validity ($\alpha = 0.60 – 0.88$; $\alpha = 0.85 – 0.95$; $\alpha = 0.83 – 0.96$) and high test-retest reliability ($r = 0.83$; $r = 0.94$; $r = 0.93$) (Miller & Tonigan, 1996). The measure was administered at all four time points.

Motivation. The Change Questionnaire (Miller & Johnson, 2008) is a 12-item self-report measure of motivation for change that was selected to assess for motivation to change over time. Higher scores of motivation to change have been found to predict decreased risk for hazardous tobacco ($p = 0.046$) and alcohol ($p = 0.03$) use (Gaume, Bertholet, Daeppen, & Gmel, 2013). The measure was administered at all four time points.

Substance Use Consequences. The Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989) is a 23-item self-report measure used to assess problems due to drinking. The measure was designed for use with adolescents. The RAPI has high internal consistency ($\alpha = 0.92$) and a 3-year stability coefficient of 0.40 (White & Labouvie, 1989). A shorter, 18-item, version of the RAPI (S-RAPI; Earleywine, LaBrie, & Pedersen, 2008) has been found to

correlate highly with the original measure (r = 0.99). The Rutgers Marijuana Problem Index (RMPI; Johnson & White, 1995; Simons, Correia, Carey, & Borsari, 1998) is based on the RAPI and was developed to assess problems due to marijuana use. It was written in a way allowing it to be used to measure problems due to any drug. The S-RMPI (18-item version) was administered at all four time points.

Participant Feedback. Participant opinion toward the messages was measured twice (post and follow-up) using an open-ended question asking for their opinion about the messages. During, post-treatment, and follow-up assessments include closed-ended questions on a 5-point Likert scale asking participants about the frequency and duration of the messages. Participants also completed questions regarding perceived reminder effectiveness and support from the messages on a 7-point Likert scale.

2.2.3 Message Content

Mr. Schwebel, with the help of clinical leaders in various community counseling agencies, created an initial list of 100 intervention messages and 28 control messages. The content of each message was refined using youth feedback from five focus groups. The final list of 128 messages was selected with the help of Dr. Larimer. Each intervention message was classified as belonging to one of four content categories: supportive/empowering; threatening/consequential; commitment reminders; and educational. The entire message list is included in Appendix A. Sample messages include:

- "Think about your future. Your health matters."
- "Choose your friends wisely."
- "You are in control."
- "This decision is for a better life."

2.2.4 Design and Procedure

Due to the locations of participant referral sources being dispersed across the United States, recruitment primarily occurred online or over the phone. Participants recruited through agencies using The Seven Challenges program were approached by agency personnel who distributed flyers inviting participants to take part in the study. Participants recruited through BMIs were either approached by counselors with flyers or were shown a flyer on a PowerPoint slide. A waiver of written documentation of consent and a waiver of parental consent (for participants under the age of 18) was obtained from the University of Washington Institutional Review Board. This allowed the study to obtain participant assent/consent (henceforth described as consent) online. Participants completed basic demographic information after obtaining consent.

Participants were randomly assigned[1] to either (1) a group that received self-selected SU related preventive messages (self-selected); (2) a yoked-intervention group that do not self-select their messages, but receive the same SU related messages that were chosen by a counterpart in Group 1 (yoked-intervention); or (3) a control condition that received non-SU related, general health messages (control) (for more detail see Figure 2). Each participant was assigned or chose 28 messages to receive depending on the group to which they were randomly assigned. Participants received four messages per day for the first two weeks of the study (all 28 messages every seven days in random order). Participants received two messages per day for the final two weeks of the intervention portion of the study (all 28 messages every 14 days in random order). At the end of each day, participants were asked to rate their opinion of the supportiveness of the messages during the past day on a 1-5 scale. At the start of each day, participants were asked to reflect on how helpful they found the last message they received on a 1-5 scale. The response

[1] Due to needing messages from participants in Group 1 to yoke to participants in Group 2, individuals that signed up earlier in recruitment were more likely to be assigned to Group 1.

messages were used both as confirmation that the intervention messages were being received and to investigate at what point participants begin to experience message fatigue. Similar messages have been successfully implemented by researchers to verify participant message receipt (Cadigan, Martens, & Sher, 2015). Messages were sent using Twilio, a cloud-based messaging service that was integrated with DatStat Illume, a comprehensive secure survey software program frequently used within the Center for the Study of Health & Risk Behaviors (where the research project was housed). After all 28 intervention messages were sent, the message order was re-randomized. On weekdays when participants received four intervention messages per day, the messages were sent at 10 AM, 2 PM, 6 PM, and 10 PM within a +/- 30-minute interval (e.g., a random time between 9:30 AM and 10:30 AM). On weekends, the message delivery schedule was delayed one hour to meet focus group youth reported preference. When participants were receiving two intervention messages per day (i.e., the last two weeks of the intervention portion of the study), participants randomly received a message one of the first two message times (10 AM or 2 PM) and one of the second two message times (6 PM or 10 PM). Weekend messages were similarly delayed an hour when receiving two intervention messages per day.

Assessment occurred at four times (baseline, during, post, and follow-up; see Figure 1 for further detail on data collection timeline). The primary constructs of interest (level of self-efficacy and relapse status) were assessed at each time point. Additional assessments measured attitudes toward the amount and content of messages and attitudes toward SU behavior change. Survey length was piloted and the expected time to complete each survey ranged from 10 to 30 minutes. Participants were emailed and texted an invitation and reminders to complete study assessments. Additionally, they were informed of the deadline for response in order to be paid

for participation (to ensure participants completed measures within an appropriate time-frame). The measures were selected to be as simple to read as possible due to the possibility that some participants might have reading difficulties.

2.2.5 Compensation

Participants received a total of $40 in compensation for completing all study assessments. Payment value increased depending on time-enrolled in study ($5 for baseline, $7.50 for during, $12.50 for post, and $15 for follow-up assessments). Payments were made using electronic gift certificates.

2.3.0 Data Analysis

All analysis were conducted using SPSS, Version 21.0 statistical software (IBM Corp., 2012).

2.3.1 Descriptive Data Analysis

Frequency distributions, measures of central tendency, and variation were examined for all demographic and outcome variables.

2.3.2 Inferential Data Analysis

All outcomes were analyzed from an intent-to-treat perspective; data from all participants who enrolled in the study and were randomized to a condition were included, regardless of whether they initiated and continued treatment or only provided baseline data. Due to an unbalanced number of adolescents and young adults recruited to the study, analyses were conducted with and without the inclusion of adolescent participants in the sample to ensure that adolescent data did not change patterns observed among young adults. There was no substantial difference in estimates or pattern of results, and data utilizing the full sample is reported.

Generalized Estimating Equations (GEE; Liang & Zeger, 1986) were used to interpret data with binary data and other exponentially distributed response variables count outcomes (e.g., SU goal and negative SU consequences). GEE is an extension of the generalized linear model and can model outcomes with a variety of distributions. Binomial variables can be modeled using tests such as Repeated Measure Analysis of Variance (rmANOVA). However, rmANOVA excludes subjects who have missing observations at one or more time points which may bias results (e.g., participants with complete data may not represent a random sample of the target population) and decrease power due to attrition in sample size (Ma, Mazumdar, & Memtsoudis, 2012). GEE focus on average change over time and the impact of covariates on this change. GEE are better suited to account for missing data including all participants who have contributed at least one data point. In the current study, a GEE with a logit link was used to model the binary outcome of AYA SU behavior change goal. Due to the high rate of individuals meeting their substance use goals over time (88%; 126/143), data were entered to interpret the impact of predictors on rate of individuals *not* meeting their SU behavior change goal.

Distributions of count variables (non-negative integers) are often positively skewed when the mean is low, as is often the case when examining AYA SU behavior where there are many zeros (e.g., individuals who do not experience any negative consequences). It is recommended to use models that allow for alternative data distributions (e.g., the negative binomial model) as simple transformations of count variables make interpretation difficult and lead to poor model performance (Atkins, Baldwin, Zheng, Gallop, & Neighbors, 2013). In the current study, negative SU consequences were modeled using a negative binomial model rather than a Poisson distribution to account for over-dispersion of conditional variance relative to conditional mean among the outcome variable (Atkins et al., 2013). Regression coefficients from a negative

binomial model, similarly to the Poisson model, lie on a log scale so coefficients are raised to the base of *e* and are interpreted as an odds ratio (Atkins et al., 2013). Odds ratios above 1.0 indicate a percentage increase in the count outcome and odds ratios below 1.0 indicate a percentage decrease in the count outcome, while an odds ratio of 1.0 indicates no effect. GEE treats within-subject variance as an error, unlike multilevel models which do model within-subject variance.

Multi-level modeling (MLM) was used to interpret change over time for self-efficacy, motivation and readiness to change, and the impact of message content on SU behavior change. MLM was utilized to account for the longitudinally clustered nature of the data. That is, data from repeated measure observations, clustered within individuals over time (within-person, level 1) had the potential to confound comparisons of individuals assigned to the three conditions (between-person, level 2). Additionally, MLM allows for unequal spacing between observations and allows time to be treated as a continuous instead of discrete variable which can increase power for detecting growth effects (Muthén & Curran, 1997). MLM has several advantages over ordinary least squares regression (OLS); (1) MLM does not require independence of observations; rather, it allows for and models variability within and between individuals; and (2) MLM account for missing data using full maximum likelihood estimation and do not require listwise deletion of missing data; this allows for the inclusion of participants that have contributed at least one data point and have missing data.

The MLM and GEE models were built starting with the simplest model parameters (e.g., an empty model including only intercept and residual and excluding predictors) to the most complex (e.g., a fixed and random effect model). However, since some predictors are hypothesized (e.g., impact of treatment condition and time), they are always included as predictors. Otherwise, GEE model fit was compared using Quasi Likelihood under Independence

Model Criterion and MLM models were compared using Likelihood Ratio Test. The final models have been trimmed to best account for model fit and can been seen in Tables 6-21. Results can be interpreted as follows: significant effects of condition suggest that participants' score in one condition is significantly different from participants in the other condition(s); significant effects of time suggest that participants' scores changed significantly over time, independent of treatment condition; and a significant interaction between time and condition suggest participants' scores in one condition changed differently over time compared to participants in the other condition(s).

2.3.4 Covariance Structure

MLM requires specification of covariance structure that designates how repeated measures are related because it accounts for within-person correlation of repeated measures data. The covariance structure was determined analytically using Bayesian Information Criteria model fit indices (Schwarz, 1978). The unstructured components structure produced the best model fit for the MLM analysis and is generally considered to be the most flexible options, allowing every variance and covariance to be freely estimated from the data (Kwok et al., 2008). For the GEE, the exchangeable covariance matrix was chosen to account for the within-person correlation in the data.

2.3.5 Coding

Data were not centered but were coded to maximize interpretability of parameter estimates (Biesanz, Deeb-Sossa, Papadakis, Bollen, & Curran, 2004). Time was coded as 0 at baseline and then treated as a continuous variable in order to examine weekly patterns of change across the course of the study. For all outcomes other than SU behavior change goal, the intercept estimates are for the baseline assessment. Because SU behavior change goal is measured beginning at the

during assessment, the time variable is coded to account for changes as participants are further removed from intervention and the intercept estimate is for the during assessment.

Because time was not equal between data collection points, substance use and substance use urge measures variables were combined in order to compare rates of use across equal portions of time. That is, data for use from during and post assessments were merged in order to calculate use over a four-week period, the same length of time assessed for in the baseline and follow-up assessments.

2.3.6 Missing Data

Missing data can be interpreted one of three ways, (1) missing completely at random (MCAR), if the probability of a planned observation missing is independent of the observed or missing data values; (2) missing at random (MAR), if the probability of a planned observation missing depends on the observed data but not the missing data, or (3) missing not at random (MNAR), if the probability of a planned observation missing is correlated with both the observed and missing data (Schafer & Graham, 2002). Data for this study were considered to be MAR and are interpreted as "ignorable nonresponse" (Schafer & Graham, 2002). In longitudinal studies, it is typical to experience "wave nonresponse", a term describing individuals that complete some but not all planned observations (i.e., study attrition/dropout and participants that are absent for a planned observation(s) and then reappear) (Schafer & Graham, 2002). MLM is an appropriate and efficient way to model data when wave nonresponse occurs as it uses all available data for each participant instead of removing participants with missing data (Schafer & Graham, 2002).

3.0.0 Results

3.1.0 Sample Characteristics

Participants were 59 AYAs ages 13 to 22 (M = 18.47). A majority of participants identified as female (57.6%), non-Hispanic (91.5%), and White/Caucasian (72.9%). Most participants were YAs (81.4%). The most common SU behavior change goal was to cut back or set limits (71%). Complete baseline demographics are summarized in Table 1. The means and standard deviations of the continuous outcomes are listed in Table 2.

3.2.0 Randomization Check

Chi-square tests and one-way analysis of variance (ANOVA) were used to assess for differences between groups at baseline. A chi-squared test was performed to examine the relationship between treatment condition (control, self-selected, and yoked-intervention) and (1) gender and (2) baseline behavior change goal and (3) baseline lifetime substance use. There was no statistically significant difference between treatment conditions on (1) gender (χ^2 (2, N = 59) = 4.4 p = 0.11), (2) baseline SU behavior change goal (χ^2 (2, N = 59) = 2.26 p = 0.89 or (3) baseline lifetime substance use (tobacco: χ^2 (2, N = 59) = 1.74 p = 0.42; alcohol: unable to compute due to variable being constant (i.e., all participants reported past use); cannabis: χ^2 (2, N = 59) = 0.62 p = 0.73; cocaine: χ^2 (2, N = 59) = 0.41 p = 0.81; amphetamine type stimulants: χ^2 (2, N = 59) = 0.63 p = 0.73; inhalants: χ^2 (2, N = 59) = 0.002 p = 0.99; sedatives or sleeping pills: χ^2 (2, N = 59) = 3.6 p = 0.16; hallucinogens: χ^2 (2, N = 59) = 0.51 p = 0.77; opioids: χ^2 (2, N = 59) = 0.81 p = 0.67).

A one-way between-subjects ANOVA was used to examine the relationship between treatment condition and (1) baseline past month substance use and (2) baseline past month substance use urge, (3) baseline self-efficacy, (4) baseline motivation to change, (5) baseline recognition of need for change, (6) baseline level of ambivalence for change, (7) baseline level of readiness to change, and (8) baseline negative SU consequences. Due to lack of variability and

data points (e.g., substance use) on past month substance use outcomes, only alcohol and cannabis variables were analyzed. There was not a significant effect of treatment condition on (1) baseline past month substance use (alcohol: [$F(2, 56) = 0.34$, $p = 0.71$]; cannabis: [$F(2, 56) = 0.02$, $p = 0.99$), (2) baseline past month substance use urge (alcohol: [$F(2, 56) = 0.57$, $p = 0.57$]; cannabis: [$F(2, 56) = 0.40$, $p = 0.67$]), (3) baseline self-efficacy (DASES: [$F(2, 54) = 0.27$, $p = .97$]; TAAS-Self-Efficacy: [$F(2,56) = 1.22$, $p = 0.30$]), (4) baseline motivation to change (Change Questionnaire: [$F(2, 55) = 0.82$, $p = 0.44$]; TAAS-Motivation: [$F(2, 56) = 1.05$, $p = 0.36$]), (5) baseline recognition of need for change (SOCRATES-Recognition: [$F(2, 56) = 0.43$, $p = 0.65$]), (6) baseline level of ambivalence for change (SOCRATES-Ambivalence: [$F(2, 56) = 0.50$, $p = 0.61$]), (7) baseline level of readiness to change (SOCRATES-Taking Steps: [$F(2, 56) = 0.94$, $p = 0.40$]), and (8) baseline negative SU consequences (SRMPI: [$F(2, 56) = 0.36$, $p = 0.70$]). These results indicate the randomization protocol was successful.

3.3.0 Attrition

Participants that provided data at baseline and did not complete assessments at any additional time points were considered to have dropped out of the study. Out of 59 participants, 8 (13.6%) provided only baseline data; 51 participants completed at least two assessments (86.4%). Chi-square tests and independent *t*-tests were used to compare participants who did and did not drop out of the study on baseline demographics, condition assignment, SU behavior change goal, lifetime substance use, past month substance use, motivation to change, self-efficacy to change, stage of change, and negative SU consequences to assess for potential bias due to differential attrition (Table 3).

A Fisher's exact test (to account for violation of expected cell count assumption) revealed a statistically significant effect of race on participant dropout (χ^2 (5, $N = 59$) = 14.27 $p = 0.01$),

with non-white participants being more likely to drop-out. Additionally, a significantly greater proportion of participants who dropped out of the study had more SU consequences than those who remained in the study (t (59) = -2.5, p = 0.02). However, study drop-out did not vary by intervention condition (χ^2 (1, N = 59) = 0.05, p = 0.82).

3.4.0 Feasibility

Feasibility of the intervention was measured by the percentage of participants that met study inclusion criteria who then agreed to participate in the study and by assessing dropout rate. For both assessments of feasibility, an *a priori* hypothesis of greater than or equal to 80% was selected as feasibility criteria.

Due to the remote nature of recruitment, not all individuals referred to be assessed for study inclusion criteria (183) responded to study screening prompts (115 individuals responded). Ninety-three of 115 screened participants were determined to meet eligibility criteria. Of the eligible study participants, 63% (59/93) enrolled in the study, falling below the *a priori* feasibility criteria of 80% or greater. With respect to retention, 86% (51/59) of participants remained enrolled in the study as measured by completing at least one more assessment after baseline. This rate met the *a priori* hypothesis. Additionally, 85% (50/59) of participants completed at least one of the post-treatment or follow-up assessments and 63% (37/59) of participants completed all assessments.

3.5.0 Acceptability

Participants answered a battery of questions at post-treatment and follow-up to assess for perceived ways the messages were supportive, helpful, and otherwise liked or disliked. This information was used to further assess message acceptability. At post-treatment, participants

selected 349 “likes” and 234 “dislikes”. At follow-up, participants selected 335 “likes” and 201 “dislikes”. Participants were nearly 1.5 times more likely to report a like than dislike.

Participants were also asked to reflect on amount of messages received at both post-treatment and follow-up assessments. At post-treatment, 21.3% (10/47) of participants reported feeling they received “way too many messages,” 55.3% (26/47) of participants reported feeling they received “too many messages,” and 23.4% (11/47) of participants reported feeling they received the “right amount of messages.” At follow-up, 22.7% (10/44) of participants reported feeling they received “way too many messages,” 34.1% (15/44) of participants reported feeling they received “too many messages,” 34.1% (15/44) of participants reported feeling they received the “right amount of messages,” 2.3% (1/44) of participants reported feeling they received “too few” messages, and 6.8% (3/44) of participants reported feeling they received “way too few” messages.

Participants were invited to leave open-ended comments regarding opinion toward messages and the study in general. Specific responses can be seen in Appendix B. In general, most comments indicated a positive reaction toward the study.

Lastly, all participants were informed that sending a “stop” text message to the study would end study messages and withdraw participants from the study. No participants used the “stop” message option to withdraw from the study.

3.6.0 Baseline Relationship Between Variables

Bivariate correlations between baseline outcome variables were examined to understand the direction and magnitude of their relationships (Table 4). All significant correlations between variables were in the expected direction.

3.7.0 Message Content Selection

All participants selected what intervention messages they would prefer to receive. A one-way between-subjects ANOVA was used to assess for differences in message content preferences by treatment condition. There were no significant differences in message content preferences by treatment condition. Means and standard deviations for each condition and message type are listed in Table 5.

3.8.0 Longitudinal Outcomes

GEE and MLM models were created to predict the main outcomes of interest: SU behavior change, SU quantity, and SU behavior change self-efficacy (Tables 6-14). SU motivation to change, SU readiness to change, and negative SU consequences were also assessed using GEE and MLM models (Tables 15-20).

3.8.1 Impact of Intervention on SU Behavior Change

To examine the effect of time and condition on SU behavior change goal achievement, a GEE for binary data with logit link function was used (Table 6). Three GEE models were run at two time points, (1) post-treatment and (2) follow-up to compare (a) individual intervention condition (self-selected, yoked-intervention) against control, (b) pooled intervention condition (self-selected and yoked-intervention) against control, and (c) intervention conditions (self-selected against yoked-intervention). Due to participants reporting meeting their goal at a high rate (overall: 88% [126/143]; during: 87% [45/52]; post-treatment: 87% [41/47]; follow-up: 91% [40/44]), the models were run to assess the likelihood of not achieving self-identified behavior change goal.

All post-treatment models (1a, 1b, and 1c) did not reveal any statistically significant differences in not meeting SU behavior change goal. The model comparing individual intervention conditions against control using follow-up data (2a) revealed a significant linear

effect of time, odds ratio (OR) = 0.58, 95% CI [0.37, 0.91], which indicated a 42% decrease in failure to meet SU behavior change goal over time (e.g., using drugs beyond selected limit). There also was a significant interaction between self-selected intervention condition and time, OR = 1.98, CI [1.14, 3.44], which indicated a 98% increase in failure to meet SU behavior change goal over time in the self-selected condition relative to control. The model comparing the pooled intervention condition against control using follow-up data (2b) revealed a significant linear effect of time, OR = 0.58, 95% CI [0.37, 0.90], which indicated a 42% decrease in failure to meet SU behavior change goal over time. The pooled intervention by time interaction was statistically significant, OR = 1.76, 95% CI [1.09, 2.87], which indicated a 76% increase in failure to meet SU behavior change goal over time in intervention conditions (self-selected and yoked-intervention) relative to control. The model comparing the self-selected message condition against the yoked-intervention condition using follow-up data (2c) revealed a significant effect of intercept (OR = 0.19, 95% CI [0.06, 0.61]) and did not reveal any additional statistically significant differences between outcomes for intervention conditions on not meeting SU behavior change goal.

3.8.2 Impact of Intervention on Substance Use and Substance Use Urge

The ADIS substance use frequency and substance use urge measures were used to assess for SU (measured in number of days and number of times) and SU urge (number of days experiencing an urge to use). Due to data overdispersion, GEE models with negative binomial log link distributions were run at two time-points, (1) post-treatment and (2) follow-up to compare the effects of individual intervention condition (self-selected, yoked-intervention) against control (ADIS Substance Use Days, Tables 7 [Alcohol], 8 [Cannabis]; ADIS Substance

Use Episodes, Tables 9 [Alcohol], 10 [Cannabis]; ADIS Substance Use Urge Days, Table 11 [Alcohol], 12 [Cannabis]).

The model for total days of alcohol use at follow-up (Table 7-2), revealed a significant linear effect of time, independent of condition, (OR = 0.78, 95% CI [0.69, 0.88]) indicating that reported days of alcohol use decreased by 11% over time. However, relative to baseline, all conditions experienced a decrease in total days of alcohol use over time.

The model for total days of cannabis at post-treatment (Table 8-1), revealed a significant linear effect of time, independent of condition, (OR = 0.76, 95% CI [0.60, 0.96]) indicating that reported days of cannabis use decreased by 24% over time. Additionally, there was a significant interaction between yoked-intervention condition and time (OR = 1.30, 95% CI [1.00, 1.69]), indicating that participants in the yoked-intervention condition were 30% more likely to report increased days of cannabis use relative to control at over time. The model for total days of cannabis use at follow-up (Table 8-2), revealed a significant linear effect of time, independent of condition, (OR = 0.80, 95% CI [0.70, 0.90]), indicating that reported days of cannabis use decreased by 20% over time. Additionally, there was a significant interaction between yoked-intervention condition and time (OR = 1.16, 95% CI [1.01, 1.34]), indicating that participants in the yoked-intervention condition were 16% more likely to report increased days of cannabis use relative to control condition over time. However, relative to baseline, all conditions experienced a decrease in days of cannabis use over time.

The model for total episodes of alcohol use at follow-up (Table 9-2), revealed a significant linear effect of time, independent of condition, (OR = 0.74, 95% CI [0.63, 0.87]) indicating that reported episodes of cannabis use decreased by 26% over time. Additionally, there was a significant interaction between self-selected intervention condition and time (OR = 1.31, 95% CI

[1.11, 1.56]), indicating that participants in the self-selected condition were 31% more likely to report increased episodes of alcohol use relative to control condition over time. Relative to baseline, all conditions experienced a decrease in episodes of alcohol use over time.

The model for total episodes of cannabis use at follow-up (Table 10-2), revealed a significant linear effect of time, independent of condition (OR = 0.81, 95% CI [0.75, 0.88]), indicating that reported episodes of marijuana use decreased by 19% over time. Additionally, there was a significant interaction between self-selected intervention condition and time (OR = 1.15, 95% CI [1.06, 1.26]), indicating that participants in the self-selected condition were 15% more likely than control group participants to report increased episodes of cannabis over time. Relative to baseline, all conditions experienced a decrease in episodes of alcohol use over time.

The model for total days with at least one urge to use alcohol at follow-up (Table 11-2) revealed a significant linear effect of time, independent of condition (OR = 0.81, 95% CI [0.75, 0.88]), indicating that reported urges decreased by 19% over time. Additionally, there were significant interaction effects of both intervention conditions (self-selected (OR = 1.15, 95% CI [1.05, 1.26]) and yoked-intervention (OR = 1.12, 95% CI [1.03, 1.23])) and time. These results indicate that participants in the self-selected and yoked-intervention conditions were 15% and 12%, respectively, more likely to report increase in urges relative to control over time at follow-up. However, relative to baseline, all conditions experienced a decrease in urges to use alcohol over time.

The model for total days with at least one urge to use cannabis at follow-up (Table 12-2) revealed a significant linear effect of time, independent of condition (OR = 0.80, 95% CI [0.74, 0.86]), indicating that reported urges decreased by 20% over time. Additionally, there were significant interaction effects of both intervention conditions (self-selected (OR = 1.19, 95% CI

[1.07, 1.32]) and yoked-intervention (OR = 1.20, 95% CI [1.08, 1.33])) and time. These results indicate that participants in the self-selected and yoked-intervention conditions were 19% and 20%, respectively, more likely to report increase in urges relative to control over time. However, relative to baseline, all condition experienced a decrease in urge to use cannabis over time.

3.8.3 Impact of Intervention on Self-Efficacy

The study used two measures to assess individual self-efficacy to make a SU behavior change. MLM models were run at two time-points, (1) post-treatment and (2) follow-up to compare the effects of (a) pooled intervention condition (self and yoked) against control, (b) self-selected message condition against control, (c) yoked-intervention condition against control, and (d) self-selected message against yoked-intervention for both the DASES (Table 13) and TAAS self-efficacy measure (Table 14). High scores on the DASES and TAAS indicate higher levels of self-efficacy.

All post-treatment DASES models (1a, 1b, 1c, and 1d) revealed a significant fixed effect of time ($p< 0.001$). This indicates that in all four comparisons, time was a significant predictor in increasing self-efficacy. For every one-week interval since baseline there was an increase in participants' rating of self-efficacy of 3.40, 3.39, 3.41, and 2.70 points in models (1a), (1b), (1c), and (1d) respectively. All post-treatment DASES models (1a, 1b, 1c, and 1d) also had a significant random effect of intercept. This indicates that participants experience individual differences in intercept but that this does not vary by condition. None of the follow-up DASES models (2a, 2b, 2c, and 2d) revealed any statistically significant fixed effect predictors. All follow-up DASES models revealed a significant effect of random intercept indicating that intercept varied between participants but not by condition.

None of the post-test or follow-up TAAS-Self-Efficacy models (1a, 1b, 1c, 1d, 2a, 2b, 2c, and 2d) revealed any statistically significant fixed effect predictors. At post-test, the model comparing yoked-intervention condition against control revealed a significant random intercept, indicating that participants reported individual differences in intercept but not by condition. At follow-up, the models comparing pooled intervention condition against control and yoked-intervention condition against control both revealed a significant random intercept effect. This indicates that participants reported individual differences in intercept, but this did not vary by condition.

3.8.4 Impact of Intervention on Negative Substance Use Consequences

A GEE with negative binomial log link distribution (due to overdispersion of data) was used to examine the effect of time and condition on negative SU consequences (Table 15). GEE models were run at two time-points, (1) post-treatment and (2) follow-up to compare (a) individual intervention conditions (self-selected, yoked-intervention) against control and (b) intervention conditions (self-selected against yoked-intervention). Higher scores indicate increased experience of negative substance use consequences.

The model comparing self-selected intervention condition against yoked-intervention condition at post-treatment (1b) revealed an additional significant linear effect of time, independent of condition (OR = 0.79, 95% CI [0.71, 0.88]), indicating that negative SU consequences decreased by 21% over time. The model comparing individual intervention conditions against control at follow-up (2a) revealed an additional significant interaction between self-selected intervention condition and time (OR = 0.84, 95% CI [0.76, 0.92]), indicating that participants in the self-selected condition reported decreased negative SU consequences (by 16%) relative to control. The model comparing self-selected intervention

condition against yoked-intervention condition at follow-up (2b) revealed a significant linear effect of time, independent of condition (OR = 0.86, 95% CI [0.79, 0.94]), indicating that negative SU consequences decreased by 14% over time.

3.8.5 Impact of Intervention on Motivation and Readiness to Change

The Change Questionnaire and TAAS were used to assess motivation to change SU behavior. The SOCRATES has three subscales (ambivalence, taking steps, recognition) and was used to assess readiness to change SU behavior. MLM models were run at two time-points, (1) post-treatment and (2) follow-up to compare the effects of (a) pooled intervention condition (self and yoked) against control and (b) self-selected messages against yoked-intervention for both measures (Change Questionnaire, Table 16; TAAS, Table 17; SOCRATES, Tables 18, 19, 20). Higher scores on the Change Questionnaire and TAAS indicate increased motivation to change. Higher scores on SOCRATES subscales indicate increases in subscale target behavior.

None of the Change Questionnaire models (1a, 1b, 2a, and 2b) revealed a statistically significant effect other than a significant random effect of intercept ($p < 0.001$).

The TAAS-Motivation Scale models comparing pooled intervention condition against control and self-selected message condition against yoked-intervention condition revealed a significant random intercept, indicating that participants reported individual differences in intercept but did not vary by condition. At follow-up the model comparing pooled intervention condition against control revealed a significant random intercept, indicating that participants reported individual differences in intercept but did not vary by condition. The model comparing self-selected messages against yoked-intervention at follow-up (2b) revealed a significant interaction between self-selected message condition and time (95% CI [-0.38, -0.03]), indicating that participants in the self-selected condition rating of motivation to change decreased by 0.21

points relative to yoked-intervention condition over time. This is difficult to interpret. It may be that the messages prompted participants to have decreased motivation to change over time. It also is possible that these participants may have already made changes to their behavior and had less motivation to change as a result.

All SOCRATES-Ambivalence, SOCRATES-Taking Steps, and SOCRATES-Recognition Subscale models revealed a statistically significant fixed and random effect of intercept ($p < 0.001$). The SOCRATES-Recognition subscale model comparing pooled intervention condition against control at follow-up (2a) revealed a significant intervention (self-selected and yoked-intervention) by time interaction, 95% CI [-0.72, -0.02], indicating that participants in the intervention condition reported decreased recognition of need for SU behavior change relative to control over time. Relative to baseline, all conditions reported increased recognition over time.

3.9.0 Post-hoc Analysis

Given the pilot nature of this RCT, a number of additional outcomes were investigated that had no *a priori* hypotheses but still offer important information regarding the utility of text messages as an adjunct to treatment.

3.9.1 Impact of Message Type on Substance Use Behavior Change

Total quantity of each message type (e.g., educational, supportive, reminder, threat) received by participants in the intervention conditions (self-selected and yoked-intervention) were entered into a MLM to assess for the impact of each message relative to reminder messages in changing SU behavior (Table 21). None of the predictors were statistically significant.

3.9.2 "Remindfulness" of Messages

Participants were asked multiple questions to further understand what benefits message may offer including (1) how helpful they found the messages as a reminder of their SU behavior

change goals and (2) how supportive the messages felt. Responses were made on a 1-7 Likert scale. Means across conditions and times are reported in Table 22. Overall, means across conditions ranged from a slight reminder to a moderately strong reminder. The highest perceived mean "remindfulness" was observed in the yoked-intervention condition and the lowest perceived mean "remindfulness" was observed in the control condition. Mean perceived "remindfulness" of self-selected messages was higher than the control messages at all four measurements.

3.9.3 Message Content Preference

At baseline, all participants were asked to select the 28 messages they would most like to receive. Totals, within group rank, and overall rank at baseline are reported in Appendix A. At post-treatment, participants were asked to rate their three favorite messages. Totals are also reported in Appendix A. The most frequently selected message content category was supportive-empowering messages (M = 8.80, S.D. = 2.98) followed by commitment reminder messages (M = 7.41, S.D. = 2.37), educational messages (M = 6.27, S.D. = 2.32), and threatening/consequential messages (M = 5.52, S.D. = 2.87). The most frequently selected message ("Live smart. Think of the future.") was classified as an educational message followed by four supportive/empowering messages ("You're stronger than you think."). The most frequently selected commitment reminder message ("This decision is for a better life.") was the sixth most frequently selected and the most frequently selected threatening/consequential message ("Choose your friends wisely.") was the 17th most frequently selected message.

At post-treatment, all participants were asked to identify their three favorite messages received. The most frequently selected messages were supportive/empowering messages (M = 1.00, S.D. = 0.98) followed by commitment reminders (M = 0. 58, S.D. = 0.73), control

messages (M = 0. 58, S.D. = 1.10), threatening/consequential messages (M = 0. 56, S.D. = 0.83), and educational messages (M = 0.28, S.D. = 0.50). The most popular message (selected eight times) was a supportive/empowering message ("You are in control."), as were the following five most popular messages. The most popular commitment reminder ("You decided. You can do it.") and threatening/consequential message ("Choose your friends wisely.") was the tied for 7th (three selected). The most popular educational ("Got an urge? Try to distract yourself with something else.") and control message ("Creating a list of goals can help you stay focused on your task.") was tied for 13th (two selected).

The control messages were most popular among control group participants (M = 1.69, S.D. = 1.44) and virtually unselected by self-selected condition (M = 0.07, S.D. = 0.27) and yoked-intervention condition participants (M = 0.07, S.D. = 0.26).

3.9.4 Message Frequency Preferences

At all time-points, participants were asked to report preferences for message frequency (e.g., how many messages per day) and quantity (e.g., how many weeks of messaging) (Table 23). At baseline, during, and follow-up assessments, participants most commonly reported preferring to receive one message per day. At post-treatment, participants most commonly reported a preference to receive two messages per day. At baseline, during and post-treatment participants most commonly reported a preference to receive messages for four weeks and at follow-up they most commonly selected two weeks. Participants were also asked an open-ended question regarding their preference for timing of receipt of messages during the week and on the weekend. Responses can be seen in Appendix C.

3.9.5 Preferred Message Content

Participants were offered the opportunity to provide feedback regarding specific messages or general message content they would have liked to have received. Responses can be seen in Appendix D.

4.0.0 Discussion

This study investigated the feasibility, acceptability, and effectiveness of a four-week text messaging intervention as an adjunct to interventions for adolescents and young adults (AYAs) who are attempting to change their substance use (SU) behavior. This is the first study to investigate the use of adjunctive text message reminders to supplement SU behavior change treatment and utilized a randomized controlled design.

Two primary hypotheses were tested, (1) implementing the text messaging adjunct to treatment would be feasible and AYAs would find the messaging to be acceptable and (2) participants assigned to text messaging adjunct to intervention conditions (i.e., self-selected and yoked-intervention) would experience significantly greater reductions in SU and in not meeting SU behavior change goal and significantly greater increases in self-efficacy relative to control. Due to the pilot nature of this RCT, further investigation into participant preference regarding message content, timing, and other factors were investigated to help inform future research.

4.1.0 Feasibility of Text Messaging Adjunct to Treatment

Study feasibility was assessed using participant-level variables, including recruitment into the study and dropout rates. Sixty-three percent of eligible participants were enrolled in the study, falling below the *a priori* hypothesis of 80% or greater enrollment rate. Overall, the study had mixed findings on feasibility.

There are various possible explanations for the lower-than-anticipated recruitment rates. In general, study recruitment was more challenging than expected. Despite having more than 10

letters of support from adolescent SU treatment agencies using The Seven Challenges program, only 11 participants were able to be recruited from this group. Due to the remote nature of adolescent recruitment (over 90% of agencies were located outside of Washington State) and reliance on treatment agencies and providers to disseminate study information, it is possible that many eligible adolescents were not informed or not fully-informed about the study. Repeated attempts were made to offer agencies and treatment providers recruitment training sessions with Mr. Schwebel, in addition to having recruitment information printed and mailed to them. Only one agency agreed to this opportunity (notably, this agency enrolled the most adolescents, 3). Due to difficulty recruiting adolescents, the study was expanded to include young adults. Young adult recruitment was considerably more successful. Young adult recruiters requested and received individual recruitment training sessions with the author and availed themselves of the opportunity to ask questions and provide feedback about the recruitment process. They also confirmed the use of flyers (or a flyer PowerPoint slide) for recruitment and requested more materials as needed.

Another possible explanation is that randomization into treatment conditions may have been unacceptable to participants. It is also possible that participants were reluctant to take part in a study focused on supporting SU behavior change. Participants may have felt embarrassed to receive information about the study in front of peers as it could imply that they 'need more help.' Similarly, interest in the study might indicate that they are interested in changing their SU behavior which could be incongruent with their behavior otherwise.

While the study assessments took approximately 90 minutes to complete in total, it is possible that the amount of assessments (four) was daunting. Additionally, the length of the study might have been considered to be unacceptably long (eight weeks total). It also is possible

that the financial incentive to continue completing assessments was insufficient ($40 for completing all assessments). However, given the low rate of dropout (14%), it seems less likely that these were major barriers to participation.

Finally, efforts to recruit participants may have been insufficient. Incomplete or inaccurate recruitment information (e.g., only email or only phone number) limited the methods that were possible for recruitment. The study recruitment contact efforts (up to seven contacts with complete information) are similar to other studies offering similar opportunities to AYAs but well below the amount of contact seen as necessary and sufficient in business marketing efforts (16; Zech, personal communication, January 17, 2019).

While it seems likely that complete and accurate contact information as well as increased frequency of recruitment contacts might have improved study recruitment, the greatest difficulty in recruitment occurred with adolescent SU treatment agencies. It seems likely that a more robust training and follow-up recruitment requirement (e.g., direct training from study staff, designated check-ins to ensure that recruitment is occurring in a complete and accurate manner, and assessing frequency of additional flyers requests) may be required when working with remote recruiters. When working with local recruiters that received training from study staff, the rate at which individuals were recruited for screening was considerably higher. However, it also might be that adolescents in SU treatment had more severe SU problems than YAs which may have made them less interested in the study. Future interventions likely should include more robust efforts at contacting participants in various ways including email, text messaging, and phone calls. Given the increased demands on attention it is increasingly important to maintain visibility among other marketing efforts and to work to distinguish research studies from traditional marketing attempts.

4.2.0 Acceptability of Text Messaging Adjunct to Treatment

Acceptability of text messaging was assessed via self-report and participant dropout. A substantially higher proportion of messaging likes than dislikes were reported by participants (1.5 times more "likes" than "dislikes"). This suggests that overall, the messages were satisfactory and helpful for participants. However, a majority of participants felt that they received too many messages and for too long at both post-treatment (76.6% reported "too many" or "way too many messages") and follow-up (56.8% reported "too many" or "way too many messages"). The most frequently selected preferred amount of messages per day was two and the most frequently selected preferred length of messaging was two weeks. Despite this, the study dropout rate (as assessed by not completing any assessments after baseline) was 14%, meeting the *a priori* hypothesis of less than or equal to 20%. In addition to that, it is notable that despite being informed of a stop-messaging option (e.g., to send a message saying "Stop" to end messages), no participant chose to withdraw from the study in this way. This suggests that the messages were less burdensome (or more easily ignored) than replying "stop" to end messaging. This is important given a common barrier to participant engagement with technology-based treatments is requiring participants to download an application. Application downloading is completed at less-than-ideal rates and possible reasons for this include lack of motivation, knowledge (e.g., not knowing how to download the application), or ability (e.g., not having a smartphone) to interact with the technology (Berry, Bucci, & Lobban, 2017; Bucci, Schwannauer, & Berry, 2019; Lord, Moore, Ramsey, Dinauer, & Johnson, 2016; Ramsey, Lord, Torrey, Marsch, & Lardiere, 2016). This study utilized the approach of having study staff enter participant contact information into the text messaging program. This was done to ensure that all enrolled participants received study text messages in order to remove any additional participant

burden to receiving intervention content. This strategy may be effective for other studies to implement as a strategy to help increase rates of participant engagement with technology-based treatments. Additionally, the low dropout rate witnessed in this study is notable given the high rates (30% prior to one month and 50% or more prior to three months) typically experienced in outpatient substance use treatment (Palmer, Murphy, Piselli, & Ball, 2009). However, given the high rate of young adult participants, the severity of participant SU was likely lower than is typically seen in an outpatient SU treatment setting.

It is important to note that a greater proportion of study completers were white compared to non-completers and there was a statistically significant difference in race of completers as compared to non-completers. Due to the study's small sample size (only 8 participants dropped out) and the fact that we did not have *a priori* hypotheses regarding race/ethnicity, it is difficult to interpret whether differential drop-out based on race is attributable to issues with the intervention or the study design or some third-variable explanation. However, it is important to consider this for any future studies as it may be that the content of the messages, the delivery method, or some other factor is not relevant or comfortable for people of color.

Additionally, there was a statistically significant greater likelihood of experiencing negative consequences due to SU at baseline among dropout participants relative to participants who remained in the study (although there was no difference across intervention conditions). This suggests that the intervention may not be an effective way to reach participants with a higher frequency of negative SU outcomes.

Despite the fact that likely too many messages were sent for too long, it appears that the text messaging adjunct to treatment was still fairly well accepted. Appendix B includes all participant open-ended responses regarding opinion toward the messages and the study in

general. A majority of the messages appeared to take a positive perspective on the study. Additional work is needed to understand if different messages would be more appropriate for individuals with different racial backgrounds as well as if this intervention is appropriate for individuals reporting a higher frequency of negative SU outcomes.

4.3.0 Text Messaging Adjunct to Treatment—Primary Outcomes

The second research question investigated relapse rates (operationalized as failures to maintain the goal of abstinence or reduced use), substance use, and self-efficacy levels across text messaging conditions. It was hypothesized that relapse rates and substance use at post-treatment and follow-up would be decreased and self-efficacy would be increased in the self-selected and yoked-intervention conditions relative to the control condition and that the self-selected condition would experience greater improvements than the yoked-intervention condition in these outcomes. These hypotheses were not supported.

4.3.1 Substance Use Goal Outcomes

Across all time points, a high rate of participants (88%; 126/143) reported meeting their SU behavior change goal. At the during assessment, 87% (45/52) of participants reported meeting their goal. 87% (41/47) and 91% (40/44) reported meeting their SU behavior change goal at post-treatment and follow-up, respectively. There were no statistically significant differences between messaging conditions or time on not meeting SU behavior change goal at post-treatment, relative to baseline.

At follow-up, there was a statistically significant effect of time but not condition indicating that participants, independent of condition, were 42% less likely to fail to meet SU behavior change goal over time. There was a statistically significant interaction between self-selected message condition and time indicating that these participants were 98% more likely to not meet

their SU behavior change goal over time relative to control condition at follow-up. There were no statistically significant differences between self-selected and yoked-intervention condition. These results indicate that overall, participants regardless of condition were statistically significantly less likely to fail to meet their substance use behavior change goal over time—that is, the risk of relapse reduced over time for participants across condition. The interaction effect indicates the self-selected condition participants were more likely than control group participants to not meet their substance use goal over time at follow-up, contrary to the hypothesis. It is notable that this pattern of result was not seen at post-test. This suggests that the low response rate of self-selected participants at follow-up may have played some role in the result (Table 2).

4.3.2 Substance Use Outcomes

There was a statistically significant effect of time, independent of condition, at follow-up, on the number of self-reported days of alcohol use (11% decrease), number of self-reported drinking episodes (26% decrease), and self-reported days of experiencing urges to drink (19% decrease). There was a statistically significant interaction between self-selected intervention condition and time at follow-up. This indicates that participants in the self-selected condition were 31% more likely to report increased drinking episodes relative to control condition over time. However, relative to baseline, both groups exhibited decreases in drinking episodes. There also was a statistically significant interaction between self-selected condition and time and yoked-intervention condition and time indicating that participants in these conditions were 15% and 12%, respectively, more likely to report increased urges to drink relative to control condition over time at follow-up. Again, the drinking rates were higher than control and lower than baseline measures of drinking. These results indicate that overall, regardless of condition, participants reported less drinking and urges to drink over the follow-up period, however the

significant interaction effects indicated that both self-selected and yoked-intervention conditions were less successful at decreasing urges to drink relative to control at follow-up.

Results for cannabis use outcomes were similar to alcohol use outcomes. Specifically, there was a significant effect of time, independent of condition, on self-reported days of cannabis use at post-treatment and follow-up, indicating participants overall were 24% and 20%, respectively, less likely to report days of cannabis use over time. There also was a significant interaction between self-selected condition and time on days of cannabis use at post-treatment and follow-up, indicating that participants in the yoked-intervention condition were respectively, 30% and 16% more likely than control group participants to report increased days of cannabis use over time. While yoked-intervention participants reported increased use relative to control, all conditions experienced decreased days of cannabis use relative to baseline.

There was a statistically significant effect of time, independent of condition, at follow-up, on the number of self-reported marijuana use episodes (19% decrease), and self-reported days of experiencing urges to use marijuana (20% decrease). This effect was qualified by a significant interaction between self-selected condition and time on self-reported episodes of cannabis use at follow-up, indicating that participants in the self-selected condition were 15% more likely than control group participants to report episodes of cannabis over time. This pattern was again similar with respect to urges to use cannabis at follow-up, with significant interaction effects for both self-selected and yoked-intervention conditions by time indicating participants in these conditions were 19% and 20%, respectively, more likely to report urges to use cannabis relative to control over time. Relative to baseline, all conditions experienced decreased episodes and urges to use cannabis.

These results indicate that at post-treatment, all participants experienced decreased days of cannabis use. Similarly, at follow-up, all participants experienced decreased cannabis use days, episodes, and urges. Participants in the control condition generally reported fewer days, episodes, and urges to use cannabis relative to intervention conditions. However, all participants experienced decreased cannabis use days, episodes, and urges relative to baseline.

4.3.3 Self-Efficacy Outcomes

There was a statistically significant effect of time, independent of condition, on level of self-efficacy in all DASES models. This indicated that participant self-reported rating of self-efficacy increased anywhere from 2.70 to 3.41 points per week at post-treatment, a modest improvement. There were no significant predictors of self-efficacy at follow-up aside from fixed and random intercept which means that self-efficacy levels vary by individuals but not by condition. This indicates that the treatment effects did not last at four-week follow-up.

4.3.4 Primary Outcomes Review

While none of the results matched the initially hypothesized outcomes in terms of statistical significance, participants, regardless of condition, experienced improved outcomes over time (e.g., 88% achievement of SU behavior change goal and increases in self-efficacy across all time points; during: 87% [45/52]; post-treatment: 87% [41/47]; follow-up: 91% [40/44]). Overall, the vast majority of outcomes provided unexpected results, indicating that participants in the control condition experienced the best outcomes. There are a number of reasons why the self-selected and yoked-intervention conditions might not have had the hypothesized effect on SU behavior change, overall SU, and self-efficacy levels.

First, participants that enrolled earlier in the study were more likely to be assigned to the self-selected condition as the messages they selected were needed to send to participants in the

yoked-intervention condition. Early recruitment only included adolescents. They were slightly less likely to complete follow-up measures than young adult participants. While this decreased completion rate did not impact the direction or pattern of results, it is notable that only 12 self-selected condition participants completed follow-up, compared to 15 control and 17 yoked-intervention condition participants. Given the size of the sample and the amount of the results run it is possible that there was some alpha-inflation (although using a parsimonious model building approach to analyses should help control for this) and the observed results may not be stable.

Second, the interventions the messages were intended to serve as an adjunct to may have been so robust that the messages did not exhibit significant improvements across conditions. Both The Seven Challenges Program (e.g., Stevens, Schwebel, & Ruiz, 2007) and Brief Motivational Interventions (e.g., Schwebel et al., 2018) have moderate to strong evidence supporting their efficacy in alcohol and other drug use behavior change. Due to the fact that overall, participants exhibited reductions in SU over time, decreased rates of not meeting SU behavior change goal, and a statistically significant increase in self-efficacy over time this data might suggest the messages did not provide much additional support beyond the initial treatment effects. However, it is notable that the dropout rate (13.6%) was considerably lower than typical SUD treatment dropout rates and that the rate of not meeting SU behavior change goal (12%) is significantly lower than typical SU relapse rates (estimated 40-60%).

Third, the messages selected for use in the study may not have been optimal and participants may not have selected the best messages for themselves. That is, participants who received self-selected messages may have been presented with a less than optimal message list to choose from, and, individuals may not be readily able to identify the messages that are most

likely to support their SU behavior change goal. Additionally, it is possible that the control messages were not dissimilar enough from intervention messages to find differences between groups. Despite spending considerable time developing message content, the general health text messages sent to the control group talk about maintaining a healthy lifestyle. This content is designed to increase motivation to lead a healthy lifestyle, which may overlap with an individual's motivation to change their SU behavior (e.g., they may want to decrease SU in order to lead a healthier lifestyle). This suggests the control message content likely has some overlap or relation to the SU-related behavior change messages sent to self-selected and yoked-intervention group conditions. Thus, reading message content related to general health promotion may still prompt recipients to consider what impact SU has on their health.

Lastly, it may simply be that a text messaging adjunct to treatment is not beneficial to changing SU behavior. Overall, improvements independent of condition in outcomes (e.g., increased self-efficacy, high rate of meeting SU behavior change goal, decreased SU frequency, episodes, and urges) were found and the control group most frequently experienced the strongest results. While the small sample size may lead to instability of results it appears that control messages outperformed intervention messages. It may be that the results are more easily attributed to regression to the mean, however, a lack of no-treatment control makes this comparison impossible to investigate within the content of this study. It also may be that the control messages reminded participants of their underlying motivation to change (e.g., to lead a healthier life) without reference to substance use. Regardless, overall feedback regarding the messages was positive. It is probable that too many messages were sent for too long and at less than optimal times, yet participants still reported more positive than negative opinions toward the messages and the study. These findings are quite similar to those found in a recently published

study investigating the use of text messages to deliver normative feedback to college student drinkers. They found their study was underpowered to identify between group differences in outcomes, but that messages were generally well-received and that the intervention was considered to be feasible and acceptable by participants (Merrill et al., 2018).

4.4.0 Text Messaging Adjunct to Treatment—Secondary Outcomes

Due to the pilot nature of the study various secondary outcomes of interest related to behavior change were investigated including negative SU consequences and motivation and readiness to change. The same hypotheses used for the primary outcomes were applied but given the small sample size, all results should be interpreted cautiously (given the exploratory nature of these results, the same recommendation would have applied even if target sample size had been obtained). Additionally, there is limited research on basic information regarding the use of text messages in supporting SU behavior change interventions. Relevant information such as preferred frequency, quantity, timing, and content of messages is reviewed as well.

4.4.1 Negative Substance Use Consequences

There was a significant effect of time, independent of condition, at post-treatment and follow-up, in the self-selected and yoked-intervention comparison models. Results indicated negative SU consequences decreased by 21% and 14%, respectively, over time. There was a significant interaction between self-selected condition and time at follow-up; indicating that participants were 16% less likely to experience negative SU consequences in the self-selected condition relative to control over time.

Overall, these results indicate that participants in the intervention conditions experience fewer negative SU consequences over time and this result is found both at post-treatment and remains after four-week follow-up. Additionally, the significant interaction indicates that

participants in the self-selected message condition appeared to predict better outcomes (e.g., fewer negative SU consequences) relative to yoked-intervention condition. This supports our *a priori* hypothesis that participants receiving intervention messages will report better outcomes than control. Additionally, the hypothesized relationship between self-selected and non-self-selected messages was supported.

4.4.2 Motivation and Readiness to Change

There was a significant interaction at follow-up between self-selected message condition and time indicating that participants' motivation rating on the TAAS in the self-selected condition decreased by 0.21 points relative to yoked-intervention condition over time at follow-up. There was a significant pooled intervention by time interaction at follow-up, indicating that participants in the intervention conditions reported decreased recognition of need for SU behavior change over time.

Overall, these results indicate that participants in the self-selected condition were significantly less likely than those in the yoked-intervention condition to report increased motivation to change SU behavior at follow-up. This result does not support the *a* priori hypothesis that participants receiving self-selected messages will report better outcomes than participants receiving non-self-selected messages. The recognition of need for SU behavior change results indicate that participants in the control condition reported a higher need for change relative to participants in the self-selected and yoked-intervention conditions. This data is slightly more difficult to interpret. Decreased recognition may be attributed to decreased awareness of a problem (e.g., less mindful of a problem behavior). This would imply that the intervention messages might have decreased participant awareness of need for SU behavior change. Decreased recognition could also be attributed to a decreased existence of a problem

(e.g., if there no longer is a problem, there is nothing to be aware of). This would imply that participants in the intervention condition might have decreased awareness of need for SU change due to no longer needing to change this problem behavior. It is possible that the control messages both helped participants meet their SU behavior change goal and increase their awareness that they have a behavior that they still wish to modify (e.g., they may be continuing to set and meet more restrictive use limits).

4.4.3 Message Selection Preference

At baseline, all participants selected the 28 messages they would like to receive. The most frequently selected message content category was supportive/empowering messages, followed by commitment reminder messages, educational messages, and threatening/consequential messages. The most popular message was an educational message but it also was randomly selected to be the first message displayed. Supportive/empowering messages comprised four of the five most commonly selected messages. The most popular commitment reminder message was the sixth most popular overall, and the most popular threatening/consequential message was the 17th most popular overall. It appears that education and supportive/empowering messages were the most commonly selected messages at baseline while threatening/consequential messages were the least commonly selected at baseline. However, the threatening/consequential messages had the second largest variability in selection. This is similar to the pattern of reactions expressed by individuals in focus groups when discussing threatening messages. Typically, a minority of participants indicated a strong preference for threatening/consequential messages while another small group of participants reported a strong dislike of these messages.

At post-treatment, all participants were asked to identify their three favorite messages received. The most frequently selected messages were supportive/empowering messages,

followed by commitment reminders, control messages, threatening/consequential messages, and educational messages. The six most popular messages were supportive/empowering messages. The most popular commitment reminder and threatening/consequential message was tied for 7th most frequently selected. The most popular educational and control message was tied for 13th frequently selected. It appears that at follow-up, supportive/empowering messages were perceived as being helpful by the greatest proportion of participants while control and educational messages were perceived as being helpful by substantially fewer participants.

It is unclear what ability individuals have to accurately identify and select the messages that will be most effective in supporting SU behavior change, and it is likely this ability varies between individuals. However, in terms of message preference at baseline, supportive/empowering messages were the most popular while threatening/consequential messages were the least popular. Note that due to study design, popularity of control group messages was not assessed at baseline (for further discussion, see Limitations). At post-treatment, all participants were shown all messages (intervention and control). The supportive/empowering messages again were the most popular message type and the educational messages appeared to be the least popular. The control messages were most popular among control group participants (M = 1.69, S.D. = 1.44) and virtually unselected by self-selected condition (M = 0.07, S.D. = 0.27) and yoked-intervention condition participants (M = 0.07, S.D. = 0.26).

However, given the positive results among all conditions and especially the control group, it is worth considering the impact the control messages may have served as a complementary approach to treatment. While there is limited research on most complimentary approaches to treatment, aside from mindfulness, the complimentary approach to treatment is one that

individuals often use and is acceptable to substance users (Substance Abuse and Mental Health Services Administration, 2015). The messages were chosen for their utility as general health reminders and the focus on content not specific to substance use may have been perceived as helpful in motivating SU behavior change.

4.4.4 Message Type and Substance Use Behavior Change Goal

A MLM was used to compare the relative impact of message type (e.g., quantity of each message type) on SU behavior change goal outcome. Message types were compared against commitment reminder messages (the messages that most closely approximate a simple reminder). No significant difference between conditions or relative to commitment reminder messages were found. Further refinement of message category and content seems appropriate.

4.4.5 Message "Remindfulness"

Participants answered questions regarding perceived support and perceived level of reminder effectiveness about the messages on a 1 to 7 Likert scale. Overall, participants reported high perceived levels of message "remindfulness," with the highest ratings in the yoked-intervention condition and the lowest in the control condition. Mean perceived "remindfulness" of self-selected intervention condition was higher than the control condition at all four measurements. While these results should be interpreted cautiously due to lack of statistical modeling and small sample size, the data appear to suggest intervention messages were more effective at increasing participant perceived "remindfulness".

4.4.6 Message Frequency, Quantity, and Timing

Participants reported a strong preference to receive either one or two messages per day. They reported a preference to receive messages for four weeks at three of four assessments and for two weeks at follow-up. The preference to receive messages for four weeks was narrowly

greater than those preferring to receive messages for two weeks. All data exhibited a strong positive skew. Preferred timing of messages was assessed in an open-ended format and the most common themes for message timing preferences during weekdays were evenings/nights, events (e.g., parties, organized events), other social gatherings, and specific days (e.g., Tuesday and Thursday). On weekends, the most common themes for message timing preferences were evenings/night, events (e.g., parties, football games), and specific days (e.g., Friday and Saturday). This feedback supports findings that event-specific SU is a high-risk time for using and further suggests that interventions targeting specific events (e.g., spring break or 21st birthday) are likely to be well-received by AYAs (e.g., Geisner et al., 2017; Pedersen, Neighbors, Atkins, Lee, & Larimer, 2017).

4.4.7 Preferred Message Content

Participants were offered the opportunity to provide additional information regarding preferred message content at follow-up. Some common themes among message content include that messages be sent at more relevant times, that messages be more relevant to the recipient (e.g., tailored), as well as preferences for and against threatening/consequential messages.

5.0.0 Limitations and Future Directions

5.1.0 Limitations

There were several limitations to this study. First, the study was initially intended to be conducted with adolescents who wanted to stop their SU and were in on-going outpatient treatment. Due to recruitment difficulties the study was expanded to allow for individuals who wanted to set limits on their SU and again expanded to include young adult participants who received BMIs. Despite this, the study sample was smaller than anticipated, which resulted in less power to detect differences between conditions. Additionally, the number of analyses run

might have caused alpha inflation (this should be mitigated by using a parsimonious model building approach). As a result of expanding study inclusion criteria, the messages served both as an adjunct to treatment (for adolescent participants) and aftercare or possibly even an intervention (for young adult BMI participants), rather than primarily an adjunct to treatment as originally intended.

Second, the study relied on self-report to assess outcomes. While self-report is fairly typical in SU treatment research and substantial research suggests it provides valid results, it may be somewhat more challenging when asking participants to self-report a dichotomous outcome (e.g., yes or no) as was done in assessing SU behavior change goal (Babor, Steinberg, Anton, & Del Boca, 2000; Babor, Stephens, & Marlatt, 1987; Chermack, Singer, & Beresford, 1998; Darke, 1998). While details of the behavior change goal were assessed for over time (i.e., participants were asked to detail what their goal was at the time of assessment), participants goals might change between measurement points. However, self-report of SU may actually be more accurate when assessing for stigmatizing behaviors (Farvolden, Cunningham, & Selby, 2009; Le, Blum, Magnani, Hewett, & Do, 2006).

Third, while participants were asked to respond to daily messages as a means of assessing whether or not participants were receiving messages, it is impossible to know if participants were actively reading messages or not. Given participants reported preferring to receive fewer than four messages per day, it is possible that participants ignored some messages or started ignoring messages after a certain amount of time.

Fourth, the order in which messages were presented at baseline for selection by participants was randomized and presented the same way for all participants. The first message visible (e.g., in the top left of the screen) was the most frequently selected message. It is possible that this was

the most popular message due to its content, however, it was not nearly as popular when re-assessed at post-treatment. Continual re-randomization of the message list may have revealed a difference distribution of message preference at baseline. Additionally, participants were not presented with control messages at baseline. This is because messages selected at this time were actually received by participants in the self-selected condition. Allowing individuals to choose control messages would confound the study by mixing control (e.g., general health) and intervention (e.g., SU-related) messages. However, this means it is not possible to assess whether control messages would have been more popular than intervention messages if both were offered for selection at baseline.

Lastly, follow-up was only able to be obtained at one-month post-intervention. A longer-term follow up would offer more insight into what impact the intervention has over time on relapse rates.

5.2.0 Future Directions

Despite study limitations, the current study represents the first randomized controlled trial investigating the effects of text message reminders as an adjunct to SU interventions to support SU behavior change. While the study had a small sample size and results may not be stable, the data suggests that overall, participants met their SU behavior change goal at a relatively high rate. Further research to understand the best utility of text messaging in SUD treatment is merited. Specifically, it is important to investigate whether text messages can serve as an effective adjunct to treatment, as an effective method of aftercare support, or both.

The current study began to explore several research questions that merit further investigation, particularly around text message timing, frequency, duration, and content. As research about the use of text messages to help deliver or support SUD interventions continues, it

is important to know what type of message content is most effective. While this study's message content categories were identified with help from focus group participants, it is likely that other content areas may also be effective (e.g., future-oriented messages; reminders of benefits gained by changing SU). In addition, participant feedback suggests that fewer messages per day over shorter periods of time may be preferable. However, it is unclear at what point individuals start ignoring messages and it remains to be seen whether or not receiving fewer messages for less time improves behavior change outcomes. Additionally, timing of messages appears to be important. Future research using features such as ecological momentary assessment (EMA) may help interventionists reach individuals in a timely manner to help support behavior change. Lastly, it seems probable that the timing, frequency, duration, and message content will vary between individuals and across a variety of factors. For example, someone who is in the pre-contemplative stage of change with low ratings of motivation, readiness to change, and self-efficacy may respond to different messages than someone who is in the preparation stage and has moderate levels of motivation, readiness to change, and high levels of self-efficacy. Further research investigating individual differences and message content can be further explored through the use of big data, predictive algorithms, and more interactive technology such as EMA and two-way messaging.

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Table 1

Participant Baseline Demographics (N = 59)

Demographic	%
Women	57.6
Age (M (SD))	18.5 (1.7)
Adolescents	18.6
Young Adults	81.4
Race	
White/Caucasian	72.9
Asian/Asian American	15.3
More Than One	6.8
Alaska Native/American Indian	1.7
Native Hawaiian/Other Pacific Islander	1.7
Other	1.7
Ethnicity	
Non-Hispanic	91.5
Hispanic	6.8
Missing	1.7

Table 2.

Main Outcomes Means and Standard Deviations at Baseline, During, Post, and Follow-Up Assessments (N = 59)

	Condition					
	Control		Self		Yoked	
	n	M (SD)	n	M (SD)	n	M (SD)
SU Goal Achievement Total						
Baseline (Goal)	20	N/A	19	N/A	20	N/A
During (Goal)	17	15	16	13	19	17
Post (Goal)	14	13	17	15	16	13
Follow-up (Goal)	15	15	12	9	17	16
DASES (Self-Efficacy) Total (Higher scores = Higher self-efficacy)						
Baseline	20	68.5 (9)	18	69.3 (8.9)	19	68.7 (14.6)
During	15	70.0 (8.9)	16	66.2 (8.5)	18	69.2 (11.8)
Post	14	82.4 (13.9)	16	75.3 (11.6)	15	81.0 (14.7)
Follow-up	15	68.0 (10.9)	12	67.4 (7.6)	17	70.0 (13.0)
TAAS Self-Efficacy (Higher scores = Higher self-efficacy)						
Baseline	20	5.3 (1.3)	19	5.2 (1.5)	20	4.6 (1.5)
During	16	5.6 (1.5)	16	4.6 (1.5)	19	5.3 (0.9)
Post	14	5.6 (1.2)	17	4.9 (1.8)	16	5.3 (1.1)
Follow-up	15	5.7 (1.2)	12	5.0 (1.6)	17	5.4 (1.4)
SRMPI (SU Consequences; Higher scores = Increased consequences)						
Baseline	20	9 (10.9)	19	11.2 (11.3)	20	11.6 (8.3)
During	15	5.9 (12.8)	16	5.9 (5.2)	18	6.2 (6.3)
Post	14	5.8 (12.5)	16	3.0 (3.8)	15	4.1 (4.4)

Follow-up	15	6 (11.8)	12	1.4 (2.0)	16	3.1 (5.0)
SOCRATES Ambiv. (Higher scores = Higher ambivalence)						
Baseline	20	15.5 (7.4)	19	14.7 (6.6)	20	16.6 (4.6)
During	15	15 (7.8)	16	14.4 (6.9)	18	14.9 (4.9)
Post	14	9.0 (5.1)	16	8.1 (3.9)	15	8.6 (4.3)
Follow-up	15	8.8 (5.5)	12	5.1 (1.6)	17	8.0 (4.3)
SOCRATES Recog. (Higher scores = Higher problem recognition)						
Baseline	20	9 (4.3)	19	9.5 (5.1)	20	10.4 (4)
During	15	8.9 (5)	16	8.1 (4.2)	18	8.7 (3.8)
Post	14	15.2 (8.7)	16	14.0 (6.8)	15	15.3 (5.4)
Follow-up	15	16.3 (8.6)	12	9.8 (3.4)	16	13.4 (4.7)
SOCRATES Steps (Higher scores = Higher rating of taking steps to change)						
Baseline	20	24.1 (10.2)	19	20.9 (9)	20	24.5 (6.9)
During	15	26.1 (7.5)	16	19.8 (8.5)	18	24.7 (8.6)
Post	14	27.2 (8.2)	16	21.3 (9.2)	15	28.7 (8.1)
Follow-up	15	26.5 (7.5)	12	19.4 (10.1)	16	26.9 (7.8)
CHANGEQ Total (Higher scores = Higher readiness to change)						
Baseline	19	5.9 (2.5)	19	6.2 (2.7)	20	6.9 (2.2)
During	15	6.5 (2.4)	16	6.4 (2.3)	18	6.6 (2.3)
Post	14	6.6 (2.4)	16	6.0 (2.5)	15	6.4 (2.3)
Follow-up	15	6.1 (2.7)	12	5.2 (2.5)	16	6.8 (2.5)
TAAS Motivation (Higher scores = Higher motivation to change)						
Baseline	20	4.2 (1.6)	19	4.1 (1.7)	20	4.8 (1.6)
During	16	4.8 (1.6)	16	3.6 (1.4)	19	4.3 (1.7)
Post	14	4.8 (1.6)	17	3.5 (1.6)	16	4.4 (1.9)

Follow-up	15	5.0 (1.6)	12	3.0 (1.4)	17	5.2 (1.4)
ADIS Alcohol Days (Lower scores = Decreased days with alcohol use)						
Baseline	20	5.8 (4.9)	19	7.2 (5.1)	20	7.3 (6.0)
During	15	1.1 (1.3)	16	3.3 (1.6)	18	2.9 (2.3)
Post	14	2.1 (1.7)	17	1.9 (1.4)	15	4.3 (3.2)
Follow-up	15	1.1 (1.3)	12	2.4 (1.6)	17	2.5 (2.9)
ADIS Alcohol Episodes (Lower scores = Decreased episodes of alcohol use)						
Baseline	20	9.4 (13.0)	19	7.5 (5.5)	20	11.5 (12.3)
During	15	1.1 (1.12)	16	3.8 (2.8)	18	5.0 (5.7)
Post	14	2.2 (1.7)	17	2.9 (2.7)	16	6.9 (7.9)
Follow-up	14	1.5 (1.7)	12	2.7 (2.0)	17	6.9 (12.8)
ADIS Alcohol Urge (Lower scores = Decreased days with at least one urge to use alcohol)						
Baseline	20	4.4 (4.7)	19	4.8 (4.3)	20	5.9 (4.4)
During	15	1.5 (2.5)	16	4.1 (3.5)	18	3.6 (3.9)
Post	14	1.1 (1.4)	17	1.2 (1.6)	16	2.8 (2.8)
Follow-up	14	0.6 (0.9)	12	2.5 (2.6)	17	2.5 (2.4)
ADIS Cannabis Days (Lower scores = Decreased days with cannabis use)						
Baseline	20	4.6 (6.6)	19	5.0 (7.8)	20	5.2 (8.9)
During	15	0.8 (1.0)	16	1.8 (4.1)	18	1.6 (1.8)
Post	14	1.5 (2.2)	17	1.7 (3.3)	16	1.1 (1.8)
Follow-up	15	0.5 (0.8)	12	1.8 (4.0)	16	1.4 (2.7)
ADIS Cannabis Episodes (Lower scores = Decreased episodes of cannabis use)						
Baseline	20	7.8 (14.0)	19	7.5 (14.7)	20	6.8 (9.9)
During	15	0.8 (1.0)	16	2.0 (4.9)	18	1.9 (2.1)
Post	14	1.7 (2.4)	17	2.4 (4.3)	16	1.5 (2.6)

Follow-up	14	0.6 (0.9)	12	5.6 (17.2)	17	2.1 (4.1)
ADIS Cannabis Urges (Lower scores = Decreased days with at least one urge to use cannabis)						
Baseline	20	4.1 (4.3)	19	3.6 (5.3)	20	2.9 (3.6)
During	15	1.4 (1.8)	15	1.4 (2.1)	18	1.8 (2.7)
Post	14	0.9 (1.5)	17	0.9 (1.6)	16	1.8 (2.7)
Follow-up	14	0.5 (0.7)	12	2.1 (4.1)	17	1.8 (3.1)

Note. ADIS = Adolescent Drug Involvement Scale; CHANGEQ = Change Questionnaire Total Score; DASES Total = Drug Avoidance Self-Efficacy Scale – Total Score; SOCRATES Ambiv. = Stages of Change Readiness and Treatment Engagement Scale – Ambivalence Subscale; SOCRATES Recog. = Stages of Change Readiness and Treatment Engagement Scale – Recognition Subscale; SOCRATES Steps = Stages of Change Readiness and Treatment Engagement Scale – Taking Steps Subscale; SRMPI = Short Rutgers Alcohol/Drug Problem Index; TAAS Motivation = Thoughts about Abstinence Scale, Motivation to Change Score; TAAS Self-Efficacy = Thoughts about Abstinence Scale, Self-Efficacy Score.

Table 3.

Baseline Characteristics by Study Dropout Status (N = 59)

	Dropped out (n=8) %	**Did not drop out (n=51) %**	χ^2/t	*p*
Women	62.5	56.9	0.09	0.76
Age (M (SD))	17.6 (2.1)	18.6 (1.6)		0.13
Race			14.3	0.01*
White	50	76.5		
Asian/Asian American[+]	0	17.6		
Alaska Native/American Indian[+]	12.5	0		
Native Hawaiian/Other Pacific Islander[+]	0	2		
More than one race[+]	25	3.9		
Other[+]	12.5	0		
Control Condition	37.5	33.3	0.05	0.82
Goal: Set-Limits or Cut Back[+]	50	75		0.21
Lifetime Alcohol Use[1] (ADIS)				
Lifetime Cannabis Use (ADIS) [+]	100	92.2		1.0
Past Month Days of Alcohol Use (ADIS) (M (SD))	8.6 (6.6)	6.4 (5.1)	-1.09	0.28
Past Month Days of Cannabis Use[1] (ADIS) (M (SD))	11.8 (12.9)	3.9 (6.1)	-1.61	0.15
CHANGEQ (M (SD))	7.6 (2.4)	6.1 (2.4)	-1.54	0.13
DASES	62.9 (6.2)	69.8 (11.3)	1.68	0.10
Negative SU Consequences (SRMPI) (M (SD))	18.5 (14.5)	9.3 (8.8)	-2.5	0.02*
SOCRATES Ambiv.	11.8 (4.8)	9.3 (4.3)	-1.46	0.15

SOCRATES Recog.	18.4 (6)	15.2 (6.2)	-1.35	0.18
SOCRATES Steps	27.8 (9.2)	22.5 (8.6)	-1.6	0.11
TAAS Motivation[1] (M (SD))	4.75 (2.4)	4.3 (1.5)	-0.49	0.64
TAAS Self-Efficacy (M (SD))	4.9 (1.5)	5 (1.4)	0.26	0.79

Note. $*p < 0.05$. $^{+}$ = Fisher's Exact Test significance value used when less than five cases in a cell. [1]Homogeneity of variance violated, Welch *t*-test score reported. ADIS = Adolescent Drug Involvement Scale; CHANGEQ = Change Questionnaire Total Score; DASES = Drug Avoidance Self-Efficacy Scale; SRMPI = Short Rutgers Alcohol/Drug Problem Index; SOCRATES Ambiv. = Stages of Change Readiness and Treatment Engagement Scale – Ambivalence Subscale; SOCRATES Recog. = Stages of Change Readiness and Treatment Engagement Scale – Recognition Subscale; SOCRATES Steps = Stages of Change Readiness and Treatment Engagement Scale – Taking Steps Subscale; TAAS Self-Efficacy = Thoughts about Abstinence Scale, Self-Efficacy Score; TAAS Motivation = Thoughts about Abstinence Scale, Motivation to Change Score

Table 4.

Baseline Correlations Among Study Variables (*N* = 59)

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. ADIS Alcohol Days	__													
2. ADIS Alcohol Episodes	.63**	__												
3. ADIS Alcohol Urges	.44**	.38**	__											
4. ADIS Cannabis Days	.18	.10	-.06	__										
5. ADIS Cannabis Episodes	.08	.33*	-.11	.74**	__									
6. ADIS Cannabis Urges	.09	.08	.24	.68**	.58**	__								
7. TAAS-Motivation	.12	.19	.12	.21	.22	.18	__							
8. TAAS-Self-Efficacy	-.22	-.11	-.17	.05	.23	-.01	.29*	__						
9. ChangeQ	-.01	-.01	-.03	.30*	.24	.20	.38**	.13	__					
10. DASES	-.09	-.14	-.06	-.21	-.16	-.10	-.26	-.06	-.13	__				
11. SOCRATES Ambiv.	.25	.31*	.28*	.39**	.37**	.36**	.48**	.05	.33*	-.21	__			
12. SOCRATES Recog	.15	.27*	.20	.47**	.50**	.42**	.47**	.06	.41**	-.32*	.88**	__		
13. SOCRATES Steps	-.07	.06	.07	.24	.28*	.32*	.49**	.18	.55**	-.15	.62**	.65**	__	
14. SRMPI	.32*	.23	.14	.63**	.48**	.48**	.37**	.01	.34**	-.26	.66*	.67**	.47**	__

Notes. * $p < 0.05$, ** $p < 0.01$. ADIS = Adolescent Drug Involvement Scale – Past month use; ChangeQ = Change Questionnaire Total Score; DASES = Drug Avoidance Self-Efficacy Scale; SOCRATES = Stages of Change Readiness and Treatment Eagerness Scale; Ambiv =

SOCRATES Ambivalence Subscale; Recog = SOCRATES Recognition Subscale; Steps = SOCRATES Taking Steps Subscale; SRMPI = Short Rutgers Alcohol/Drug Problem Index. TAAS = Thoughts About Abstinence Scale.

Table 5.

Means and Standard Deviations of Message Preference by Treatment Condition (N = 59)

Message Type	Condition	N	M	SD
Educational	Control	20	6.6	2.6
	Self-selected	19	6.2	2.0
	Yoked-intervention	20	6	2.4
	Total	59	6.3	2.3
Supportive	Control	20	9.2	3.7
	Self-selected	19	8.1	2.8
	Yoked-intervention	20	9.1	2.3
	Total	59	8.8	3.0
Reminder	Control	20	6.5	2.4
	Self-selected	19	7.7	2.6
	Yoked-intervention	20	8.1	2.0
	Total	59	7.4	2.4
Threat	Control	20	5.8	3.1
	Self-selected	19	6	2.6
	Yoked-intervention	20	4.9	2.9
	Total	59	5.5	2.9

Table 6.

Generalized Estimating Equation Predicting Not Achieving Substance Use Behavior Change Goal (Binary Outcome) (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Model 1a: Comparing individual interventions against control				
Intercept	-1.28	0.27	1.26	[0.23, 3.22]
Yoked-intervention	-1.43	0.24	1.95	[0.01, 11.01]
Self-selected	-0.86	2.35	1.57	[0.11, 51.26]
Control	0[a]	1		
Time	-0.37	0.69	0.47	[0.27, 1.75]
Yoked x Time	0.66	1.94	0.65	[0.55, 6.91]
Self x Time	-0.02	0.98	0.57	[0.32, 2.97]
Control x Time	0[a]	1		
Model 1b: Comparing pooled interventions against control				
Intercept	-1.31	0.27	1.25	[0.02, 3.11]
Intervention	-0.30	0.74	1.52	[0.04, 14.68]
Control	0[a]	1		
Time	-0.37	0.69	0.47	[0.28, 1.74]
Intervention x Time	0.32	1.38	0.54	[0.48, 3.98]
Control x Time	0[a]	1		

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Model 1c: Comparing self-selected condition against yoked-intervention condition				
Intercept	-2.75	0.06	1.48	[0.01, 1.16]
Self-selected	2.18	8.83	1.78	[0.27, 289.85]
Yoked-intervention	0[a]	1		
Time	0.30	1.36	0.43	[0.58, 3.17]
Self x Time	-0.67	0.51	0.54	[0.18, 1.49]
Yoked x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Intervention = Both intervention conditions (self-selected and yoked-intervention) grouped together.

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Model 2a: Comparing individual interventions against control				
Intercept	-0.78	0.46	0.86	[0.09, 2.48]
Yoked-intervention	-0.86	0.42	1.04	[0.06, 3.27]
Self-selected	-1.21	0.30	1.25	[0.03, 3.47]
Control	0[a]	1		
Time	-0.55	0.58	0.23	[0.37, 0.91]*
Yoked x Time	0.46	1.58	0.25	[0.96, 2.59]
Self x Time	0.69	1.98	0.28	[1.14, 3.44]*
Control x Time	0[a]	1		

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Model 2b: Comparing pooled interventions against control				
Intercept	-0.80	0.45	0.86	[0.08, 2.44]
Intervention	-1.01	0.36	1.04	[0.05, 2.78]
Control	0[a]	1		
Time	-0.55	0.58	0.23	[0.37, 0.90]*
Intervention x Time	0.57	1.76	0.25	[1.09, 2.87]*
Control x Time	0[a]	1		
Model 2c: Comparing self-selected condition against yoked-intervention condition				
Intercept	-1.64	0.19	0.59	[0.06, 0.61]**
Self-selected	-0.35	0.71	1.08	[0.08, 5.88]
Yoked-intervention	0[a]	1		
Time	-0.09	0.91	0.09	[0.76, 1.09]
Self x Time	0.23	1.26	0.18	[0.88, 1.79]
Yoked x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Intervention = Both intervention conditions (self-selected and yoked-intervention) grouped together.

Table 7.

Generalized Estimating Equation Predicting Alcohol Use Days (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.53	4.60	0.31	[2.49, 8.49]***
Yoked-intervention	0.11	1.12	0.49	[0.43, 2.93]
Self-selected	0.07	1.08	0.47	[0.43, 2.71]
Control	0[a]	1		
Time	-0.16	0.85	0.13	[0.66, 1.09]
Yoked x Time	0.01	1.01	0.14	[0.76, 1.34]
Self x Time	0.11	1.11	0.16	[0.81, 1.52]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.62	5.06	0.27	[3.00, 8.54]***
Yoked-intervention	0.02	1.02	0.45	[0.42, 2.45]
Self-selected	0.02	1.02	0.43	[0.44, 2.37]
Control	0[a]	1		
Time	-0.25	0.78	0.06	[0.69, 0.88]***
Yoked x Time	0.10	1.11	0.09	[0.93, 1.31]
Self x Time	0.17	1.18	0.08	[1.01, 1.38]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 8.

Generalized Estimating Equation Predicting Cannabis Use Days (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	2.24	9.40	0.30	[5.21, 16.95]***
Yoked-intervention	0.10	1.10	0.39	[0.51, 2.39]
Self-selected	-0.23	0.80	0.34	[0.41, 1.56]
Control	0[a]	1		
Time	-0.28	0.76	0.12	[0.60, 0.96]*
Yoked x Time	0.26	1.30	0.13	[1.00, 1.69]*
Self x Time	0.25	1.29	0.14	[0.99, 1.68]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	2.20	9.06	0.27	[5.38, 15.27]***
Yoked-intervention	0.20	1.22	0.36	[0.61, 2.46]
Self-selected	-0.08	0.92	0.30	[0.51, 1.65]
Control	0[a]	1		
Time	-0.23	0.80	0.06	[0.70, 0.90]***
Yoked x Time	0.15	1.16	0.07	[1.01, 1.34]*
Self x Time	0.12	1.13	0.07	[0.99, 1.29]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 9.

Generalized Estimating Equation Predicting Alcohol Use Episodes (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	2.05	7.80	0.39	[3.63, 16.76]***
Yoked-intervention	-0.14	0.87	0.50	[0.33, 2.34]
Self-selected	-0.04	0.97	0.59	[0.31, 3.04]
Control	0[a]	1		
Time	-0.30	0.74	0.16	[0.54, 1.02]
Yoked x Time	0.17	1.19	0.17	[0.85, 1.67]
Self x Time	0.19	1.21	0.18	[0.85, 1.73]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	2.07	7.90	0.34	[4.09, 15.26]***
Yoked-intervention	-0.15	0.86	0.46	[0.35, 2.12]
Self-selected	-0.12	0.89	0.51	[0.33, 2.41]
Control	0[a]	1		
Time	-0.30	0.74	0.08	[0.63, 0.87]***
Yoked x Time	0.16	1.17	0.10	[0.96, 1.43]
Self x Time	0.27	1.31	0.09	[1.11, 1.56]**
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 10.

Generalized Estimating Equation Predicting Cannabis Use Episodes (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.48	4.40	0.22	[2.85, 6.79]***
Yoked-intervention	0.29	1.33	0.28	[0.77, 2.28]
Self-selected	0.10	1.10	0.30	[0.61, 1.98]
Control	0[a]	1		
Time	-0.09	0.91	0.09	[0.76, 1.09]
Yoked x Time	0.13	1.14	0.11	[0.92, 1.40]
Self x Time	0.13	1.14	0.11	[0.92, 1.41]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.59	4.92	0.21	[3.24, 7.48]***
Yoked-intervention	0.34	1.40	0.27	[0.82, 2.39]
Self-selected	0.12	1.12	0.27	[0.67, 1.89]
Control	0[a]	1		
Time	-0.21	0.81	0.04	[0.75, 0.88]***
Yoked x Time	0.12	1.12	0.05	[1.03, 1.23]
Self x Time	0.14	1.15	0.05	[1.06, 1.26]**
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 11.

Generalized Estimating Equation Predicting Alcohol Use Urges (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.48	4.40	0.22	[2.85, 6.79]***
Yoked-intervention	0.29	1.33	0.28	[0.77, 2.28]
Self-selected	0.10	1.10	0.30	[0.61, 1.98]
Control	0[a]	1		
Time	-0.09	0.91	0.09	[0.76, 1.09]
Yoked x Time	0.13	1.14	0.11	[0.92, 1.40]
Self x Time	0.13	1.14	0.11	[0.92, 1.41]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.59	4.92	0.21	[3.24, 7.48]***
Yoked-intervention	0.34	1.40	0.27	[0.82, 2.39]
Self-selected	0.12	1.12	0.27	[0.67, 1.89]
Control	0[a]	1		
Time	-0.21	0.81	0.04	[0.75, 0.88]***
Yoked x Time	0.12	1.12	0.04	[1.03, 1.23]**
Self x Time	0.14	1.15	0.05	[1.05, 1.26]**
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 12.

Generalized Estimating Equation Predicting Cannabis Use Urges (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.41	4.10	0.23	[2.62, 6.42]***
Yoked-intervention	-0.36	0.70	0.36	[0.34, 1.41]
Self-selected	-0.14	0.87	0.40	[0.40, 1.92]
Control	0[a]	1		
Time	-0.12	0.89	0.09	[0.74, 1.06]
Yoked x Time	0.18	1.20	0.11	[0.97, 1.49]
Self x Time	0.02	1.02	0.14	[0.78, 1.34]
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Intercept	1.52	4.56	0.22	[2.94, 7.05]***
Yoked-intervention	-0.34	0.71	0.34	[0.36, 1.39]
Self-selected	-0.28	0.76	0.37	[0.37, 1.55]
Control	0[a]	1		
Time	-0.22	0.80	0.04	[0.74, 0.86]***
Yoked x Time	0.18	1.20	0.05	[1.08, 1.33]***
Self x Time	0.17	1.19	0.05	[1.07, 1.32]**
Control x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 13.

Multilevel Model Predicting Level of Self-Efficacy (DASES) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention condition against control			
Intercept	67.00	2.55	[61.95, 72.05]***
Condition (Self and Yoked)	0.16	3.15	[-6.08, 6.39]
Time	3.40	0.87	[1.69, 5.12]***
Condition x Time	-1.38	1.05	[-3.47, 0.72]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	47.03	15.87	[24.28, 91.09]**

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against control			
Intercept	67.01	2.16	[62.71, 71.31]***
Condition (Self)	0.35	3.11	[-5.85, 6.54]
Time	3.39	0.76	[1.87, 4.92]***
Condition x Time	-2.01	1.07	[-4.15, 0.12]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	28.05	13.34	[11.04, 71.26]*

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Fixed Effects	Coefficient	S.E.	95% CI
Model 1c: Comparing yoked-intervention condition against control			
Intercept	67.00	2.72	[61.58, 72.42]***
Condition (Yoked)	-0.05	3.87	[-7.75, 7.65]
Time	3.41	0.91	[-1.58, 5.23]***
Condition x Time	-0.71	1.28	[-3.27, 1.85]

Random Effects	Variance	S. E.	95% CI
Intercept	55.79	22.24	[25.53, 121.87]*

Fixed Effects	Coefficient	S.E.	95% CI
Model 1d: Comparing self-selected condition against yoked-intervention condition			
Intercept	66.95	2.70	[61.58, 72.32]***
Condition (Self)	0.39	3.87	[-7.32, 8.09]
Time	2.70	0.88	[0.93, 4.46]***
Condition x Time	-1.34	1.25	[-3.83, 1.15]

Random Effects	Variance	S. E.	95% CI
Intercept	54.09	21.80	[24.55, 119.16]*

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention condition against control			
Intercept	71.11	2.43	[66.30, 75.92]***
Condition (Self and Yoked)	-1.30	2.99	[-7.22, 4.61]
Time	0.14	0.43	[-0.71, 0.99]
Condition x Time	-0.03	0.53	[-1.08, 1.02]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	47.38	14.77	[25.72, 87.28]**

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against control			
Intercept	71.15	2.07	[67.03, 75.26]***
Condition (Self)	-1.67	2.97	[-7.58, 4.23]
Time	0.15	0.40	[-0.65, 0.95]
Condition x Time	-0.20	0.60	[-1.38, 0.98]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	23.44	11.84	[8.71, 63.10]*

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2c: Comparing yoked-intervention condition against control			
Intercept	71.10	2.65	[65.83, 76.37]***
Condition (Yoked)	-0.93	3.73	[-8.37, 6.50]
Time	0.14	0.45	[-0.76, 1.04]
Condition x Time	0.11	0.63	[-1.14, 1.36]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	61.65	21.78	[30.84, 123.22]**

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2d: Comparing self-selected condition against yoked-intervention condition			
Intercept	70.17	2.50	[65.18, 75.14]***
Condition (Self)	-0.72	3.59	[-7.88, 6.44]
Time	0.25	0.41	[-0.57, 1.07]
Condition x Time	-0.37	0.63	[-1.61, 0.88]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	55.53	20.22	[27.20, 113.37]**

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 14.

Multilevel Model Predicting Level of Self-Efficacy (TAAS Self-Efficacy) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention condition against control			
Intercept	5.32	0.38	[4.76, 5.86]***
Condition (Self and Yoked)	-0.34	0.24	[-1.02, 0.34]
Time	0.07	0.10	[-0.13, 0.28]
Condition x Time	-0.01	0.13	[-0.26, 0.24]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.34	0.18	[0.12, 0.94]

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against control			
Intercept	5.31	0.29	[4.74, 5.89]***
Condition (Self)	-0.05	0.41	[-0.87, 0.76]
Time	0.08	0.11	[-0.14, 0.30]
Condition x Time	-0.14	0.15	[-0.45, 0.17]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.24	0.21	[0.04, 1.47]

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Fixed Effects	Coefficient	S.E.	95% CI
Model 1c: Comparing yoked-intervention condition against control			
Intercept	5.32	0.27	[4.79, 5.86]***
Condition (Yoked)	-0.63	0.38	[-1.38, 0.13]
Time	0.07	0.09	[-0.11, 0.24]
Condition x Time	0.13	0.12	[-0.11, 0.38]

Random Effects	Variance	S. E.	95% CI
Intercept	0.57	0.23	[0.26, 1.24]*

Fixed Effects	Coefficient	S.E.	95% CI
Model 1d: Comparing self-selected condition against yoked-intervention condition			
Intercept	4.70	0.27	[4.16, 5.25]***
Condition (Self)	0.56	0.39	[-0.22, 1.34]
Time	0.19	0.10	[-0.01, 0.39]
Condition x Time	-0.28	0.14	[-0.54, 0.03]

Random Effects	Variance	S. E.	95% CI
Intercept	0.27	0.20	[0.06, 1.17]

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention condition against control			
Intercept	5.35	0.25	[4.85, 5.85]***
Condition (Self and Yoked)	-0.33	0.31	[-0.94, 0.29]
Time	0.04	0.05	[-0.06, 0.14]
Condition x Time	-0.01	0.06	[-0.13, 0.11]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.33	0.15	[0.13, 0.81]*

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against control			
Intercept	5.36	0.25	[4.85, 5.86]***
Condition (Self)	-0.14	0.36	[-0.86, 0.58]
Time	0.04	0.05	[-0.06, 0.15]
Condition x Time	-0.08	0.08	[-0.24, 0.08]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.16	0.18	[0.02, 1.35]

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Fixed Effects	Coefficient	S.E.	95% CI
Model 1c: Comparing yoked-intervention condition against control			
Intercept	5.35	0.25	[4.85, 5.85]***
Condition (Yoked)	-0.50	0.35	[-1.19, 0.21]
Time	0.04	0.04	[-0.05, 0.12]
Condition x Time	0.04	0.06	[-0.07, 0.16]

Random Effects	Variance	S. E.	95% CI
Intercept	0.56	0.20	[0.28, 1.14]**

Fixed Effects	Coefficient	S.E.	95% CI
Model 1d: Comparing self-selected condition against yoked-intervention condition			
Intercept	4.36	0.25	[4.37, 5.35]***
Condition (Self)	0.37	0.36	[-0.34, 1.08]
Time	0.08	0.05	[-0.01, 0.18]
Condition x Time	-0.12	0.07	[-0.27, 0.02]

Random Effects	Variance	S. E.	95% CI
Intercept	0.27	0.17	[0.08, 0.95]

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 15.

Generalized Estimating Equation Predicting Negative Substance Use Consequences (N = 59)

Model 1 (Post-treatment results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Model 1a: Comparing individual intervention conditions against control				
Intercept	2.16	8.63	0.27	[5.06, 14.72]***
Yoked-intervention	0.27	1.31	0.31	[0.71, 2.39]
Self-selected	0.28	1.33	0.35	[0.67, 2.64]
Control	0[a]	1		
Time	-0.13	0.88	0.09	[0.74, 1.04]
Yoked x Time	-0.10	0.91	0.10	[0.75, 1.10]
Self x Time	-0.15	0.86	0.10	[0.71, 1.05]
Control x Time	0[a]	1		
Model 1b: Comparing self-selected condition against yoked-intervention condition				
Intercept	2.42	11.24	0.14	[8.47, 14.92]***
Self-selected	0.01	1.01	0.26	[0.60, 1.69]
Yoked-intervention	0[a]	1		
Time	-0.24	0.79	0.05	[0.71, 0.88]***
Self x Time	-0.06	0.94	0.08	[0.81, 1.10]
Yoked x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Model 2 (Follow-up results)

Parameter	Coefficient	Odds Ratio	S.E.	95% CI
Model 2a: Comparing individual intervention conditions against control				
Intercept	2.08	7.99	0.30	[4.42, 14.46]***
Yoked-intervention	0.25	1.28	0.34	[0.66, 2.49]
Self-selected	0.30	1.34	0.37	[0.64, 2.97]
Control	0[a]	1		
Time	-0.05	0.95	0.04	[0.88, 1.03]
Yoked x Time	-0.09	0.91	0.06	[0.82, 1.02]
Self x Time	-0.18	0.84	0.05	[0.76, 0.92]***
Control x Time	0[a]	1		
Model 2b: Comparing self-selected condition against yoked-intervention condition				
Intercept	2.31	10.12	0.15	[7.55, 13.56]***
Self-selected	0.04	1.05	0.26	[0.63, 1.74]
Yoked-intervention	0[a]	1		
Time	-0.15	0.86	0.04	[0.79, 0.94]***
Self x Time	-0.10	0.91	0.05	[0.82, 1.01]
Yoked x Time	0[a]	1		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 16.

Multilevel Model Predicting Level of Motivation to Change (Change Questionnaire) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention conditions against control			
Intercept	5.96	0.52	[4.93, 6.99]***
Condition (Self and Yoked)	0.63	0.63	[-0.63, 1.89]
Time	0.13	0.11	[-0.09, 0.36]
Condition x Time	-0.17	0.14	[-0.44, 0.10]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	3.96	0.85	[2.61, 6.05]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against yoked-intervention condition			
Intercept	6.87	0.51	[5.84, 7.88]***
Condition (Self)	-0.56	0.73	[-2.01, 0.90]
Time	-0.10	0.11	[-0.33, 0.13]
Condition x Time	0.12	0.16	[-0.20, 0.44]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	3.70	1.00	[2.18, 6.29]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention conditions against control			
Intercept	6.10	0.51	[5.08, 7.12]***
Condition (Self and Yoked)	0.52	0.63	[-0.73, 1.77]
Time	0.02	0.05	[-0.08, 0.12]
Condition x Time	-0.07	0.06	[-0.19, 0.06]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	4.18	0.87	[2.79, 6.27]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against yoked-intervention condition			
Intercept	6.77	0.49	[5.78, 7.77]***
Condition (Self)	-0.32	0.71	[-1.74, 1.11]
Time	-0.02	0.05	[-0.13, 0.09]
Condition x Time	-0.06	0.08	[-0.22, 0.10]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	3.82	0.99	[2.29, 6.35]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 17.

Multilevel Model Predicting Level of Motivation to Change (TAAS-Motivation Subscale) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention conditions against control			
Intercept	4.32	0.35	[3.62, 5.01]***
Condition (Self and Yoked)	0.08	0.43	[-0.77, 0.94]
Time	0.14	0.11	[-0.09, 0.37]
Condition x Time	-0.26	0.14	[-0.53, 0.01]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	1.01	0.32	[0.55, 1.88]**

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against yoked-intervention condition			
Intercept	4.71	0.34	[4.03, 5.39]***
Condition (Self)	-0.64	0.49	[-1.62, 0.34]
Time	-0.10	0.12	[-0.33, 0.14]
Condition x Time	-0.04	0.16	[-0.37, 0.29]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.74	0.34	[0.30, 1.83]*

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention conditions against control			
Intercept	4.37	0.33	[3.72, 5.01]***
Condition (Self and Yoked)	-0.12	0.40	[-0.91, 0.67]
Time	0.08	0.06	[-0.03, 0.20]
Condition x Time	-0.10	0.07	[-0.24, 0.04]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.87	0.28	[0.46, 1.62]**

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against yoked-intervention condition			
Intercept	4.47	0.30	[3.89, 5.05]***
Condition (Self)	-0.41	0.43	[-1.26, 0.43]
Time	0.07	0.06	[-0.04, 0.19]
Condition x Time	-0.21	0.09	[-0.38, -0.03]*

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	0.42	0.25	[0.13, 1.35]

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 18.

Multilevel Model Predicting Readiness to Change, Level of Ambivalence (SOCRATES-Ambivalence Subscale) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention conditions against control			
Intercept	8.99	0.94	[7.11, 10.87]***
Condition (Self and Yoked)	0.80	1.16	[-1.51, 3.12]
Time	-0.14	0.20	[-0.54, 0.26]
Condition x Time	-0.12	0.24	[-0.61, 0.36]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	13.53	2.90	[8.89, 20.59]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against yoked-intervention condition			
Intercept	10.19	0.92	[8.35, 12.02]***
Condition (Self)	-0.81	1.31	[-3.44, 1.82]
Time	-0.32	0.21	[-0.74, 0.10]
Condition x Time	0.09	0.30	[-0.51, 0.68]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	11.84	3.31	[6.85, 20.48]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention conditions against control			
Intercept	8.90	0.92	[7.06, 10.73]***
Condition (Self and Yoked)	0.91	1.13	[-1.34, 3.16]
Time	-0.05	0.10	[-0.25, 0.14]
Condition x Time	-0.22	0.12	[-0.46, 0.02]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	13.22	2.80	[8.73, 20.01]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against yoked-intervention condition			
Intercept	10.01	0.85	[8.29, 11.73]***
Condition (Self)	-0.41	1.23	[-2.87, 2.06]
Time	-0.19	0.10	[-0.39, 0.01]
Condition x Time	-0.22	0.15	[-0.52, 0.08]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	10.74	2.99	[6.22, 18.54]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 19.

Multilevel Model Predicting Readiness to Change, Level of Recognition of Need to Change (SOCRATES-Recognition Subscale) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention conditions against control			
Intercept	15.39	1.42	[12.57, 18.21]***
Condition (Self and Yoked)	0.19	1.74	[-3.28, 3.66]
Time	-0.30	0.28	[-0.86, 0.25]
Condition x Time	0.28	0.34	[-0.40, 0.95]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	31.75	6.61	[21.11, 47.76]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against yoked-intervention condition			
Intercept	16.27	1.27	[13.71, 18.83]***
Condition (Self)	-1.44	1.83	[-5.10, 2.23]
Time	-0.08	0.29	[-0.65, 0.49]
Condition x Time	-0.06	0.40	[-0.74, 0.87]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	23.41	6.42	[13.68, 40.08]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention conditions against control			
Intercept	14.97	1.36	[12.27, 17.67]***
Condition (Self and Yoked)	0.98	1.67	[-2.34, 4.30]
Time	0.06	0.14	[-0.22, 0.33]
Condition x Time	-0.37	0.17	[-0.72, -0.02]*

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	29.33	6.10	[19.51, 44.11]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against yoked-intervention condition			
Intercept	16.49	1.16	[14.16, 18.81]***
Condition (Self)	-1.15	1.66	[-4.48, 2.19]
Time	-0.27	0.15	[-0.56, 0.02]
Condition x Time	-0.14	0.22	[-0.58, 0.29]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	18.71	5.34	[10.69, 32.74]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 20.

Multilevel Model Predicting Readiness to Change, Level of Taking Steps Toward Change (SOCRATES-Taking Steps Subscale) (N = 59)

Model 1 (Post-treatment results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1a: Comparing pooled intervention conditions against control			
Intercept	24.17	1.92	[20.35, 28.01]***
Condition (Self and Yoked)	-1.32	2.36	[-6.03, 3.39]
Time	0.42	0.41	[-0.39, 1.24]
Condition x Time	0.40	0.50	[-0.59, 1.38]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	55.99	12.05	[36.72, 85.38]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 1b: Comparing self-selected condition against yoked-intervention condition			
Intercept	24.85	1.76	[21.32, 28.38]***
Condition (Self)	-4.16	2.52	[-9.22, 0.89]
Time	1.22	0.42	[0.38, 2.07]**
Condition x Time	-0.85	0.59	[-2.04, 0.34]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	42.20	11.81	[24.38, 73.04]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Model 2 (Follow-up results)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2a: Comparing pooled intervention conditions against control			
Intercept	24.42	1.85	[20.73, 28.11]***
Condition (Self and Yoked)	-0.75	2.27	[-5.28, 3.78]
Time	0.27	0.20	[-0.12, 0.66]
Condition x Time	-0.07	0.24	[-0.55, 0.41]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	54.08	11.37	[35.82, 81.65]***

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Model 2b: Comparing self-selected condition against yoked-intervention condition			
Intercept	26.05	1.71	[22.62, 29.47]***
Condition (Self)	-4.90	2.45	[-9.82, 0.01]
Time	0.31	0.20	[-0.09, 0.71]
Condition x Time	-0.28	0.30	[-0.88, 0.32]

Random Effects	**Variance**	**S. E.**	**95% CI**
Intercept	43.00	11.51	[24.45, 72.65]***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 21.

Multilevel Model Predicting Influence of Message Content on Not Achieving Substance Use Behavior Change (N = 59)

Fixed Effects	**Coefficient**	**S.E.**	**95% CI**
Intercept	0.02	0.27	[-0.52, 0.56]
Threat Messages	-0.01	0.02	[-0.04, 0.02]
Educational Messages	0.03	0.02	[-0.01, 0.07]
Supportive Messages	-0.01	0.02	[-0.04, 0.03]
Reminder Messages	0[a]		

Note. [a]Set to 0 because parameter is redundant. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 22.

"Remindfulness" and Impact of Message Support (N = 59)

How much did the messages help keep your decision in mind to not use drugs or to limit your use of drugs?

		Post-			Follow-up	
Condition	N	Mean	S.D.	N	Mean	S.D.
Self-selected	17	3.88	1.54	12	4.00	1.28
Yoked-intervention	16	4.31	1.58	17	4.41	1.18
Control	14	3.43	1.65	15	3.67	1.80

How much did the messages help support you in not using drugs or using within your limits?

		Post-			Follow-up	
Condition	N	Mean	S.D.	N	Mean	S.D.
Self-selected	17	3.12	1.12	12	3.25	1.22
Yoked-intervention	16	3.50	1.41	17	3.71	1.21
Control	14	3.00	2.00	15	2.93	1.58

Table 23.

Participant Preference for Message Frequency and Quantity (N = 59)

	Baseline	During	Post-treatment	Follow-up
Frequency				
0 messages	1	8	4	2
1 message	32	15	14	15
2 messages	9	8	17	12
3 messages	9	10	3	4
4 messages	2	4	7	7
5 messages	2	2	1	1
6 messages	0	1	0	1
7 messages	0	0	0	1
8 messages	0	0	0	0
9 messages	1	0	0	0
10 or more messages	3	2	1	1
Quantity				
Less than 1 week	2	5	5	3
1 week	3	7	6	3
2 weeks	5	9	10	12
3 weeks	5	5	5	7
4 weeks	19	11	12	7
5 weeks	7	5	1	2
6 weeks	3	3	1	4
7 weeks	1	0	1	0
8 weeks	4	1	1	1
9 weeks	1	1	0	1
10 or more weeks	8	3	5	4

Figure 1.

Data Collection Timeline

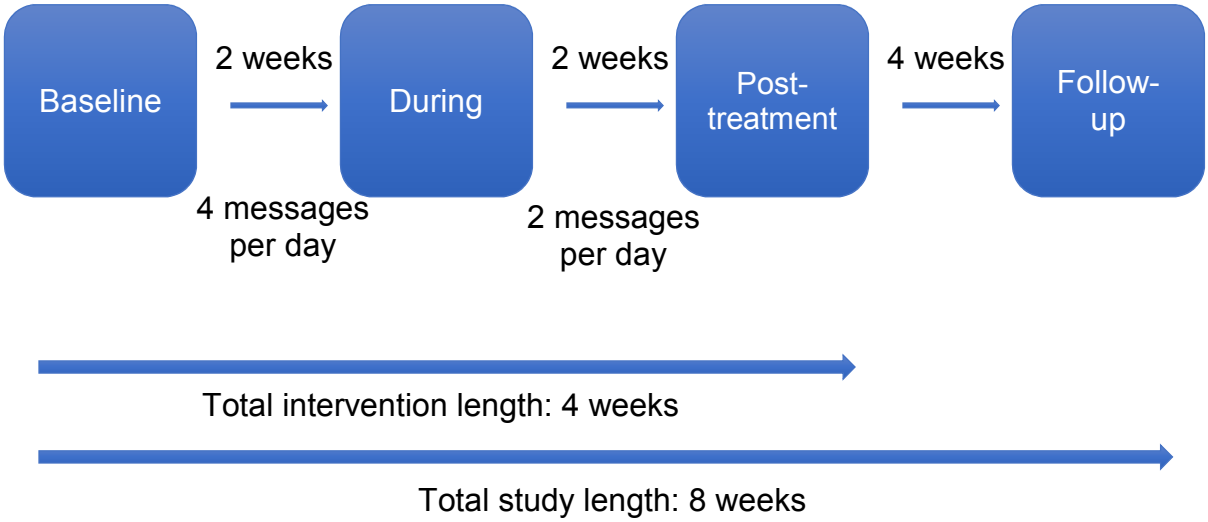
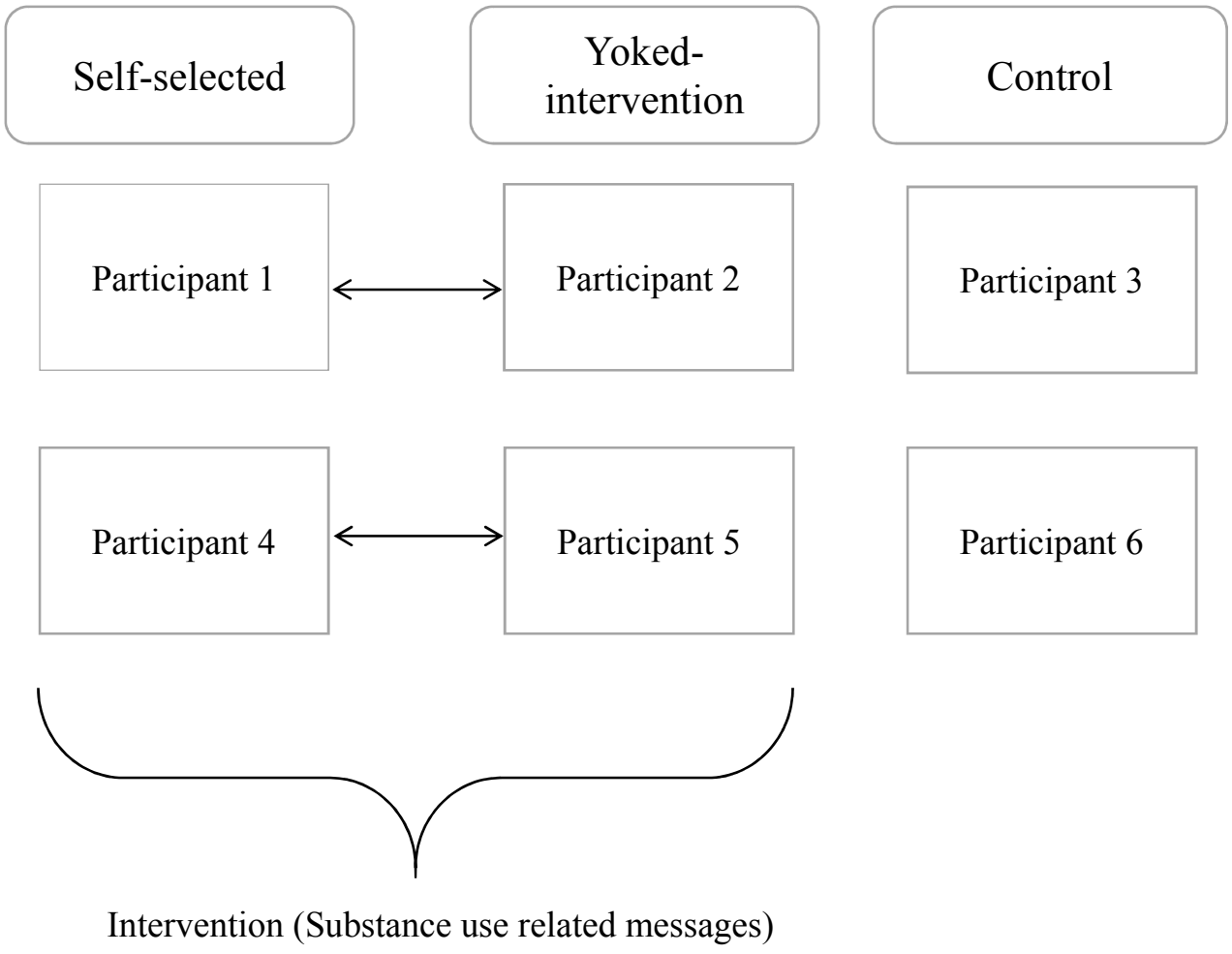


Figure 2.

Example of Participant Condition Assignment



Appendix A.

Intervention and Control Messages

Educational Messages	Baseline (Total/Edu Rank/Overall Rank)	Post-treatment (Total)
1. Live smart. Think of the future.	36 / 1 / 1	2
2. Got an urge? Try to distract yourself with something else.	15 / 10 / 48	2
3. Making thoughtful decisions to not use can help keep you out of trouble.	11 / 18 / 70	0
4. Sometimes you have to sacrifice things you like for a better life.	11 / 18 / 70	1
5. Think about your future. Your health matters.	24 / 2 / 15	1
6. Having a plan can help you stay in control.	12 / 14 / 64	1
7. If you used to spend $20 on drugs a week, by stopping you can save $1,040 a year.	19 / 4 / 34	0
8. We show that we care in different ways. Not using can be one of them.	11 / 18 / 70	0
9. Staying clean and sober takes work. Use your will power and remember to enjoy success!	8 / 23 / 91	1
10. If you stay away from trouble places you will be less likely to be tempted or slip up.	6 / 25 / 97	0
11. You can have an urge and let is pass.	13 / 12 / 58	0
12. You can resist urges. They will pass.	18 / 7 / 41	0
13. You can't use difficult situations as an excuse.	19 / 4 / 34	1
14. Don't view drugs as a reward. Right now they are a problem.	12 / 14 / 64	0

15. Don't give in to temptation.	21 / 3 / 25	0
16. Try something new. Try something that isn't drugs.	18 / 7 / 41	0
17. Make smart choice and stick to it. No exceptions.	17 / 9 / 44	0
18. Got an urge? Consider the consequences.	12 / 14 / 64	0
19. When facing temptation, call on your will power and remember your decision.	14 / 11 / 52	1
20. Setting and aiming for a goal can help you stay in control.	12 / 14 / 64	0
21. Making an exception can be the first step down a bad path.	10 / 22 / 79	0
22. Almost 570,000 people in the U.S. die every year due to drug use.	11 / 18 / 70	0
23. More people die from drug overdoses every year than from guns or car crashes.	8 / 23 / 91	0
24. Plan ahead for tough situations.	13 / 12 / 58	1
25. Sometimes you have to give up things you like for a better future.	19 / 4 / 34	1

Threatening/Consequential	Baseline (Total/Threat Rank/Overall Rank)	Post-treatment (Total)
1. If you don't live smart, you will end up in jail or dead.	16 / 6 / 47	1
2. Got an urge? Think about the consequences.	5 / 25 / 99	1
3. You are going to get in trouble if you don't think and take control.	10 / 19 / 79	1
4. If you keep using, will you get the better life you want?	7 / 24 / 96	0

5. Giving in is giving up on your future.	14 / 9 / 52	2
6. If you lose control, bad things can happen.	14 / 9 / 52	0
7. Do you even care about your money?	14 / 9 / 52	0
8. If you really cared you would stop using.	8 / 21 / 91	2
9. You made the choice to stay clean and sober. Don't let yourself down.	8 / 21 / 91	1
10. Stay away from trouble places.	11 / 16 / 70	1
11. Stay away from trouble.	20 / 2 / 29	2
12. Remember, probation.	11 / 16 / 70	1
13. Remember, there are drug tests.	13 / 13 / 58	1
14. Don't try to get away with it. It never works.	11 / 16 / 70	0
15. Don't forget the consequences from before.	13 / 13 / 58	1
16. Choose your friends wisely.	24 / 1 / 15	3
17. You better not get in trouble!	15 / 7 / 48	0
18. If you slip up you're going to get in trouble.	8 / 21 / 91	0
19. You're letting your down people who really care about you.	13 / 13 / 58	1
20. If you use you're disappointing people who care about you.	9 / 20 / 86	1
21. Think about who your friends really are. Are they part of the problem or the solution?	14 / 9 / 52	1
22. Who are you hurting when you use drugs?	15 / 7 / 48	1
23. People like you better sober.	17 / 4 / 44	2
24. Think about what you want in your future.	17 / 4 / 44	0
25. Remember what happens when you get in trouble.	19 / 3 / 34	1

Supportive/Empowering	Baseline (Total/Support Rank/Overall Rank)	Post-treatment (Total)
1. You chose to live smart. You can do it!	22 / 13 / 21	0
2. It is normal to have an urge to use. You can get through it!	9 / 23 / 86	0
3. Think! Think! Think! Take control of things.	20 / 15 / 29	1
4. This is about a better life. You have the power.	19 / 17 / 34	0
5. Think about your future!	30 / 4 / 5	0
6. You are in control.	32 / 1 / 2	8
7. Think about all the money you are saving!	28 / 6 / 10	3
8. Remember, you really do care, even though sometimes you feel like you don't.	10 / 21 / 79	1
9. You made the choice. You can stay clean and sober!	11 / 20 / 70	1
10. You can stay away from trouble places!	9 / 23 / 86	1
11. You can do it!	23 / 10 / 18	2
12. Be strong. Use will power. Enjoy success	20 / 15 / 29	0
13. Take charge of your life. It's your future. Make it good.	24 / 9 / 15	2
14. You have the power.	23 / 10 / 18	2
15. You got this!	32 / 1 / 2	3
16. You can make it through the storms.	26 / 7 / 11	0
17. Don't let others control you.	23 / 10 / 18	2
18. You're stronger than you think.	32 / 1 / 2	6
19. Remember to accept the things you cannot change.	15 / 19 / 48	3

20. You are loved.	29 / 5 / 7	4
21. You chose to stop using because you care about your health.	6 / 25 / 97	1
22. Every day clean is a way of showing yourself you care.	10 / 21 / 79	0
23. Fight through the tough times!	19 / 17 / 34	0
24. Your future is not set in stone. You have the power to make it great!	25 / 8 / 13	1
25. The people who really care about you will always be by your side.	22 / 13 / 21	2

Commitment reminders	Baseline (Total/Remind Rank/Overall Rank)	Post-treatment (Total)
1. Stick with your choice to live smart.	20 / 11 / 29	0
2. You chose to stop using. That means not using even when you have an urge.	9 / 23 / 86	0
3. You made the decision to take control of things. Keep working toward your goal.	13 / 16 / 58	0
4. Your commitment is to a better life. Stick with the plan.	21 / 8 / 25	0
5. Think about the choice you made for your future!	14 / 15 / 52	0
6. Your decision to stop using means you are in control.	10 / 20 / 79	0
7. Do you care more about drugs or money? Remember your commitment.	11 / 19 / 70	0
8. You chose to stop using. Remember, you care!	10 / 20 / 79	0
9. Stay clean and sober. It's your choice.	10 / 20 / 79	2

10. Not using means staying away from trouble places.	4 / 25 / 100	0
11. Don't try to get away with something. Stick with your decision.	12 / 17 / 64	0
12. Stay focused on your goal.	29 / 2 / 7	3
13. Stay in control of your life.	26 / 4 / 11	3
14. Remember why you are doing this. Think!	22 / 6 / 21	0
15. This decision is for a better life.	30 / 1 / 5	2
16. You decided. You can do it.	19 / 13 / 34	3
17. It's your decision. Today counts.	29 / 2 / 7	1
18. Stay on track with your decision!	25 / 5 / 13	0
19. Stick with the plan.	21 / 8 / 25	2
20. Remember how you got here and why you want to change.	9 / 23 / 86	0
21. You can resist urges.	22 / 6 / 21	3
22. Consider the consequences.	21 / 8 / 25	3
23. You quit because you want to be healthy.	18 / 14 / 41	1
24. You made this choice for a better future.	20 / 11 / 29	0
25. Remember why you decided to stop using? Stick with it!	12 / 17 / 64	2

Control	Baseline (Total/Control Rank/Overall Rank)	Post-treatment (Total)
1. Stretching in the morning can help boost your mood.	N/A	1
2. Getting 8 to 10 hours of sleep each night can help you function better.	N/A	1

3. Remember, calcium helps keep your bones strong.	N/A	1
4. If you brush your teeth everyday it will keep you healthier.	N/A	0
5. Eating fruits and vegetables promotes good health.	N/A	1
6. Not drinking enough water can make you dizzy, tired, and confused.	N/A	0
7. Think about it: eating fruit instead of a candy bar is a smart way to eat less sugar and still have a sweet treat!	N/A	1
8. Skipping breakfast makes you more likely to gain weight.	N/A	1
9. How about your overall health? Try eating blueberries, strawberries, and raspberries.	N/A	2
10. Eating tomatoes and apples can help reduce your risk of asthma and lung diseases.	N/A	2
11. Eating regular, small meals throughout the day can help keep your energy up all day.	N/A	1
12. Remember to reapply sunscreen every two hours.	N/A	0
13. Eating fish can help lower your risk of heart disease, dementia, and depression.	N/A	1
14. Find time to balance work with fun activities.	N/A	1
15. Try working for 25 minutes and then taking a 5-minute break to help with concentration.	N/A	2
16. Creating a list of goals can help you stay focused on your task.	N/A	2
17. Do you like to BBQ? Overcooked and burnt meats can be bad for your health.	N/A	0
18. Too much bright light before going to sleep makes it harder to fall asleep.	N/A	1

19. Watching TV in bed is more likely to keep you awake than help you fall asleep.	N/A	0
20. Eating plenty of protein has been shown to lower blood sugar and blood pressure levels.	N/A	0
21. Did you know whole wheat bread is healthier than white bread?	N/A	1
22. It is important to be physically active for at least 60 minutes per day.	N/A	2
23. You control what goes into your body. Eat mindfully.	N/A	0
24. Texting while driving is dangerous and illegal in many states!	N/A	0
25. Popping zits increases the risk of spreading bacteria and getting more of them.	N/A	1
26. If you take a nap, keep it short. Longer than 20 minutes and you're likely to feel more tired.	N/A	1
27. Make a list to help stay in control of your tasks.	N/A	1
28. If you're nervous about something, practice can help you feel less nervous.	N/A	1

Appendix B.

Responses to open-ended questions about message likes and dislikes

"Like" responses at post-treatment:

- Helped me think about what I want to do in the future for a career
- Informed me on healthy eating habits
- It helped by making me think of what kind of future I want for myself
- Kind of motivated me because it reflected others' perceptions
- Nice reminders about other things you can do to stay healthy
- Reminders of healthy activities
- They helped remind me to stay focused
- They just reminded me
- They made me work harder on my homework
- They served as a reminder and has caused to consider my health more which in turns has decreased the amount of times I have thought about alcohol

"Dislikes" responses at post-treatment:

- They were irrelevant
- They were repetitive. If they were new ones everyday it would be interesting
- Too extreme

"Like" responses at follow-up:

- Kept the messages in mind
- Knowing that someone else was there supporting me
- Good reminder
- They reminded me that being intoxicated was unnecessary in order to have fun.
- They just a good reminder
- Reminders about general health issues
- Helped with other decisions and mentality

"Dislikes" responses at follow-up:

- Lack of relevancy

Final feedback:

- Text messages that included positive vibes instead of the ones that were intimidating were more helpful and the concept of the study was good.
- This was my first psych study and I was very happy to be apart of it!
- Thank you for doing this! These texts acted as a subtle reminder and were very helpful.
- I think that maybe this study could be used for people trying to quit vaping as well. It will provide resolution for those people like me.
- Way too many messages that felt very robotic and not personal
- It is a good idea, I think other people would like it a lot. It seems to really care about the people who want to stop using. Since I do not have an issue the messages were slightly

misguided for me. I do drink alcohol on the occasion, but its once or twice a month so nothing I need help for either. Thanks.

- In the end it helped me on my journey to getting sober
- I think they should be concentrated around a timeline that people say they tend to use drugs. It's annoying to get a text telling me to stay away from drugs or remember my goals while I'm in my 9:30am lectures.
- Just more custom tailored to the person. Some of mine were. kind of religious sounding and I am agnostic.
- It was an interesting experience that definitely made me think about my consumption of alcohol and drugs!
- I think they help slightly but they're only as good as someone wants them to be. It also depends on personality.
- I think the most effective ones are the ones that include stats about deaths or harm related to drugs or alcohol
- They seemed very corny. And it might have been better to not have us pick them because they get very redundant.
- The study seems very interesting and that it could definitely prove to be a beneficial way to help others work on their goals for managing their use of alcohol/drugs. Text messages are definitely an effective way to get a message to someone and is a good way to remind people of their goals.
- They started becoming kind of boring after the second week. if there was more variety that were more inspirational and talked about random health facts you feel more motivated to keep up a healthy life style.
- I really liked then and they were healthful. Except less bout fruit
- No! Thank you!
- If I had chosen more relevant texts, it could've been more useful.
- The messages kept my day going.
- I noticed an overall slight decrease in my desire to use alcohol during the whole study.
- This really helped

Appendix C.

Responses to open-ended questions about message timing preferences on weekdays and weekends

Weekdays.

Baseline

- Friends
- Late night
- Parties (x5)
- At night when going to parties with friends.
- For smoking weed, most evenings/nights when I get home from classes at around 5pm
- When I am with my friends and we want to have a little fun.
- Night (x8)
- None
- Lunch
- Frat parties
- On Tuesday and Thursday nights when I go to parties. Also on Friday nights when I hang out with friends or my girlfriend.
- Late afternoon, night
- 5-9 pm
- Going out (x2)
- Later in the evening like 7
- Midday around 2 to transfer from stressful morning to a better evening.
- Parties, hanging out with friends
- When I go to parties and I feel awkward without alcohol dulling my senses and making me outgoing.
- If I get really stressed, mad, or sad
- 8pm-11 pm
- If there is a party happening that I know friends will be going to.
- Not a lot during week days
- Tuesday and Thursday at 9:30 PM
- Tuesdays and Thursdays around 9 PM
- 8-12am
- Tuesday and Thursday nights
- Mostly on Fridays or days off
- During party days at my fraternity or when we have various events such as gamedays or exchanges with sororities.
- Nighttime on Sundays or Thursday's.
- Evenings at social occasions
- None (x2)
- When my friends are with me or when I'm bored and have nothing else to do.

- I get tempted in the evening, and sometimes I smoke in the morning or drink alcohol in the evening.
- Mostly during the night time when the parties are starting.
- Just Friday occasionally
- N/A would definitely not drink on the weekdays
- 8-10 pm
- When my friends are doing it
- 9pm
- Tuesday and Thursday nights.
- Friday nights.
- Drinking when my friends go out, using nicotine when drunk
- after 10pm with friends or at parties
- Tuesday and Thursday nights
- 8:00pm, 9:00pm, 10:00pm
- Before school

During

- When my friends have weed
- At night (x3)
- Gamedays, Saturday nights
- Tuesday or Thursday nights when my friends go out and party.
- Tuesday, Thursday nights and Friday whole day
- Day
- At night with friends if we had a get together.
- Nights, frat nights
- On Tuesday and Thursday nights when I go to parties at my fraternity.
- Afternoons
- Evening
- Evenings (8-10)
- Tuesday and Thursday nights when my friends and I go out
- The evenings
- Only when I have sudden free time, and I am bored
- After a bad day, parties, with friends
- Late at night at parties
- Thursday nights
- Nights, parties
- With friends
- Past 8pm
- All day
- Tuesdays and Thursdays 9-11PM
- Tuesday and Thursday nights
- Tuesdays and Thursdays
- Evenings
- 9 pm

- On Fridays or if I have nothing going on the next day
- Rarely ever, maybe Friday night
- Friday nights only.
- At night at party
- During parties
- At night, but rarely.
- Parties / Celebrations
- Never
- All the time
- When I'm with friends or right after school at 3
- 8-10pm
- At night
- 10pm
- Tuesday and Thursday evenings after 9:30 pm
- Nighttime
- Friends going out
- Parties, with friends after 10 PM
- No
- Party
- Before school, and when I get home from school

Post-treatment

- At night, post 9-10pm
- Tuesdays and Thursdays nights
- Weekday nights when my friends go out to party.
- Midday
- Friday, Thursday and Tuesday nights or times when I am out with my friends
- The evening with friends on Friday.
- At nights when my friends were going out to parties or using, typically Tuesdays, Thursdays, and Fridays.
- Night (x5)
- Tuesdays
- Tuesday and Thursday nights at 9 pm
- Only evenings beginning around 9 if I do not have work.
- With friends, at parties
- During fraternity parties or when my friends are going to
- Parties (x2)
- On Thursday nights, when the parties are
- If I'm with friends
- After a test
- After work
- Tues, Thurs, 9:30PM
- Tuesday and Thursday (x2)
- During the night on Tuesdays and Thursdays

- 9 pm on Tuesdays and Thursdays
- Fridays or days where I wouldn't need to wake up early
- Parties, with friends in the evening
- The start of the night, when social events are occurring.
- At night with close friends.
- Never (x3)
- Parties and Fridays
- After school around 4 and at night.
- 8-10 pm
- At night or with friends
- 9pm
- Evenings
- if all of my friends/roommates were going out
- 8pm
- With friends when they come up and before and after school

Follow-up

- After 10pm
- Social gatherings
- Tuesday and Thursday nights when parties are going on around the Greek system.
- Friday nights. Thursday nights
- Day
- In the evenings with friends. Typically only on Friday.
- Night time (x4)
- Family
- After 8 or 9 most nights but especially on nights when my fraternity hosts parties.
- Evenings
- 8pm-12am
- None (x6)
- Evening (x2)
- Noon
- With family and friends, evenings, parties
- Parties (x2)
- With friends, hanging out after doing homework to blow off steam.
- After work
- Tuesday Thursday Friday 9PM
- Tuesday Thursday
- 9pm
- If I don't have class in the morning
- Late at night
- At parties
- Social settings at nights
- Pretty much only Friday Night
- 8-10 pm

- Social
- At night, around 9 or 10pm
- Evenings
- Later in the night, if my boyfriend wants to watch a movie and drink wine or something
- Parties, late nights with friends
- Party nights specific for each campus or area
- Before / after school

Weekends.

Baseline
- Late night/during Sunday
- Gamedays and parties
- Saturdays for football games. Sometimes Saturday nights when going to parties with friends.
- At night time starting at 9pm
- Saturday and Sunday Nights with friends.
- Night (x6)
- With friends in a get together/party usually in the evening.
- I rarely drink on the weekends but Saturday nights I have the strongest urge when I am not at home.
- Friday - night
- Saturday - all day (x2)
- Sunday - morning/night
- 4-12 pm
- Being around friends
- Anytime after 5
- Around 9pm - 12pm
- Every night (x2)
- Parties, sporting events, with friends
- Parties (x4)
- If there's a football game. otherwise i will be completely sober on the weekends.
- If I'm hanging with friends
- 6pm - 12 am
- In social settings, such a simple parties or just casual nights with a few friends.
- All day
- Friday at 9:30PM
- Saturday afternoons
- 5-12pm
- When me and my friends decide to drink or use drugs together
- The only time I'd drink is on Saturday, for a party with my fraternity or for a Husky home game.
- Nighttime on Fridays or Saturdays.
- Evenings or late at night at social occasions

- At night, during parties
- During the night when I usually see my friends.
- I'm not tempted to use drugs
- Saturday's especially on game days what tailgating is happening.
- When I'm at parties or at bars.
- Social parties on Friday and Saturdays
- After 6PM most likely. However, if there are events to go to it would just be before them.
- Saturdays and Sunday at around noon and night time.
- 8-10 pm
- When my friends are doing it.
- 9pm
- Saturday game days.
- Saturday nights (x3)
- Using nicotine when I'm with my boyfriend
- Parties, gameday
- 8:00pm, 9:00pm, 10:00pm, 11:00pm, 12:00am
- Mornings. Afternoon. Night.

During-

- When I have weed
- At night, Sunday throughout day
- Gamedays and/or Saturday nights when my friends want to go out and party.
- Saturday Whole day
- Night (x6)
- Evening with my girlfriend and/or with friends.
- With boyfriend
- I rarely drink on the weekends but sometimes when I go out with friends on a Friday night I am tempted to drink with them.
- Mornings
- Evening
- Evenings (7-10)
- Not very often on weekends
- Friday and Saturday nights at like 9-12
- Most likely closer to evening, especially if we are having a rager.
- Evening
- During parties and tailgates
- Gamedays
- Days, on Dawg Saturdays
- With friends
- Past 10pm
- After school or work
- Saturday (x2)
- Friday Nights and Saturdays
- When I'm with friends

- 9pm
- If my friends were doing it
- On Saturday if there's a football game
- Saturday and Sunday nights
- At night while socializing or at a party
- Parties / Celebrations (x5)
- All the time
- 8-10pm
- 10pm
- Husky football game days
- Tailgating, going out with friends
- None
- With friends

Post-treatment

- Most of the time
- Friday nights, game day
- During the evenings when my friends want to go out and party.
- Evening, starting around 9 pm
- Whenever I am out with friends or when I am trying to get creative.
- Evenings with friends because of a lack of responsibilities and a longing to relax and forget about life for a minute.
- Concerts, friends
- Some Saturday nights when I was bored or with my girlfriend.
- Night (x4)
- Fridays and Saturdays
- N/A
- Any time after 12
- Only on evenings starting at 9 if I do not have work.
- With family, parties
- Parties, tailgates
- Boredom
- On football tailgates
- At parties or with friends
- With friends
- After work
- Friday and Saturday 9:30PM
- Maybe Saturdays
- Saturdays during the night
- All day Saturday
- If I was with friends
- parties
- Late into the night or during large social events.
- At night with close friends.

- Parties
- Parties, playing video games or watching a movie
- Saturdays
- Nights. with friends
- 8-10 pm
- At night or with friends
- 9pm (x2)
- Saturday nights/ any time there's a special event.
- Evenings/nights
- If all of my friends/roommates were going out or if my boyfriend wanted to drink
- Football games, special occasions
- With friends whenever they come up

Follow-up

- After 8pm
- Game days or parties
- On Saturday nights when my friends want to go out.
- Saturday Sunday nights
- Night (x6)
- In the evenings with friends.
- Saturday (x2)
- Going out with friends
- Only when I'm bored. Typically on Friday or Saturday nights.
- Evenings (x3)
- 7pm-2am
- None (x3)
- Anytime after 7
- Sporting events, parties, with friends
- Parties & social gatherings like tailgating.
- Parties (x3)
- Gamedays, celebrations
- At night, since I know I won't have to wake up early for class the next day.
- All day
- Saturdays 9PM
- 9pm
- If my friends plan to do it
- At night or late in the day
- Social settings at nights
- Saturday Evening when I hang out with my friends
- Night but low key all day
- 8-10 pm
- Social
- At night, around 9 or 10 pm, but the chances of drinking or using drugs during the day was increased (day parties, game days, other events)

- Social events with friends.
- If my friends are going out
- With friends

Appendix D.

Responses to open-ended question asking for participant created messages and opinion toward messages.

- What is your reason for drinking/smoking/etc.
- Dare to resist drugs
- Remember what your goal is.
- More positive things such as "You can do it" instead of things that would scare me or negative things.
- Remember, you don't need much to have fun
- You want to remember your fun
- Don't be a burden to people- control yourself
- Just stuff that is encouraging and reminds me of my goal.
- Something about saving money
- More of "you can do it" sentiment
- You behave better when you are in control
- You can do this!
- Stay focused!
- Think about what truly matters in your life. It is your family, your future/job, and your friends/SO. Those things may seem distant at times, however they are always there and will in the future. Consequences can always come much later than you think.
- Your future is in your hands
- More general encouragement instead of consequence based
- You can do it
- Don't give in to peer pressure
- Standing up for yourself is evidence of strength
- Focus on the things that matter
- Those messages were pretty good
- Think about who else this could effect
- Don't embarrass yourself
- It's time to stop. Seriously
- Treat your body kindly.
- Do you have control?
- You cool
- Being sober means better grades
- More facts about the dangers
- The negative consequences are greater than the positive consequences. Think wisely before making rash decisions.
- Don't do it.
- They would say how important it is to follow through with my goals and why this decision is for the better.
- You made a promise to yourself. If someone else can resist, why can't you?
- Don't drink and drive

- Dessert isn't worth it
- Missing meals and/or lack of sleep will you make nauseous.
- Remember there are people here for you, don’t give up
- Just encouraging words that were supportive to me.
- You aren't worthless.
- I would choose messages that were more applicable to me. These messages were all very generic and informational, and didn’t feel special or emotional at all. I would have preferred messages that said ‘become the best version of yourself’ or something inspirational, not factual.
- Keep it up! You got this!
- Find and maintain balance.
- Work on stabilizing yourself so you don’t have to constantly battle it.
- You are strong.
- You are important.
- Keep your head up, and your mind clear.
- You are the only one who is in control of your choices. Make the right one, for yourself, and other loved ones.