



Building Social Connections: Testing the Efficacy of Two Brief Cognitive-Behavioral Interventions to Reduce Loneliness Among Young Adults

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Building social connections: Testing the efficacy of two brief cognitive-behavioral interventions
to reduce loneliness among young adults

A dissertation presented

by

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to

The Department of Psychology

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

in the subject of

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Abstract

Background: Loneliness is the negative emotional response that accompanies perceived social isolation. Researchers believe that it is an evolved mechanism for activating a psychobiological stress response in humans, given that social isolation would have signaled survival threat throughout our evolutionary history. However, when prolonged, the stress of loneliness increases risk for both physical and mental health problems. Epidemiological research indicates that young adults experience particularly high rates of loneliness. Furthermore, the high prevalence of loneliness in this age group may be one factor contributing to the increasing rates of mental illness among the current cohort of young adults (i.e., the Millennials, people born in the 1980s and 1990s). Yet little is known about how to mitigate loneliness in this age group. Multi-session cognitive-behavioral interventions have demonstrated efficacy for reducing loneliness in a few studies; however, brief interventions are needed for use as primary prevention measures. The primary aim of the present study was therefore to develop and test the efficacy of two, single-session interventions to reduce loneliness among young adults. The first intervention, termed the Negative Affect Treatment (NAT), taught skills (reappraisal and avoidance reduction) to decrease negative affect in social situations. The second intervention, termed the Positive Affect Treatment (PAT), taught skills (noticing positives and performing kind acts) to increase positive affect in social situations. **Method:** Young adults ($N = 180$) who wished to increase their social

connections were recruited to participate. Participants completed baseline measures in the lab and were then randomized to receive one of three single-session interventions: NAT, PAT, or active control (which taught two skills for self-monitoring of daily activities). Intervention sessions (approximately 60 minutes) were conducted in the lab, guided by detailed protocols. Participants then practiced their assigned skills daily for 13 days, prompted by daily messages delivered to their smartphones. At Day 14 and Day 28, participants completed follow-up measures via online survey. **Results:** Participant retention was good (89% completed the study), and adherence to daily skills practice was excellent (participants completed a mean of 18.16 ($SD = 6.90$) daily skills out of 26 possible skills practice sessions). Multilevel linear modeling was used to examine change from baseline (Day 0) to follow-up (Day 28) in loneliness. Results revealed modest decreases in loneliness during the study period (Cohen's $d = -0.19, p = .003$); however, loneliness change did not differ between the NAT and control intervention (Cohen's $d = 0.15, p = .35$), or between the PAT and control intervention (Cohen's $d = 0.02, p = .89$). Mediation analyses indicated that neither the NAT nor the PAT engaged its target mechanism of NA or PA, respectively, which likely explains the limited efficacy of the active interventions. At Day 28, participants in the NAT reported higher treatment satisfaction than those in the control intervention ($p = .02$). Qualitative feedback at Day 28 suggested that participants desired a more comprehensive loneliness intervention that taught more skills and afforded for a longer practice period. **Discussion:** Loneliness improvement did not differ between the NAT, PAT, and control conditions, and could be explained by extra-therapeutic factors (e.g., regression to the mean, maturation) or non-specific therapeutic factors shared across the three conditions (e.g., expectancy, effort justification, therapist attention). Additional research is therefore needed to develop and test more effective interventions for loneliness among young adults. Cognitive-

behavioral treatments that teach the flexible use of emotion regulation skills across social contexts should be examined in future studies. In addition, researchers should continue to explore scalable modes of treatment delivery (e.g. internet-delivered interventions). Finally, additional research on the causes of chronic loneliness among young adults will further inform treatment development research.

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1. Loneliness: Definition and clinical import

Social connectedness and wellbeing

Human beings have a fundamental need for social connection (Baumeister & Leary, 1995; Bowlby, 1969/1982; J. T. Cacioppo, Hawkley, et al., 2006). Our instinctive drive to establish and maintain social bonds is present throughout the life span. Indeed, John Bowlby, developer of attachment theory, famously wrote that, “attachment behavior is held to characterize human beings from cradle to grave” (Bowlby, 1979, p. 129). Infants evince reflexive behaviors (e.g., crying, smiling, vocalizing, following) that maintain them in close proximity to their caregivers (Bowlby, 1969/1982), whereas adults form social relationships easily and spontaneously (Baumeister & Leary, 1995).

The ubiquity and innate nature of attachment behavior led to the hypothesis that the drive for social connection is an adaptation that has conferred survival advantage for humans throughout evolutionary history (Baumeister & Leary, 1995; Bowlby, 1969/1982; J. T. Cacioppo, Hawkley, et al., 2006). Ancestors living in groups could share food and other resources, work cooperatively, and mount a strong defense against attack, making them arguably likelier to survive than ancestors living in isolation (Cacioppo, Hawkley, et al., 2006). Interestingly, the survival advantage associated with social connection appears to persist in the modern era, as indices of social connection predict reduced risk of premature mortality (House, Landis, & Umberson, 1988) as well as enhanced physical and psychological wellbeing (Cohen & Wills, 1985).

What mechanisms might explain the association between social relationships and surviving and thriving in the modern world? Psychologists Cohen and Wills (1985) famously posited that social connection may contribute to wellbeing via both main effects (i.e. direct

predictive effects of social relationships on wellbeing) and stress-buffering effects (i.e. predictive effects of social relationships on well-being only in the context of stress). With regard to main effects, they hypothesized that social relationships might directly increase individuals' wellbeing by increasing their experience of positive emotions, as positive emotions are the natural byproducts of social interactions and engagement in meaningful social roles (Cohen & Wills, 1985). With regard to stress-buffering, they hypothesized that social supports might alter an individuals' initial appraisals of stressors, rendering them less noxious, and/or social supports might mitigate the impact of stressors on individuals' wellbeing by assisting with coping (Cohen & Wills, 1985). To investigate these hypotheses, Cohen and Wills (1985) conducted a broad literature review of studies on social connectedness and physical and psychological wellbeing, and found support for both direct effects and stress-buffering effects. Specifically, they found that integration into a broad social network is directly associated with wellbeing, while availability of instrumental or emotional support from a relationship partner is associated with wellbeing in the context of stress (Cohen & Wills, 1985).

Thus multiple facets of social connectedness impact wellbeing, and appear to do so via different pathways. This insight illustrates the complexity of the association between social connectedness and wellbeing, as myriad aspects of social connectedness may influence wellbeing via different psychological and biological mechanisms. To address this complexity and to organize research in this field, Berkman, Glass, Brissette, and Seeman (2000) developed a framework that models the impact of different social variables on health. This framework posits that social-structural factors (e.g., culture, socioeconomics, politics and social change) influence characteristics of individuals' social networks (e.g., network size, density, frequency of face-to-face contact), which influence individuals' social experiences (e.g., experiences of social

support, social influence, social engagement, and access to resources; Berkman et al., 2000). Social experiences then affect individuals' health via different mechanisms (e.g., effects on health behaviors such as exercise, psychological factors such as self-efficacy, and physiological factors such as HPA-axis response; Berkman et al., 2000). Some links in this proposed causal chain are already supported by empirical data, such as the inverse association between social support and HPA-axis response (Uchino, Cacioppo, & Kiecolt-Glaser, 1996), while some remain to be studied. In general, this model illustrates that studies on social connectedness and wellbeing should focus on *specific* social experiences and the mechanisms that connect these experiences to wellbeing (Berkman et al., 2000).

In sum, human beings have a fundamental drive to form social connections. This drive is adaptive, as social connectedness is associated with enhanced physical and psychological wellbeing. However, the relationship between social connectedness and wellbeing is complex, as different aspects of individuals' social experiences contribute to health via distinct mechanisms. Research investigating the processes that link social connection to wellbeing should focus on specific social experiences and their concomitant mechanisms.

Loneliness defined

Loneliness is one social experience that has been consistently tied to poor physical and psychological wellbeing. Weiss (1973), one of the early scholars of loneliness, described it as “a chronic distress without redeeming features (p. 15),” that “is caused not by being alone but by being without some definite needed relationship or set of relationships (p. 17).” Other researchers have defined loneliness as “a response to a discrepancy between desired and achieved levels of social contact” (Peplau & Perlman, 1982, p. 8), and as “a complex set of feelings encompassing reactions to the absence of intimate and social needs” (Ernst & Cacioppo,

1999, p. 1). As these definitions make clear, loneliness is not synonymous with being alone. Individuals vary in their desire for social connections as well as in their appraisals of whether their relationships are meeting their needs, and therefore the same objective social circumstances can lead to different levels of loneliness for different people (Peplau & Perlman, 1982). This point is supported by data indicating that loneliness is associated with depression net of the variance accounted for by objective indices of social connectedness such as marital status and social support (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006).

Researchers believe that the human propensity to feel lonely in response to perceived social isolation is an adaptation that motivated our ancestors to resist social separation (Cacioppo, Hawkley, et al., 2006). More precisely, loneliness likely reflects activation of a neural alarm that signaled the existential threat of social separation throughout evolutionary history (Cacioppo, Hawkley, et al., 2006; N. Eisenberg, 2012; MacDonald & Leary, 2005). The activation of this neural alarm system is so unpleasant that it has been likened to the affective experience that accompanies physical pain (Eisenberg, 2012). In fact, individuals withstanding social separation often use words used to describe pain such as *broken heart* or *hurt feelings* (Eisenberg, 2012). Furthermore, the experience of physical pain and social separation demonstrate activation in some overlapping neural regions, such as the dorsal anterior cingulate cortex (dACC) and the anterior insula, and opioids have been shown to assuage both physical pain and separation distress (Eisenberg, 2012). One possibility is that nodes of the neural network that register physical pain evolved to serve an additional function, i.e. to signal social threats to survival via emotional pain (Eisenberg, 2012). Pain is an ideal mechanism for signaling threats because it motivates a quick response to rectify the pain-inducing situation, and it conditions avoidance of future pain-inducing situations (Baumeister & Leary, 1995). Thus

loneliness describes emotional pain triggered by perceived social isolation.

In sum, loneliness is one social experience tied to reduced wellbeing. Loneliness is the negative affective experience that accompanies perceived social isolation. It is an emotionally painful experience, and likely reflects activation of a neural alarm system that motivated our ancestors to resist social separation via negative reinforcement.

Loneliness elicits a psychobiological stress response

The emotional pain of loneliness is highly aversive and elicits a psychobiological stress response that includes negative emotions and physiological reactions. Researchers have used factor analysis to summarize common emotional responses to loneliness, and found that these responses are best described by the following factors: desperation (desperate, panicked, helpless, afraid, without hope, abandoned, vulnerable), depression (depressed, empty, isolated, sorry for self, melancholy, alienated, longing to be with one special person), impatient boredom (impatient, bored, desire to be elsewhere, uneasy, angry, unable to concentrate), and self-deprecation (unattractive, down on self, stupid, ashamed, insecure) (Rubenstein & Shaver, 1982). In another study, researchers found that loneliness is associated with low mood, anxiety, anger, and fear of negative evaluation (J. T. Cacioppo, Hawkley, et al., 2006). Furthermore, participants who have been hypnotized to feel lonely report lower mood and greater anger, anxiety, and fear of negative evaluation, than participants who have been hypnotized to feel socially connected, which suggests that loneliness *causes* these negative emotional responses (J. T. Cacioppo, Hawkley, et al., 2006).

In extreme or chronic forms, loneliness may also lead to emotional numbness, similar to the analgesia that sometimes follows intense physical pain (DeWall & Baumeister, 2006). In one study, researchers exposed participants to a future-alone manipulation in which they were told

that their personality indicated that they would be alone indefinitely (DeWall & Baumeister, 2006). The researchers then compared physical pain threshold and pain tolerance between participants who were randomized to this future-alone manipulation and participants who were randomized to a future-belonging manipulation, a future-misfortune (non-social) manipulation, or no manipulation (DeWall & Baumeister, 2006). Pain tolerance and pain threshold were both increased among participants in the future-alone condition (DeWall & Baumeister, 2006). Furthermore, these participants demonstrated evidence of emotional numbing, as they reported less anticipated emotion in response to positive and negative future events, and reported less empathy towards a confederate purported to have recently experienced a break-up (DeWall & Baumeister, 2006). Thus loneliness can cause a range of negative emotional experiences including depression, anxiety, anger, and emotional numbness.

Loneliness also triggers a set of psychobiological changes indicative of stress (J. T. Cacioppo & Cacioppo, 2014; S. Cacioppo, Capitanio, & Cacioppo, 2014). For example, lonely individuals demonstrate greater Stroop interference from negative social words than do non-lonely individuals, suggesting that their implicit processing of social threats is heightened (J. T. Cacioppo & Hawkley, 2009). In addition, loneliness is associated with reduced sleep efficiency (i.e., the amount of time in bed spent asleep; J. T. Cacioppo, Hawkley, Berntson, et al., 2002), which may reflect an evolved tendency to be hypervigilant when socially isolated (J. T. Cacioppo & Cacioppo, 2014; S. Cacioppo et al., 2014). Finally, loneliness is associated with increased HPA-axis activity. For example, loneliness has been linked to greater cortisol awakening response among middle-aged adults (Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004), and prior day loneliness predicts heightened cortisol awakening response among older adults (Adam, Hawkley, Kudielka, & Cacioppo, 2006). Researchers have hypothesized that

lonely individuals demonstrate increased social threat-processing, hypervigilance, and heightened HPA-axis activity, because these responses would have promoted survival in the event of social isolation throughout evolutionary history (J. T. Cacioppo & Cacioppo, 2014; S. Cacioppo et al., 2014).

In sum, loneliness elicits secondary responses including negative emotions as well as psychological and biological indices of stress. These responses likely promoted short-term survival during periods of social isolation throughout evolutionary history (J. T. Cacioppo & Cacioppo, 2014; S. Cacioppo et al., 2014). When experienced over a sustained period, however, the stress of loneliness may be detrimental to both physical and mental health.

Loneliness erodes physical and mental health

Loneliness is a correlate and/or established risk factor for myriad negative health outcomes. Its deleterious effects on physical health are numerous. In one study, loneliness predicted blunted antibody response to the influenza vaccine among healthy young adults (Pressman, Cohen, Miller, Barkin, & Rabin, 2005). Loneliness is also associated with indices of poor cardiovascular health including greater age-related increases in systolic blood pressure (J. T. Cacioppo, Hawkley, Crawford, et al., 2002), higher total peripheral resistance (J. T. Cacioppo, Hawkley, Crawford, et al., 2002), and higher body mass index (Lauder, Mummery, Jones, & Caperchione, 2006). Perhaps due to its effect on these outcomes, loneliness is also a risk factor for coronary heart disease (Valtorta, Kanaan, Gilbody, Ronzi, & Hanratty, 2016). Loneliness also predicts increased risk for accelerated cognitive decline and Alzheimer's disease among elderly adults (Wilson et al., 2007). Given these findings, it is not surprising that loneliness is a risk factor for all-cause mortality (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Luo, Hawkley, Waite, & Cacioppo, 2012). A recent meta-analysis indicated that lonely vs. non-lonely

individuals have an estimated 26% increased risk of mortality across research studies (Holt-Lunstad et al., 2015). The association between loneliness and death does not appear to be mediated by negative health behaviors such as smoking or lack of exercise (Luo et al., 2012), further supporting the hypothesis that chronic stress is the mechanism linking loneliness to poor physical health.

The chronic stress of loneliness also appears to erode mental health. Specifically, loneliness predicts increased risk for depression. In one longitudinal, population-based study with older adult participants, loneliness predicted residual increases in depression symptoms after controlling for age, gender, ethnicity, education, income, marital status, social support, hostility, and perceived stress (J. T. Cacioppo, Hughes, et al., 2006). In follow-up analyses with the same sample, researchers found that loneliness predicted residual increases in depression over time, while depression did not predict residual increases in loneliness (J. T. Cacioppo, Hawkley, & Thisted, 2010). Finally, researchers have used marginal structural causal models to quantify the downstream impact that a hypothetical loneliness intervention would have on subsequent depression symptoms (VanderWeele, Hawkley, Thisted, & Cacioppo, 2011). These models suggest that an intervention administered one year prior that caused a one point decrease on the UCLA Loneliness Scale – Revised (Russell, Peplau, & Cutrona, 1980) would predict a 0.27 point decrease on the Center for Epidemiological Studies Depression scale (CES-D; Radloff, 1977) for current depression (VanderWeele et al., 2011). Furthermore, an intervention administered two years prior that caused a one point decrease on the UCLA Loneliness Scale – Revised would predict a 0.40 decrease on the CES-D for current depression, net of the effect of the one year prior intervention (VanderWeele et al., 2011). Taken together, these analyses indicate that loneliness is a risk factor for depression, and that this risk persists for an extended

time course.

Loneliness has also been linked in cross-sectional studies to other mental health problems, including alcohol abuse (Akerlind & Hornquist, 1992), past-year suicidal ideation (Stravynski & Boyer, 2001), and past-year suicide attempt (Stravynski & Boyer, 2001). However data establishing loneliness as a risk factor for these outcomes are lacking. In one study, loneliness was a non-significant predictor of suicidal ideation after controlling for baseline depression symptoms and baseline suicidal ideation, which suggests that loneliness does not increase risk for suicidal thoughts beyond its effect on depression (Lasgaard, Goossens, & Elklit, 2011). However loneliness has been implicated in theoretical models of suicide, including Émile Durkheim's sociological model (see Berkman et al., 2000) as well as the Interpersonal Theory of Suicide (Van Orden et al., 2010). The possible causal connection between loneliness and suicide therefore merits additional study.

In sum, loneliness triggers negative emotions and physiological stress. When sustained, these responses increase risk for physical and mental health problems. The longitudinal association between loneliness and depression is particularly robust. Interventions for loneliness are therefore needed to prevent these negative outcomes.

Public health need for interventions to reduce loneliness

Loneliness is a risk factor for poor physical and mental health, which suggests that effective interventions for loneliness could have a large public health impact. The need for loneliness interventions is particularly relevant for young adults, as this age group appears to be disproportionately affected by loneliness. Weiss (1973) first posited a possible connection between life stage and loneliness, noting that that certain life transitions such as college matriculation, divorce, widowhood, or old age, might be associated with increased social

disconnection (p. 71). Qualter et al. (2015) later noted that social needs and behaviors change across development, and therefore loneliness rates likely vary as a function of age. Population prevalence studies generally support their hypotheses. For example, Hawthorne (2008) reported data on the prevalence of loneliness in Australia, which were collected as part of the Australian Health Omnibus Survey. The results of this study indicated that respondents between the ages of 15-30 reported the greatest prevalence of loneliness, with 9.9% reporting being very socially isolated or isolated and an additional 11.8% reporting being somewhat socially isolated (Hawthorne, 2008). In another study, Victor and Yang (2012) reported data on the prevalence of loneliness in the United Kingdom (UK), which were derived from the European Social Survey. The researchers found a quadratic relationship between loneliness and age in this sample, such that the youngest age group (age 15-29) and the oldest group (age > 60) reported the highest rates of loneliness (Victor & Yang, 2012). The prevalence of sustained loneliness among young adults was 6.3%, and the prevalence among older adults was 7.4% (Victor & Yang, 2012). In addition, 27.5% of young adults and 18.4% of older adults reported feeling lonely some of the time. To date, population prevalence data on loneliness in the United States (US) are unavailable. However the results of the Australian and UK studies suggest that the current cohort of young adults in the US (i.e. the Millennial cohort, people born in the 1980s and 1990s) is highly lonely. Without longitudinal data it is difficult to determine whether this effect is specific to the Millennial cohort or whether it was also present for previous generations of young adults.

In addition to high rates of loneliness, the Millennial cohort also seems affected by higher rates of mental illness than were previous birth cohorts. This trend has been documented across multiple studies. For example, Twenge et al. (2010) conducted a meta-analysis of studies from 1938 to 2007 in which Minnesota Multiphasic Personality Inventory (MMPI) data were collected

from young adults. The results of this meta-analysis indicated that young adults' scores on the clinical scales of the MMPI have increased linearly with time between the years 1938 - 2007 (Twenge et al., 2010). For example, on the D (i.e. depression) scale, young adults in 2007 reported pathological symptoms at 6-8 times the rate that young adults in 1938 reported these symptoms (Twenge et al., 2010). These findings dovetail with population prevalence statistics for Major Depressive Disorder (MDD) in the US. For example, Kessler et al. (2003) examined birth cohort effects on MDD prevalence in the National Comorbidity Survey – Replication (NCS-R). The researchers used Kaplan-Meier curves to model the cumulative lifetime risk of developing MDD (Kessler et al., 2003). They found that Kaplan-Meier curves for more recent birth cohorts had steeper slopes, suggesting the highest lifetime risk for MDD among Millennials (Kessler et al., 2003). In another study, Phillips (2014) modeled suicide risk in the US as a function of age effects, time period effects, and birth cohort effects, and found that each contributed independently to the prediction of suicide rates. Importantly, Phillips (2014) found that suicide risk has increased with each successive birth cohort from the Baby Boomers (people born 1946-1964) to the Millennials, net of age and time period effects. Taken together, these data suggest that Millennials experience higher rates of mental illness than previous birth cohorts.

Myriad factors may have contributed to rising rates of mental illness among successive birth cohorts in the US (Hidaka, 2012). Increasing social disconnection and concomitant loneliness are possible contributing factors (Hidaka, 2012). Hidaka (2012) noted that social disconnection appears to be increasing in tandem with rates of mental illness. Data from the General Social Survey, a nationally representative survey of social networks in the US, indicate that core discussion networks shrank between the years 1985 to 2004 (McPherson, Smith-Lovin, & Brashears, 2006). Specifically, the mean number of close confidants decreased from 2.94 to

2.08, and the modal number of close confidants decreased from 3 to 0 (McPherson et al., 2006). In this same survey, the percentage of people who identified one non-kin confidant decreased from 80.1% to 57.2%, which suggests fraying ties between coworkers, friends, and community members in the US (McPherson et al., 2006). These environmental changes may have impacted birth cohorts differently. Such cohort effects occur when historical shifts exert a variable impact depending on the age at which individuals are exposed to the shift (Phillips, 2014). Millennials were exposed to a disconnected social milieu during adolescence, which is a sensitive period for social and emotional development (Blakemore, 2008), and they may have been particularly impacted by the stress of perceived social isolation. These insights, coupled with data indicating that loneliness is a risk factor for depression (J. T. Cacioppo et al., 2010; J. T. Cacioppo, Hughes, et al., 2006), suggest that loneliness in the US may be one factor contributing to the increasing burden of mental illness among Millennials.

Thus loneliness is a potential target for the primary prevention of depression among Millennials. Prevention efforts are particularly needed given the shortcomings of the current treatment paradigm for depression in the US. For example, in the NCS-R, only 57% of individuals with past year MDD reported receiving treatment and only 22% reported receiving minimally adequate treatment (Kessler et al., 2003). Similarly, in the World Health Organization (WHO) World Mental Health Surveys, only 47% of individuals in the US who reported past year suicidal behavior received mental health treatment (Bruffaerts et al., 2011). Rates of mental health care utilization are even lower among young adults in the US. For example, in the National Epidemiological Study on Alcohol and Related Conditions, only 34% of college students with a past year mood disorder received mental health treatment (Blanco et al., 2008). Furthermore, in the National College Health Assessment Survey, only 18% of college students

who considered attempting suicide in the past year received mental health treatment (Kisch, Leino, & Silverman, 2005). Barriers to treatment among college students include the belief that stress is normal, perceived lack of need for treatment, the belief that the problem will improve by itself, and perceived lack of time for treatment (D. Eisenberg, Golberstein, & Gollust, 2007). Thus the treatment gap seems impervious to the provision of additional mental health services, as many young adults are reluctant to access treatments for depression and suicidal ideation. On the other hand, time-limited interventions that mitigate mental health risk factors, such as loneliness, may be more acceptable to young adults. Indeed, the Center for Disease Control and Prevention (CDC) has proposed that the primary prevention of suicide by targeting social connectedness is part of their five-year vision for reducing suicidal behavior in the US (CDC, 2015). Thus effective interventions to reduce loneliness are of considerable public health import.

In sum, the current cohort of young adults appears disproportionately affected by loneliness as well as mental health problems like depression and suicide. Loneliness is a risk factor for depression and is a possible contributing factor to this trend. Effective interventions for loneliness are therefore needed for the primary prevention of depression and perhaps suicide.

Limitations of extant interventions to reduce loneliness

Despite the considerable public health need for effective interventions for loneliness, the research base on loneliness treatments is scant. Masi, Chen, Hawkley, and Cacioppo (2011) conducted a meta-analysis of this literature. Their analyses included all loneliness intervention studies published from 1970 – 2009 in English, peer-reviewed journals (Masi et al., 2011). The authors identified a total of 50 studies: 12 single group pre-post design studies, 18 non-randomized group comparisons studies, and 20 randomized group comparison studies (Masi et al., 2011). They then classified each study according to one of four intervention categories: a)

social access, i.e. providing opportunity for social contact, b) social support, i.e. providing regular social interaction, c) social skills training, i.e. providing instruction on social skills such as effective communication strategies, and d) social cognitive training, i.e. intervening to alter maladaptive patterns of social cognition (Masi et al., 2011). The researchers calculated the mean effect size within each design type and examined whether intervention category (i.e. social access, social support, social skills training, or social cognitive training) moderated effect size within each design type (Masi et al., 2011).

The results of the meta-analysis revealed modest effect sizes for loneliness interventions. For the pre-post design studies, Masi et al. (2011) reported a mean *Hedges d* effect size of 0.37, which was not moderated by intervention category. For non-randomized group comparison studies, Masi et al. (2011) reported a mean effect size of 0.46, which was not moderated by intervention category. Finally, for the randomized group comparison studies, Masi et al. (2011) reported a mean effect size of 0.20. For this design type, intervention category did moderate effect size (Masi et al., 2011). The social cognitive interventions had the largest mean effect size (0.60), followed by the social support interventions (0.16), the social contact interventions (0.06), and the social skills training interventions (-0.02; Masi et al., 2011). Masi et al. (2011) noted that mean effect sizes were larger for the pre-post and non-randomized comparison studies, but these studies suffered from threats to internal validity such as regression to the mean and selection bias that could partially account for observed treatment effects. The randomized group comparison studies controlled for these factors and thus allowed for less biased estimates of treatment effects (Masi et al., 2011). The authors therefore concluded that social cognitive training (*cf.* cognitive behavioral therapy) for loneliness has the strongest empirical support (Masi et al., 2011). However, this conclusion was based on data from just four randomized controlled studies of

cognitive behavioral therapy (CBT) for loneliness. Furthermore, in depth review of these studies indicates considerable heterogeneity in terms of patient populations, intervention approaches, and outcomes.

In the first randomized controlled CBT study included in the Masi et al. (2011) meta-analysis, Conoley and Garber (1985) examined the impact of two cognitive restructuring interventions to reduce loneliness in college students. The authors recruited a sample of depressed and lonely female students and randomly assigned them to receive two 30-minute sessions of reframing directives (i.e. discussing ways that loneliness may be beneficial), two 30-minute sessions of self-control directives (i.e. discussing ways that reduction of loneliness is within a person's control), or no treatment (Conoley & Garber, 1985). At the end of the two-week study period, they found no significant differences in change in loneliness across the three conditions (Conoley & Garber, 1985).

In the second randomized controlled CBT study included in the Masi et al. (2011) meta-analysis, McWhirter and Horan (1996) investigated the effects of two group treatments for loneliness in a sample of lonely young adults. Participants were randomly assigned to one of four group treatments: a social loneliness intervention, an emotional loneliness intervention, a combined social-emotional loneliness intervention, or a high-demand control intervention (McWhirter & Horan, 1996). The social loneliness intervention utilized CBT techniques to help participants establish friendships (e.g., homework assignments to initiate conversations), while the emotional loneliness intervention utilized CBT techniques to help participants establish intimate relationships (e.g., homework assignments to communicate with significant others) (McWhirter & Horan, 1996). Participants in each condition attended six weekly group treatment sessions (McWhirter & Horan, 1996). At the end of the six-week study period, participants who

had received the social loneliness intervention demonstrated significant reductions in loneliness, though the effects were not maintained at two-month follow-up (McWhirter & Horan, 1996). Participants who had received the emotional loneliness intervention did not demonstrate significant reductions in loneliness (McWhirter & Horan, 1996).

In the third randomized controlled CBT study included in the Masi et al. (2011) meta-analysis, Williams et al. (2004) tested a cognitive-behavioral treatment called the 'Boot Strap Intervention' to reduce psychological distress in U.S. navy recruits. Recruits who were considered to be at-risk for depression or elevated stress were randomly assigned to the Boot Strap Intervention or to a nonintervention control group (Williams et al., 2004). The Boot Strap Intervention was then administered to the experimental group in weekly sessions over the course of 9 weeks (Williams et al., 2004). The treatment focused on cognitive-behavioral strategies to manage stress and increase social connection, such as cognitive restructuring and behavioral assignments to get to know other recruits (Williams et al., 2004). At the end of the 9-week study period, those in the Boot Strap Intervention group reported significantly less loneliness than those in the control group (Williams et al., 2004).

Finally, in the fourth randomized controlled study included in the Masi et al. (2011) meta-analysis, Chiang et al. (2010) examined the effects of Reminiscence Therapy on loneliness among older adult men in Taiwan. Male nursing home residents who participated in the study were randomized to eight, 90-minute sessions of group Reminiscence Therapy or waitlist control (Chiang et al., 2010). Reminiscence therapy consisted of guided group discussions of a variety of topics including sharing memories, increasing participants' awareness and expression of feelings, and identifying and discussing important relationships (Chiang et al., 2010). Participants who

received Reminiscence therapy reported significantly less loneliness at post-test and three-month follow-up, compared to the control group (Chiang et al., 2010).

In addition to these four studies, two randomized controlled studies of CBTs for loneliness have been published subsequent to the Masi et al. (2011) meta-analysis. In one of these studies, Creswell et al. (2012) randomized older adult participants to receive an eight-week Mindfulness Based Stress Reduction (MBSR) group treatment, or to a waitlist control condition. The MBSR treatment utilized guided meditation and yoga exercises to increase present-focused awareness and consisted of two-hour weekly groups, a single day-long retreat, and 30 minutes of daily mindfulness practice (Creswell et al., 2012). At post-test, the MBSR group reported significantly greater reductions in loneliness compared to the control group with a large effect size (Creswell et al., 2012). In the second study, J. T. Cacioppo et al. (2015) developed and tested a social resilience training program to reduce loneliness among army platoons, and compared it to the effects of a cultural awareness training program. Platoons were randomly assigned to receive one of the two programs via eight, 50-minute sessions that were delivered over a one-week period (J. T. Cacioppo et al., 2015). The social resilience training involved instruction regarding various aspects of social cognition including the importance of social connection, perspective taking, and conflict resolution (J. T. Cacioppo et al., 2015). At the end of the one-week study period, participants who had received the social resilience training reported significantly less loneliness than participants who had received the cultural awareness training, though the effect size was small (J. T. Cacioppo et al., 2015).

In sum, extant treatments for loneliness have limitations. A review of the small loneliness treatment literature suggests that CBTs have the strongest empirical support. However, this conclusion is based on data from just six studies that varied greatly in terms of participant

population, intervention approach, and outcome. Several of the researched CBTs were developed for, and tested on, specific groups such as military personnel (J. T. Cacioppo et al., 2015; Williams et al., 2004) or nursing home residents (Chiang et al., 2010), raising questions about the generalizability of these treatments to other populations. Furthermore, treatment techniques varied widely across the studies. Some treatments included standard CBT techniques such as cognitive restructuring and behavioral assignments (McWhirter & Horan, 1996; Williams et al., 2004), whereas others included alternative approaches such as group reminiscence (Chiang et al., 2010), guided meditation (Creswell et al., 2012), and training in perspective taking (J. T. Cacioppo et al., 2015). Furthermore, treatment outcomes and effect sizes varied across the studies, making it difficult to discern which of these approaches are most effective for loneliness. More research is needed to test the efficacy of specific cognitive-behavioral techniques for the treatment of loneliness. Techniques that target mechanisms implicated in the development and maintenance of loneliness should be specifically selected for empirical testing.

Extant CBTs for loneliness are also unsuitable for use as primary prevention interventions for depression. Most of these treatments were delivered in a group format over the course of several weeks or months (J. T. Cacioppo et al., 2015; Chiang et al., 2010; Creswell et al., 2012; McWhirter & Horan, 1996; Williams et al., 2004). Perceived lack of time is a barrier to mental health treatment for young adults (D. Eisenberg et al., 2007), which suggests that multi-session group treatments for loneliness are unlikely to be acceptable or effective for this population. A single-session intervention format might offer a productive alternative. Single-session interventions are efficacious for reducing symptoms of both MDD (e.g., Gawrysiak, Nicholas, & Hopko, 2009) and social anxiety disorder (SAD; e.g., Alden & Trew, 2013), which suggests that a similar approach might work for loneliness.

Therefore, the primary purpose of the present study was to develop and test two, single-session, cognitive-behavioral interventions to reduce loneliness among young adults, and to compare their effects to a psychosocial placebo intervention. These interventions utilized cognitive-behavioral techniques to target distinct psychological mechanisms that have been implicated in the development and maintenance of loneliness.

2. Psychological factors relevant to the development and maintenance of loneliness

Bivariate model of motivation

The primary aim of the present study was to develop single-session, cognitive-behavioral interventions to reduce loneliness among young adults. This goal necessitated an understanding of the motivational systems that govern social behavior. A bivariate model of human motivation has received the most theoretical and empirical support in the literature. The bivariate model holds that two orthogonal motivation systems underlie human emotions and concomitant behaviors: a system for approach and a system for avoidance (see J. T. Cacioppo & Gardner, 1999; Carver & White, 1994; Gable, Reis, & Elliot, 2003; Gray, 1990; Watson, Wiese, Vaidya, & Tellegen, 1999). The approach system, also known as the behavioral activation system (BAS), is sensitive to rewards and motivates approach towards experiences that result in positive emotions (Carver & White, 1994). The avoidance system, also known as the behavioral inhibition system (BIS), is sensitive to punishment and motivates avoidance of experiences that result in negative emotions (Carver & White, 1994). Each system is purported to serve a distinct survival function (J. T. Cacioppo & Gardner, 1999). The BAS likely evolved to motivate exploration and goal-directed behavior, whereas the BIS likely evolved to motivate avoidance of threat (J. T. Cacioppo & Gardner, 1999). Researchers believe that separate neural networks

underlie these systems (Davidson, Jackson, & Kalin, 2000) and that individual differences exist in the sensitivity of both systems (Carver & White, 1994).

Orthogonal dimensions of affect support the approach and avoidance systems (Watson et al., 1999). Positive affect (PA), which ranges from excitement and energy on the high end to sadness on the low end (Watson & Tellegen, 1985), governs BAS motivation. Conversely, negative affect (NA), which ranges from fear and anger on the high end to calmness on the low end (Watson & Tellegen, 1985), governs BIS motivation (Watson et al., 1999). PA covaries with positive, rewarding events in daily life, while NA covaries with negative, threatening events in daily life (Gable, Reis, & Elliot, 2000). Furthermore, individual differences in BAS and BIS sensitivity predict individual differences in daily experiences of PA and NA, respectively (Gable et al., 2000). Individuals with greater BAS sensitivity report greater average PA and greater exposure to positive events, while individuals with greater BIS sensitivity report greater average NA and greater increases in NA in response to negative events (Gable et al., 2000). Thus PA supports and reflects BAS motivation, while NA supports and reflects BIS motivation.

BAS and BIS sensitivity also predict individual differences in patterns of cognition and behavior. With regard to cognition, BAS sensitivity is associated with attention, interpretation, and memory biases for positive stimuli, while BIS sensitivity is associated with attention, interpretation, and memory biases for negative stimuli (Gomez & Gomez, 2002; Rusting & Larsen, 1998). The association of BAS and BIS sensitivity with behavior is more complex, due to the numerous internal and external forces that regulate behavior, including personality characteristics, personal goals, and environmental context (Hofmann, Baumeister, Forster, & Vohs, 2012). However BAS and BIS sensitivity do predict certain behavioral outcomes. First, BAS and BIS sensitivity impact rates of behavioral learning under conditions of reward and

punishment, respectively (Smillie, Dalgleish, & Jackson, 2007). Individuals with high BAS sensitivity demonstrate faster learning under confirmatory feedback (i.e., reward), while individuals with higher BIS sensitivity demonstrate faster learning under corrective feedback (i.e., punishment; Smillie et al., 2007). Second, BAS and BIS sensitivity facilitate the development of behavioral response styles. Individuals with higher BAS sensitivity have a tendency to develop a response bias towards rewarded stimuli, while individuals with higher BIS sensitivity have a tendency to develop a response bias away from punished stimuli (Smillie et al., 2007). BAS and BIS sensitivity also predict distinct patterns of behavioral engagement in daily life. In one study, researchers evaluated the effect of BAS and BIS sensitivity on behavioral approach toward appetitive rewards (e.g., food, drink, social activities, etc.; Hofmann et al., 2012). They found that BAS sensitivity predicted greater appetitive desire, which then predicted behavioral approach (Hofmann et al., 2012). On the other hand, BIS sensitivity negatively predicted behavioral approach, above and beyond the effect of appetitive desire and self-reported reward resistance (Hofmann et al., 2012). The researchers concluded that BAS sensitivity impacts approach motivation through its effect on desire, while BIS sensitivity impacts approach motivation by biasing individuals to ‘do nothing’ in response to desires, perhaps in order to avoid potential risks (Hofmann et al., 2012).

Finally, BAS and BIS sensitivity share statistical variance with dimensions of personality. Personality traits are defined as stable individual differences in emotional, cognitive, and behavioral styles (McCrae & Costa, 1997). Though numerous models of personality structure have been proposed, the preponderance of empirical data support a five-factor model that explains variability in personality according to five dimensions: neuroticism, extraversion, agreeableness, conscientiousness, and openness to experience (McCrae & John, 1992). The

dimensions of extraversion reflects individual differences in one's propensity to be energetic, optimistic, and to experience positive emotions (McCrae & John, 1992), and this dimension is positively correlated with BAS sensitivity (Gable et al., 2003). Neuroticism reflects a propensity to experience chronic distress and negative emotions (McCrae & John, 1992), and is positively correlated with BIS sensitivity (Gable et al., 2003).

In sum, motivated behavior is supported by separate systems of approach (BAS) and avoidance (BIS). The BAS governs approach towards rewards, and high BAS sensitivity predicts a profile of emotions, cognitions, and behaviors, that overlaps with extraversion. Conversely, the BIS governs avoidance of threat, and high BIS sensitivity predicts a profile of emotions, cognitions, and behaviors, that overlaps with neuroticism. Social behavior is likely governed by both systems, which means that loneliness could result from attenuated approach motivation, heightened avoidance motivation, or both.

Bivariate model of the development and maintenance of loneliness

Both the BAS and BIS regulate social behavior, and might therefore be implicated in the development and maintenance of loneliness. The BAS appears to motivate social interactions and the formation of social connections. Baumeister and Leary (1995) noted that humans are inherently motivated to approach potential relationship partners and to form new social bonds. Moments of social connection, such as the experience of falling in love, are characterized by intense PA (Baumeister & Leary, 1995). Furthermore, stimuli that evoke thoughts of a beloved relationship partner are associated with activation in neural areas that support reward processing, such as the ventral tegmental area (VTA; Aron et al., 2005). When a relationship ends or a loved one dies, a person may experience yearning or longing to reunite with the relationship partner (Bonanno & Kaltman, 2001), as well as activation in neural areas that supports reward

processing, including the VTA and nucleus accumbens (Fisher, Brown, Aron, Strong, & Mashek, 2010; O'Connor et al., 2008). Conversely, BIS motivation is most evident in human responses to social exclusion. Baumeister and Leary (1995) observed that experiences of social exclusion or rejection are threatening and are associated with intense NA. Furthermore, experiences of social evaluative threat, social rejection, and loss, are associated with activation in neural regions that overlap with emotional pain processing, including the dorsal anterior cingulate cortex and the anterior insula (N. Eisenberg, 2012). These data suggest that humans are motivated to avoid threats to social relationships. Thus the BAS and BIS regulate social behavior via distinct mechanisms, and attenuated social approach and/or heightened social avoidance might lead to loneliness.

Lonely individuals also exhibit personality traits that suggest attenuated approach motivation and heightened avoidance motivation. Loneliness is negatively associated with extraversion and positively associated with neuroticism (J. T. Cacioppo, Hawkley, et al., 2006; Stokes, 1985). The relationship between neuroticism and loneliness appears to be particularly strong. In one study, Qualter et al. (2013) found that children high in negative reactivity at age five are more likely to experience an elevated and chronic course of loneliness throughout adolescence. In another study Vanhalst, Klimstra, et al. (2012) found that neuroticism strengthens the bidirectional, longitudinal associations between loneliness and depression among adolescents. Given that BAS sensitivity overlaps with extraversion and BIS sensitivity overlaps with neuroticism (Gable et al., 2003), these results further support the hypothesis that loneliness is caused by attenuated approach motivation and/or heightened avoidance motivation.

Finally, BAS and BIS dysregulation are implicated in etiological models social anxiety disorder (SAD) and MDD, which are two mental disorders that share phenomenological overlap

with loneliness. SAD is an anxiety disorder characterized by intense fear and anxiety in social situations, as well as a pervasive social avoidance behavior (APA, 2013). Social anxiety is positively associated with loneliness (Bruch, Kaflowitz, & Pearl, 1988), and individuals with SAD report difficulties forming and maintaining social relationships (Alden & Taylor, 2010). Thus etiological models of SAD may inform our understanding of the factors that contribute to loneliness. Alden and Taylor (2010) proposed that SAD is caused both by heightened social avoidance behavior as well as attenuated approach motivation in social situations. They noted that Brown, Chorpita, and Barlow (1998) identified SAD as the only anxiety disorder characterized by both low PA and high NA (Alden & Taylor, 2010). Furthermore, Alden and Taylor (2010) referenced research indicating that individuals with SAD report equal approach and avoidance motivation in novel social situations, whereas healthy individuals reports mainly approach motivation (Meleshko & Alden, 1993). Alden and Taylor (2010) hypothesized that multiple factors likely contribute to attenuated approach motivation among those with SAD. For example, in one study, researchers found that individuals with SAD generated interpretations of positive social experiences that render these experiences less rewarding (e.g., the belief that a positive social experience increases the chance of a subsequent negative social experience; Alden, Taylor, Mellings, & Laposa, 2008). Furthermore, they found that these interpretations partially mediated the association between participants' social interaction anxiety and low PA (Alden et al., 2008). In sum, Alden and Taylor (2010) proposed that attenuated social approach and heightened social avoidance both contribute to the reinforcing cycle of thoughts, emotions, and behaviors, that causes SAD. Loneliness may result from a similar process.

BAS and BIS dysregulation have also been implicated in the development and maintenance of MDD. Research suggests that MDD and loneliness are overlapping but distinct

syndromes. Questionnaire items that assess MDD and loneliness load on separate statistical factors, but these factors are strongly correlated ($r = .54$; J. T. Cacioppo, Hawkley, et al., 2006). Furthermore, loneliness is sometimes identified as a symptom of MDD (Radloff, 1977) and is an established risk factor for MDD (J. T. Cacioppo et al., 2010). Thus etiological models of MDD may inform our understanding of the factors that contribute to loneliness. Though myriad biological, psychological, and environmental factors have been implicated in the development of MDD, behavioral models hold that MDD is caused by the dysregulation of motivated behavior. Ferster (1973) hypothesized that MDD develops when an individual experiences too much aversive control (i.e. negative reinforcement) and not enough positive control (i.e. positive reinforcement) over behavior. As a result, a person with MDD will display a low frequency of approach behaviors and a high frequency of avoidance behavior, both of which serve to maintain the disorder (Ferster, 1973). This model is supported by data indicating individuals with MDD engage in fewer positive daily events than individuals without MDD (Lewinsohn & Graf, 1973), and experience both low PA and high NA in daily life (Brown et al., 1998). Individuals with MDD also tend to have lower BAS sensitivity and higher BIS sensitivity than healthy and psychiatric comparison participants (Kasch, Rottenberg, Arnow, & Gotlib, 2002). Thus, similar to SAD, models of MDD implicate both BAS and BIS dysregulation.

In sum, the BAS and BIS govern social behavior and may contribute to the development and maintenance of loneliness. Lonely individuals tend to report low extraversion and high neuroticism, which is consistent with the hypothesis that loneliness is caused by attenuated approach motivation and heightened avoidance motivation. Furthermore, low approach motivation and high avoidance motivation are both implicated in the etiology of related mental

disorders such as SAD and MDD. This model can be further tested by examining research on affective correlates of loneliness for evidence of BAS/BIS dysregulation.

Loneliness and BAS/BIS: Studies of affect

Data on the subjective experience of loneliness suggests that perceived social isolation leads to low PA and high NA in the moment (J. T. Cacioppo, Hawkley, et al., 2006; Rubenstein & Shaver, 1982). First, self-reported emotional reactions to loneliness can be decomposed into four factors: desperation (desperate, panicked, helpless, afraid, without hope, abandoned, vulnerable), depression (depressed, empty, isolated, sorry for self, melancholy, alienated, longing to be with one special person), impatient boredom (impatient, bored, desire to be elsewhere, uneasy, angry, unable to concentrate), and self-deprecation (unattractive, down on self, stupid, ashamed, insecure; Rubenstein & Shaver, 1982). The first and second factors appear to reflect high NA and low PA, respectively. Second, experimental induction of loneliness via hypnosis results in high negative mood, anxiety, and anger, as well as low positive mood and optimism (J. T. Cacioppo, Hawkley, et al., 2006). Taken together, these data indicated that loneliness triggers both low PA and high NA.

Given that loneliness leads to low PA and high NA in the moment, it is not surprising that chronically lonely individuals experience low average PA and high average NA in daily life. In one study, researchers investigated the affective correlates of loneliness in a sample of college students (J. T. Cacioppo et al., 2000). High and low lonely individuals in this sample did not differ on objective indices of social fitness such as physical attractiveness, height, weight, age, socioeconomic status, intelligence, scholastic achievement, or stressful life events (J. T. Cacioppo et al., 2000). However, high and low lonely individuals did differ in self-reported affective experiences (J. T. Cacioppo et al., 2000). Specifically, lonely individuals reported less

vigor, less sociability, less optimism, more fatigue, and more dejection than socially connected individuals, suggesting lower PA in this group (J. T. Cacioppo et al., 2000). Lonely participants also reported more tension, more hostility, more anxiety, more anger, more shyness, and more fear of negative evaluation, than the socially connected participants, suggesting high NA (J. T. Cacioppo et al., 2000). In another study, researchers explored the daily affective experiences of older adults using an ecological momentary assessment (EMA) design (Steptoe, Leigh, & Kumari, 2011). In this study, loneliness predicted lower PA and greater NA in participants' daily lives, above and beyond the variance accounted for by age, sex, marital status, employment, wealth, health, and depression (Steptoe et al., 2011). These studies suggest that chronically lonely individuals experience both low PA and high NA in daily life, and that objective markers of wellbeing such as health or SES do not account for these associations.

Lonely individuals may experience low PA and high NA in daily life because they respond differently to social stimuli. Researchers have explored this hypothesis by using EMA designs. In one study, researchers collected assessments of college students' baseline loneliness as well as reports of their daily social experiences, daily PA, and daily NA (Hawkley, Preacher, & Cacioppo, 2007). They found that participants' baseline loneliness predicted lower average positive social interaction quality in daily life, as well as higher average negative social interaction quality in daily life (Hawkley et al., 2007). However loneliness did not moderate the associations between interaction quality and PA or NA (Hawkley et al., 2007). These results failed to support the hypothesis that lonely individuals experience differential affective responses to social rewards or threats. Researchers observed a different pattern of results in a subsequent EMA study conducted with adolescents (van Roekel et al., 2014). In this study, researchers observed a significant moderating effect of loneliness on the association between negative social

experiences and both PA and NA (van Roekel et al., 2014). Specifically, lonely participants reported greater NA and lower PA in response to negative social experiences (van Roekel et al., 2014). In addition, lonely participants reported greater PA in response to positive social experiences (van Roekel et al., 2014). It therefore remains unclear from EMA studies whether loneliness is associated with aberrant affective response to social stimuli.

Researchers have also explored this question by using laboratory paradigms. In one study, researchers used fMRI to compare patterns of neural activation in response to positive and negative, social and nonsocial pictures between lonely and non-lonely individuals (J. T. Cacioppo, Norris, Decety, Monteleone, & Nusbaum, 2009). They found that for positive social pictures, loneliness was negatively associated with activation in the ventral striatum, which a region that is sensitive to rewarding stimuli (J. T. Cacioppo et al., 2009). However, for positive nonsocial pictures, loneliness was positively associated with activation in the ventral striatum (J. T. Cacioppo et al., 2009). These results suggest that lonely individuals may experience social interactions as less intrinsically rewarding than non-lonely individuals. For negative social pictures, the researchers found a positive association between loneliness and activation in the visual cortex (J. T. Cacioppo et al., 2009). For negative nonsocial pictures, they found no association between loneliness and activation in the visual cortex (J. T. Cacioppo et al., 2009). These results might suggest heightened attention towards negative social stimuli among the lonely, but are difficult to interpret (J. T. Cacioppo et al., 2009). In another study, researchers explored the association between participants' self-reported loneliness and their physiological responses to social stress tasks, such as giving an impromptu speech (J. T. Cacioppo et al., 2000). Lonely individuals in this study demonstrated lower heart rate and heart rate reactivity in response to the stressors (J. T. Cacioppo et al., 2000). Thus, similar to the results of the EMA

studies, the results of laboratory studies have yet to elucidate a consistent pattern of affective responding among the lonely.

In sum, loneliness triggers both low PA and high NA in the moment, and individuals who experience chronic loneliness report lower average PA and higher average NA in daily life. Given the connection between affect and motivation, lonely individuals therefore likely experience low BAS motivation as well as high BIS motivation in social situations. Differential affective responding to social rewards or threats might explain this pattern; however, EMA and laboratory studies have yielded equivocal results. Alternatively, low average PA and high average NA could result from maladaptive patterns of social cognition and/or behavior.

Loneliness and BAS/BIS: Studies of cognition

Lonely individuals could experience low average PA and high average NA due to cognitive biases in the processing of social information. For example, lonely individuals may exhibit an attention bias away from positive social stimuli or towards negative social stimuli, which could have downstream consequences on their affect and motivation. However, studies examining the association between loneliness and attention biases for social stimuli do not support this hypothesis. In one study, researchers exposed lonely and non-lonely individuals to a series of visual arrays that included positive and negative social stimuli as well as positive and negative non-social stimuli, and used an eye-tracking device to measure participants' visual attention towards these stimuli (Lodder et al., 2015). The researchers did not find significant differences between the lonely and non-lonely participants with regard to their visual attention towards positive vs. negative social stimuli, or social vs. non-social stimuli (Lodder et al., 2015). In another study, researchers examined the association between participants' number of close friendships (which served as a proxy for loneliness) and their performance on two attention tasks

(Gardner, Pickett, Jefferis, & Knowles, 2005). The first task was a vocal Stroop in which participants were asked to listen to auditory presentations of words and to name the valence (positive vs. negative) of the word meaning, while ignoring the valence (positive vs. negative) of the vocal tone (Gardner et al., 2005). The researchers found a positive association between loneliness and attention for vocal tone, such that the lonely participants demonstrated greater STROOP interference on incongruent trials spoken in both a positive and negative tone (Gardner et al., 2005). The second task in this study was an emotion detection task, in which participants viewed a series of facial photos for one second and named the emotions depicted in the photos (Gardner et al., 2005). The researchers reported a positive association between loneliness and emotion detection accuracy for both positive and negative emotions (Gardner et al., 2005). Thus, Lodder et al. (2015) reported no differences between lonely and non-lonely individuals in attention towards social stimuli, while Gardner et al. (2005) reported enhanced attention toward social stimuli among the lonely. However, neither study indicated an association between loneliness and an attention bias for either positive or negative social stimuli.

Another possibility is that chronic loneliness might be associated with a bias in the encoding or retrieval of social memories. Specifically, lonely individuals might preferentially encode or retrieve memories of negative social experiences compared to positive social experiences, leading to lower PA and higher NA in daily life. Gardner et al. (2005) investigated this hypothesis by examining the association between participants' loneliness and their incidental memory for social events. In this study, participants read a series of fake diary entries and were asked to form impressions of the diary authors (Gardner et al., 2005). Participants were then given a surprise memory test for events from the diaries (Gardner et al., 2005). The researchers found a positive association between loneliness and memory for both positive and negative

social events from the diaries, and a negative association between loneliness and memory for positive individual events (Gardner et al., 2005). Thus, although loneliness is associated with enhanced memory for social events, this effect is observed for both positive and negative events.

Finally, chronic loneliness might be associated with a bias in the way that individuals interpret or appraise social situations leading to low PA and high NA in daily life. Extant studies provide strong support for this hypothesis. Specifically, lonely individuals seem to interpret social experiences in a manner that renders these experiences less rewarding and more threatening. For example, loneliness is associated with a tendency to generate external, unstable attributions for social successes, and to generate internal, stable attributions for social failures. In one study researchers asked college students to read a series of interpersonal and non-interpersonal scenarios, to imagine themselves in these scenarios, and to choose the most likely explanation for each scenario (Anderson, Horowitz, & de Sales French, 1983). The researchers found that, for interpersonal failure scenarios, participants' loneliness scores were positively associated with ability and trait attributions, and negatively associated with strategy and effort attribution (Anderson et al., 1983). Furthermore, for interpersonal success scenarios, participants' loneliness scores were positively associated with external circumstance attributions (Anderson et al., 1983). Thus lonely individuals appear to blame internal, stable features of themselves (e.g., their abilities and traits) for social failures, and to attribute social successes to external, unstable features of the environment (e.g., luck). Individuals who generate this pattern of attributions are said to possess a depressive attributional style (Seligman, Abramson, Semmel, & Baeyer, 1979).

The cross-sectional association between loneliness and a depressive attributional style has been replicated in subsequent studies. For example, Anderson, Miller, Riger, Dill, and Sedikides

(1994) examined the association between loneliness and attributions for success and failure in a sample of college students. They found a positive association between loneliness and characterological attributions for failure, as well as a negative association between loneliness and behavioral attributions for failure (Anderson et al., 1994). They also found a positive association between loneliness and circumstantial attributions for success (Anderson et al., 1994). In another study, Newall et al. (2009) explored the connection between loneliness and attributions for affiliation (i.e. friendship formation) in a sample of older adults. They found that loneliness was negatively associated with effort attributions for affiliation, and was positively associated with context and luck attributions for affiliation (Newall et al., 2009). A depressive attributional style also appears to be a risk factor for loneliness. Toner and Heaven (2005) found that the tendency to generate stable, global attributions for interpersonal experiences predicted residual increases in loneliness among high school students over a two year period (Toner & Heaven, 2005). One interpretation of these data is that a depressive attributional style actually causes increases in loneliness over time. Another possibility is that individuals whose strategies and efforts prove ineffective in social situations are the most likely to become lonely.

Issues of causality aside, a depressive attributional style may explain why lonely individuals experience low PA and high NA in daily life. Specifically, lonely individuals who attribute social successes to context or luck may be deprived of a sense of self-efficacy and mastery that makes these experiences rewarding. Furthermore, the tendency for lonely individuals to attribute social failures to their own traits and abilities might render these interactions especially threatening. These hypotheses were investigated in a study by Vanhalst et al. (2015). In this study, researchers assessed high school students' loneliness annually for four years and then classified the students according to five loneliness trajectories: stable low,

moderate stable, high decreasing, moderate decreasing, and chronically high (Vanhalst et al., 2015). At year four, the researchers examined students' attributions for social inclusion and exclusion scenarios as well as their affective responses to these scenarios (Vanhalst et al., 2015). Compared to low lonely students, chronically lonely students generated more external, unstable attributions for social inclusion scenarios, and more internal, stable attributions for social exclusions scenarios (Vanhalst et al., 2015). Furthermore chronically lonely students reported less enthusiasm (i.e. low PA) in response to social inclusion scenarios, and greater anxiety and anger (i.e. high NA) in response to social exclusion scenarios (Vanhalst et al., 2015).

Importantly, attributional style partially mediated the association between chronic loneliness and low PA in response to social inclusion, as well as the association between chronic loneliness and high NA in response to social exclusion (Vanhalst et al., 2015). These results suggest that the tendency for lonely individuals to experience lower PA and higher NA in daily life may be partially explained by their tendency to generated unhelpful attributions for social experiences.

In additional to unhelpful attributions, lonely individuals generate other maladaptive appraisals of social situations that likely impact their affective responses and social motivation. For example, lonely individuals evidence lower expectations of social acceptance (Lucas, Knowles, Gardner, Molden, & Jefferis, 2010). In one study, researchers randomized lonely and non-lonely college students to receive either an acceptance or control prime before completing assessments of social behavior (Lucas et al., 2010). Lonely individuals who received the acceptance prime reported less concern with others' evaluations and less social avoidance on subsequent questionnaires, and were more socially responsive during an interaction task, when compared to lonely individuals who had received the control prime (Lucas et al., 2010). Non-lonely students were unaffected by the prime (Lucas et al., 2010). These data suggest that lonely

individuals generally hold negative expectations about social acceptance, and that attenuating these negative expectations can increase PA and approach motivation in social situations. Lonely individuals also seem to hold negative beliefs about others' trustworthiness (Rotenberg et al., 2010). In fact, Rotenberg et al. (2010) demonstrated that low social trust is a risk factor for increasing loneliness over time, and that priming distrust cognitions causes greater state loneliness. The belief that others are untrustworthy likely heightens lonely individuals' NA and avoidance motivation in social situations.

Finally, lonely individuals also hold maladaptive beliefs regarding societal views of negative emotions (Bastian et al., 2015). In a recent study, Bastian et al. (2015) found that college students' loneliness was associated with personal beliefs about the unacceptability of negative emotions as well as perceived social beliefs about the unacceptability of negative emotions. Furthermore, perceived social beliefs about the unacceptability of negative emotions moderated the association between students' depression symptoms and loneliness, such that this association became stronger at higher levels of perceived social unacceptability (Bastian et al., 2015). Personal beliefs about negative emotions did not moderate the association between depression symptoms and loneliness (Bastian et al., 2015). These data suggest that lonely individuals may be reticent to share emotional or stressful experiences with others because they expect self-disclosure to be met by rejection rather than acceptance. These beliefs could result in both low PA and high NA during interactions with relationship partners.

In sum, researchers have investigated biases in social information processing among lonely individuals. Extant studies do not support an association between loneliness and attention or memory biases for negative vs. positive social stimuli. However, lonely individuals do demonstrate biases in their interpretations of social situations. Specifically, lonely individuals

tend to generate unstable, external attributions for social successes and stable, internal attributions for social failures, likely rendering their social experiences less rewarding and more threatening. In addition, lonely individuals hold negative expectations about social acceptance and the trustworthiness of others. These appraisals may explain why lonely individuals self-report fewer positive social events and more negative social events in daily life, as well as lower average PA and higher average NA.

Loneliness and BAS/BIS: Studies of behavior

Given data demonstrating that lonely individuals experience low PA and high NA in daily life, it is not surprising that they also display attenuated social approach behavior and heightened social avoidance behavior. In one of the first studies of social behavior among the lonely, Rubenstein and Shaver (1982) assessed participants' self-reported behavioral reactions to loneliness and decomposed these behaviors into four statistical factors. The factors included sad passivity (crying, sleeping, sitting and thinking, doing nothing, overeating, taking a tranquilizer, watching television, drinking or get 'stoned'), active solitude (studying or working, writing, listening to music, exercising, walking, working on a hobby, going to a movie, reading, playing music), spending money (going shopping), and social contact (calling a friend, visiting someone). Rubenstein and Shaver (1982) found that participants' scores on the sad passivity factor were most strongly correlated with self-reported loneliness and depression. These data suggest that persistently lonely individuals demonstrate both attenuated approach behavior (e.g., doing nothing) as well as heightened avoidance behavior (e.g., substance use).

Subsequent studies have confirmed these insights. With regard to social approach behavior, lonely individuals demonstrate deficits in their drive to connect with both existing and new relationship partners. In one study, researchers asked participants to play a video game in

which they (the protagonist) interacted socially with other characters and rated their loneliness at several points throughout the game (Luhmann, Schonbrodt, Hawkley, & Cacioppo, 2015). At one point during the game, a character who had been introduced as the protagonist's wife left for an indeterminate amount of time and then returned (Luhmann et al., 2015). The researchers found that after the spouse's return, participants' loneliness ratings predicted *less* frequent approach behavior towards the spouse, indicating that the most lonely participants were also the least likely to demonstrate adaptive social approach (Luhmann et al., 2015). In another study, researchers found that participants who had been experimentally manipulated to feel lonely or rejected demonstrated less prosocial behavior on subsequent tasks (Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007). These results suggest that lonely individuals are less likely to perform cooperative or helpful behaviors in the service of reestablishing social connections.

Lonely individuals also demonstrate experiential and behavioral avoidance that may interfere with their ability to form and maintain social connections. For example, Arpin, Mohr, and Brannan (2015) examined the relationship between daily experiences of loneliness and subsequent drinking behavior in a sample of moderate drinkers. They found that participants' self-reported state loneliness predicted prospective increases in their solitary drinking behavior (Arpin et al., 2015). In another study, researchers found that college students who reported pessimistic and avoidant social behaviors experienced increasing loneliness over time (Nurmi & Salmela-Aro, 1997). Finally, individuals who have been experimentally manipulated to feel lonely or socially rejected demonstrate more aggressive behavior towards others (Twenge, Baumeister, Tice, & Stucke, 2001). Though different from social avoidance, aggression is another behavioral response motivated by high NA. Both social avoidance and aggression almost certainly serve to further exacerbate lonely individuals' social disconnection.

One possibility is that poor social skills could account for maladaptive patterns of social behavior among the lonely. However this hypothesis has not been supported by empirical data. For example, Vitkus and Horowitz (1987) examined the social interaction skills of non-lonely vs. lonely participants in a structured, problem-solving task with a confederate. Audiotapes of the tasks were then rated by researchers blind to condition on several objective measures of interaction quality (Vitkus & Horowitz, 1987). The results indicated that lonely participants did not differ from non-lonely participants on the number of solutions generated, the number of unsolicited remarks, the number of partner references, the total interaction time, or the number of self-disclosing statements made during the task (Vitkus & Horowitz, 1987). However, lonely individuals subsequently rated their performance on the task more poorly and reported feeling more depressed and hostile afterwards (Vitkus & Horowitz, 1987). These data suggest that lonely individuals have biased self-perceptions, but not objective social skills deficits.

In other studies, lonely individuals have demonstrated poor performance on some social tasks, but these effects have been explained by factors other than social skills deficits. For example, Jones, Hobb, and Hockenbury (1982) compared social skills between lonely and non-lonely individuals in the context of a laboratory conversation task. They found the lonely participants made fewer references to their partners during the conversation, made fewer statements that advanced or continued the conversation, and asked fewer questions of their partners (Jones et al., 1982). At first glance, these results might suggest social skills deficits among lonely individuals. However the authors conducted a follow-up study with lonely participants in which they randomly selected half of the participants to receive partner-attention training before engaging in the conversation (Jones et al., 1982). Participants who received the training demonstrated more partner attention in their subsequent conversations and reported less

loneliness after the conversations (Jones et al., 1982). These results suggest that lonely individuals may lack the motivation to use appropriate social skills unless instructed to do so.

The high NA experienced by lonely individuals in social situations may also interfere with their ability to perform skillfully. Knowles, Lucas, Baumeister, and Gardner (2015) hypothesized that lonely individuals' intense desire to form social relationships leads them to feel anxiety in social evaluative situations and to hence underperform or "choke" in these situations. They tested this hypothesis by comparing the performance of non-lonely vs. lonely individuals on two social cognition tasks (an emotion recognition task and an emotional vocal Stroop) (Knowles et al., 2015). A randomly selected half of the participants were told that the tasks were indicative of social abilities while the other half were told that the tasks were indicative of academic abilities (Knowles et al., 2015). For both tasks, the researchers found that loneliness predicted poorer performance, but only when the participants had received the social framing (Knowles et al., 2015). Furthermore, this effect was mediated by participants' anxiety and not their motivation (Knowles et al., 2015). Thus lonely individuals may demonstrate difficulties in social interactions, but these difficulties are likely explained by affective factors rather than social skills deficits.

In sum, lonely individuals demonstrate attenuated social approach and heightened social avoidance behavior. Deficits in social skills cannot explain this pattern. Instead it is likely that low PA and high NA impact lonely individuals' BAS and BIS motivation in social situations. Furthermore, low social approach and high social avoidance might have a reciprocal influence on lonely individuals' affective experiences – by limiting their exposure to social rewards and/or by eliciting negative responses from relationship partners.

Proposed loneliness interventions targeting BIS and BAS

Literature on the affective, cognitive, and behavioral correlates of loneliness suggest the existence of two positive feedback loops that may contribute to the development and maintenance of loneliness. The first feedback loop concerns BIS motivation. Lonely individuals endorse beliefs that negative social experiences are the result of indelible personality flaws or skills deficits. When negative social experiences do occur in daily life, lonely individuals are therefore likely to respond with intense NA. Furthermore, lonely individuals tend to view other individuals as untrustworthy, which might motivate social avoidance behavior. Social avoidance likely maintains lonely individuals' high NA in social situations and prevents disconfirmation of negative expectations. Over time, lonely individuals are likely to become increasingly fearful, avoidant, and isolated. The second feedback loop concerns BAS motivation. Lonely individuals tend to view positive social experiences as random events and to hold low expectations for social acceptance. These beliefs could lead to low PA in social situations and attenuated social approach behavior. Low social approach behavior might further exacerbate low PA and prevent the opportunity for lonely individuals to disconfirm their negative expectations. Over time, lonely individuals could become increasingly socially passive and isolated. Either or both of these cycles could explain why loneliness becomes chronic for some individuals.

The primary aim of the present study was to develop and test two, single-session, cognitive-behavioral interventions to reduce loneliness among young adults. The first intervention was designed to target BIS motivation, with the aim of decreasing social avoidance behavior and relieving NA in social situations. This intervention employed an eliminative framework, by targeting the reduction of maladaptive thought and behavior patterns (see Goldiamond, 1974). The second intervention was designed to target BAS motivation, with the

aim of increasing social approach behavior and enhancing PA in social situations. This intervention employed a constructional framework, by seeking to instantiate adaptive thought and behavior patterns (see Goldiamond, 1974). In the present study, I tested the efficacy of both interventions relative to an active control condition.

3. The proposed study

Cognitive-behavioral treatments that target NA and BIS motivation

The cognitive-behavioral treatment literature contains many intervention techniques that seek to reduce NA. Though CBTs for loneliness and related affective disorders, such as MDD and SAD, utilize both eliminative and constructional approaches, the predominant focus of these treatments has traditionally been the reduction of NA via correction of maladaptive thought and behavior patterns. With regard to loneliness, several extant CBTs have operated from an eliminative framework. For example, Young (1982) proposed that chronic loneliness results when an individual becomes stuck at one of the following stages of social development: 1) comfort spending time alone, 2) engaging in activities with casual friends, 3) engaging in self-disclosure with friends, 4) meeting an intimate partner, 5) developing intimacy with a partner, and 5) making a long-term commitment to a partner. He suggested that therapists could use CBT techniques (e.g., eliciting and correcting negative automatic thoughts, conducting behavioral experiments) to help patients overcome cognitive barriers that hinder progression through these stages (Young, 1982). Another example of an eliminative CBT approach to treating loneliness is Social Resilience Training (SRT), which was developed and tested by J. T. Cacioppo et al. (2015). The aim of SRT is to modify maladaptive patterns of social cognition that cause and maintain loneliness (J. T. Cacioppo et al., 2015). SRT strategies help patients notice and correct biased interpretations of nonverbal communication, use disclosure to prevent the spread of social

pain, and resolve conflict (J. T. Cacioppo et al., 2015). Other CBTs for loneliness have utilized similar techniques to help patients modify negative cognitions, reduce social avoidance, and decrease social conflict and stress (e.g., Conoley & Garber, 1985; Williams et al., 2004).

Many CBTs for MDD and SAD also employ eliminative techniques, with the aim of decreasing symptoms by reducing NA and BIS motivation. For example, Cognitive Therapy (CT) for MDD focuses on the role of maladaptive cognitions in initiating and maintaining depressive episodes (Young, Rygh, Weinberger, & Beck, 2008). The cognitive model of depression holds that depressed individuals possess negative beliefs about themselves, the world, and the future, and these beliefs lead to sadness and hopelessness, behavioral deactivation, and depression (Young et al., 2008). CT therapists utilize cognitive challenging to help patients question and modify these negative beliefs (Young et al., 2008). In addition, CT therapists employ behavioral techniques, such as graded task completion, to help patients challenge negative beliefs (Young et al., 2008). CT is superior to placebo for reducing depression symptoms and preventing relapse of MDD (Hollon & Ponniah, 2010), indicating that these techniques are efficacious for the treatment of MDD. CBT protocols for SAD also include eliminative techniques that target NA and BIS motivation. For example, most protocols include cognitive challenging of negative automatic appraisals in social situations (Rodebaugh, Holaway, & Heimberg, 2004). Most protocols also include graded exposure to anxiety-provoking social situations to facilitate reduction of NA in these situations (Rodebaugh et al., 2004). Meta-analyses support the efficacy of CBT for SAD in comparison to waitlist, psychological placebo, and pill placebo (Powers, Sigmarsson, & Emmelkamp, 2008; Rodebaugh et al., 2004). Thus eliminative CBT treatment strategies, including cognitive challenging and exposure, are the foundation of effective CBTs for MDD and SAD.

Some psychologists have proposed that CBTs for affective disorders share common strategies that can be distilled into three core principles of change: cognitive challenging of negative appraisals, reduction of emotional avoidance, and modification of emotion-driven behaviors (Allen, McHugh, & Barlow, 2008). Barlow, Sauer-Zavala, Carl, Bullis, and Ellard (2014) hypothesized that these strategies are efficacious for the treatment of different affective disorders because they target a cluster of thoughts, feelings, and behaviors, which are shared by individuals who develop these disorders. Specifically, Barlow et al. (2014) proposed that the thoughts, feelings, and behaviors, reflective of neuroticism should be the focus of CBT interventions, because these traits play a causal role in the development of affective disorders. According to their model, individuals who experience frequent and intense NA tend to become hypervigilant for threat and to engage in efforts to avoid NA (e.g., behavioral avoidance, cognitive avoidance, safety behaviors; Barlow et al., 2014). Unfortunately, these responses interfere with functioning and have the paradoxical effect of increasing NA and leading to the development of anxiety and depression (Barlow et al., 2014). To mitigate this cycle, Barlow and colleagues developed a transdiagnostic CBT treatment called the Unified Protocol (UP). The UP was designed to change patients' maladaptive responses to negative emotional experiences in order to reduce the intensity and frequency of NA (Barlow et al., 2014). UP treatment techniques include psychoeducation about the cognitive-behavioral model of emotions, training in cognitive reappraisal, reduction of emotional avoidance, and the modification of emotion-driven behaviors via emotion exposures (Allen et al., 2008). The UP is superior to waitlist in reducing symptoms of both anxiety and depression (Farchione et al., 2012).

In sum, many CBTs for loneliness and affective disorders employ eliminative techniques, which aim to alter the maladaptive cognitive and behavior patterns that sustain NA. The UP is a

transdiagnostic treatment that employs these core principles to directly target the thoughts and behaviors that maintain NA. Given the empirical evidence to support cognitive reappraisal and avoidance reduction as interventions for NA, it is probable that these techniques are also efficacious for the reduction of loneliness. I therefore chose to utilize these techniques as the foundational skills of the first single-session intervention in the present study. This single-session intervention was termed the Negative Affect Treatment or NAT.

Negative Affect Treatment (NAT) for loneliness

I developed an intervention protocol for the NAT (see Appendix A: NAT Protocol), and utilized this protocol to administer the NAT to participants in the present study. The NAT was predicated on three aims: 1) to help participants understand the role of certain thoughts and behaviors in maintaining NA in social situations, 2) to teach participants how to engage in cognitive reappraisal of negative cognitions in social situations, and 3) to teach participants how to develop a behavioral plan for countering social avoidance. During the single-session intervention, participants received instructions for how to practice these two skills, i.e. “reappraisal” and “avoidance reduction”. They were asked to practice these skills daily for the subsequent 13 days.

Cognitive-behavioral treatments that target PA and BAS motivation

As noted above, CBTs for affective disorders often focus on the reduction of NA and BIS motivation by seeking to alter maladaptive thought and behavior patterns. However this approach is not the only viable treatment paradigm. Goldiamond (1974) famously wrote that therapists can instantiate beneficial change by constructing adaptive behavioral repertoires (instead of eliminating maladaptive ones). The constructional approach has become the

cornerstone of positive psychology treatments that target PA and BAS motivation (Seligman, Rashid, & Parks, 2006).

The development of thoughts and behaviors that generate positive emotions is a worthy treatment goal in its own right. Frequent positive emotions lead to the subjective experience of happiness and well-being, which are end-states often desired by patients entering psychotherapy (see Fredrickson, 2001). However, Fredrickson (2001) hypothesized that the cultivation of positive emotions has benefits that go beyond hedonic experience. Specifically, Frederickson's (2001) broaden-and-build theory of positive emotions holds that PA leads individuals to think and behave in a more flexible, creative, and open manner, and that these changes promote flourishing and psychological resilience. In support of this hypothesis, Fredrickson (2001) cited experimental research indicating that participants who are in a positive mood think more flexibly, generate larger behavioral repertoires, and recover more quickly from psychosocial stress. Furthermore, the observed connection between positive emotions, flexible thinking, and adaptive behavior, suggests that positive emotions should compound over time in an effect known as an upward spiral (Fredrickson, 2001). The goal of positive psychology treatments is therefore not simply to make patients happier, but rather to generate upward spirals that will render patients more successful and psychologically resilient (Fredrickson, 2001).

Numerous studies have investigated whether intentional cognitive and behavioral techniques can reliably generate positive emotions. In one of the first such studies, Seligman, Steen, Park, and Peterson (2005) recruited participants online and randomly assigned them to receive one of five different happiness interventions or an active control intervention. Participants were instructed to practice their assigned intervention for one week before completing a series of follow-up assessments (Seligman et al., 2005). The happiness

interventions included 1) a gratitude visit (i.e., writing and delivering a letter of gratitude to an important person), 2) counting blessing (i.e., writing down three good things that happened each day and their causes), 3) positive recounting (i.e., recalling a positive memory about oneself and focusing on the strengths displayed in the memory, 4) identifying signature strengths (i.e., completing an assessment of personal strengths and using those strengths in daily life, and 5) using signature strengths in a new way (i.e., completing an assessment of personal strengths and using these strengths in a new way) (Seligman et al., 2005). Relative to the active control condition, participants who completed the gratitude visit reported more happiness at one week and one month follow-up (Seligman et al., 2005). Furthermore participants who counted their blessing reported significantly more happiness at one month, three month, and six month follow-up, while participants who used their signature strengths in a new way reported significantly more happiness at one week, one month, three month, and six month follow-up. (Seligman et al., 2005) The other interventions did not significantly increase happiness relative to the active control condition (Seligman et al., 2005). These results suggest that counting blessings, using strengths in a new way, and to a lesser extent expressing gratitude, can produce sustainable increases in PA (Seligman et al., 2005).

Subsequent studies have identified additional cognitive and behavioral activities that can produce reliable increases in PA. For example, Lyubomirsky, Sheldon, and Schkade (2005) randomly assigned participants to perform acts of kindness (defined as behaviors that benefit other people or make others happy, usually at some cost to oneself) for six weeks, to count their blessing for six weeks, or to perform no treatment. The results of this study indicated that both acts of kindness and counting one's blessings increased participants' well-being relative to no treatment (Lyubomirsky et al., 2005). In another study, Sheldon and Lyubomirsky (2006)

randomly assigned participants to one of three difference happiness exercises: cultivating a sense of gratitude (*cf.* counting one's blessing), visualizing one's best possible self, or to an active control condition of noticing daily life details. Participants were instructed to practice their assigned exercise as much as they wanted for four weeks (Sheldon & Lyubomirsky, 2006). At the end of four weeks, participants reported the frequency with which they performed each exercise and their PA (Sheldon & Lyubomirsky, 2006). The researchers found that exercise frequency predicted PA, and that this effect was especially strong for the participants who visualized their best selves (Sheldon & Lyubomirsky, 2006). Taken together, these studies suggest that numerous different intentional activities can generate sustainable PA including counting one's blessing, performing kind acts, expressing gratitude, cultivating one's personal strengths, and visualizing one's best self. Sin and Lyubomirsky (2009) conducted a meta-analysis of studies examining positive psychology interventions, and found that these interventions produce reliable, moderate treatment effects for both increasing wellbeing ($r = .29$) and reducing depression symptoms ($r = .31$).

Researchers have investigated the optimal activity frequency, activity variety, and mode of delivery, to maximize happiness interventions. In one study, Lyubomirsky et al. (2005) found that participants who performed intentional activities (kind acts or counting blessing) once per week experienced greater effects than participants who performed these activities three times per week. However, in a naturalistic study of the positive psychology smartphone application *Live Happy*, researchers found that users who practiced positive psychology interventions more frequently experienced greater increases in positive mood and happiness at study end point (Parks, Della Porta, Pierce, Zilca, & Lyubomirsky, 2012). These data suggest that greater activity frequency predicts greater treatment effects, though this conclusion conflicts with the results

reported by Lyubomirsky et al. (2005). In an attempt to reconcile these findings, Lyubomirsky and Layous (2013) proposed that the optimal dosage of positive psychology interventions may vary by individual, and that treatment adherence may improve if participants are allowed to determine their own dosage.

With regard to activity variety, researchers have found that diverse practice seems to increase the efficacy of positive psychology interventions. Lyubomirsky and Layous (2013) noted that both theory and research suggest that varied practice of positive activities should produce greater hedonic benefits. For example, Sheldon, Boehm, and Lyubomirsky (2012) found that participants who performed the same kind act once a week experienced less hedonic benefit than participants who performed different kind acts once a week (as cited in Lyubomirsky & Layous, 2013). Varying the activity type also seems to increase treatment efficacy. For example, in the study examining the *Live Happy* application, researchers found that participants who chose to engage in a greater variety of activities from the application experienced greater increases in positive mood and happiness during the study period (Parks et al., 2012). In order to examine the limits of this association, Schueller and Parks (2012) performed an empirical test of the optimal number of activities in a positive psychology treatment package. They recruited participants to an internet-delivered positive psychology intervention and randomized them to receive instruction in 0, 2, 4, or 6 intervention activities (Schueller & Parks, 2012). They found the largest decreases in depression for participants who were randomized to learn either 2 or 4 activities, which suggests a quadratic relationship between activity number and treatment effects (Schueller & Parks, 2012). Finally, researchers have explored the optimal mode of delivery for positive psychology interventions. In their meta-analysis, Sin and Lyubomirsky (2009) found that individual therapy interventions out-performed group interventions as well as self-help

interventions. Taken together, these studies provide useful guidelines for the format of the intervention targeting PA and BAS motivation that were tested in the present study.

Finally, researchers have explored whether constructional interventions that aim to increase PA and BAS motivation can be used to treat psychopathology. For example, Seligman et al. (2006) developed and studied Positive Psychotherapy (PPT) as a possible treatment for individuals with depression symptoms. They found that participants with mild-moderate depression symptoms who were randomized to 6 weeks of group PPT experienced significant reductions in depression at study endpoint, compared to a no treatment control group (Seligman et al., 2006). Furthermore, they found that participants with a diagnosis of MDD who were randomized to 12 weeks of individual PPT reported less depression and greater wellbeing at study endpoint than those who received treatment as usual (Seligman et al., 2006). Thus positive psychology interventions appear efficacious for MDD. These findings dovetail with the strong empirical support for Behavioral Activation (BA), which is another constructional treatment for depression (Dimidjian, Martell, Addis, & Herman-Dunn, 2008). BA is grounded in behavioral theories (e.g., Ferster, 1973) that hold that individuals become depressed when their actions fail to elicit sufficient environmental rewards (Dimidjian et al., 2008). The goal of BA is therefore to help patients reengage with rewarding life activities (Dimidjian et al., 2008). Individuals participating in BA monitor their daily activities and then begin to gradually replace avoidance behaviors with pleasure and mastery tasks (Dimidjian et al., 2008). BA is equivalent to antidepressant medication for the treatment of MDD, and both are superior to pill placebo and CT for more severely depressed patients (Dimidjian et al., 2006). Furthermore, Gawrysiak et al. (2009) found that a single-session of BA treatment outperformed a no treatment control

condition among depressed college students. Thus, constructional interventions that target PA and BAS motivation are efficacious for MDD.

Constructional treatments have also proven efficacious for other mental disorders. For example, Fava, Rafanelli, Cazzaro, Conti, and Grandi (1998) developed and tested Wellbeing Therapy as a treatment for patients with residual symptoms of affective disorders. Wellbeing Therapy involves helping patients modify cognitions that are interfering with moments of wellbeing and encouraging patients to engage in activities associated with mastery and pleasure (Fava et al., 1998). Fava et al. (1998) found that Wellbeing Therapy was superior to standard CBT in reducing residual symptom of depression in individuals who had previously remitted from affective disorders. Furthermore, Fava et al. (2005) found that CBT plus Wellbeing Therapy was more efficacious for the treatment of Generalized Anxiety Disorder (GAD) than CBT alone. In addition, Alden and Trew (2013) tested a brief positive psychology intervention for the treatment of SAD. Their intervention sought to increase PA among those with SAD by asking them to engage in kind acts towards others (Alden & Trew, 2013). Participants in the study were randomly assigned to the kind acts condition in which they were instructed to engage in three kind acts on two days each week for four weeks, or to one of two comparison conditions (behavioral experiments or recording life details) (Alden & Trew, 2013). At the end of the study, participants in the kind acts condition reported greater residual increases in positive affect and greater residual decreases in social avoidance compared to the other conditions (Alden & Trew, 2013). They also reported greater residual increases in relationship satisfaction when compared to the life details condition (Alden & Trew, 2013).

In sum, constructional approaches offer an alternative treatment paradigm to traditional symptom-reduction approaches. Rather than seeking to eliminate maladaptive thoughts, feelings,

and behaviors, constructional treatments aim to generate adaptive cognitive and behavioral repertoires in the service of increasing PA. Positive psychologists have adopted this framework, and have demonstrated that intentional activities (e.g., counting blessings, kind acts) can reliably increase PA. Furthermore, a growing treatment literature demonstrates that these approaches are efficacious for treating both mood and anxiety disorders. Given the evidence that specific intentional activities can increase PA, it is probable that a similar constructional approach can be used to reduce loneliness. I therefore chose to utilize two positive psychology skills, counting blessings and performing kind acts, as the foundational skills for the second single-session intervention in the present study. This single-session intervention was termed the Positive Affect Treatment or PAT.

Positive Affect Treatment (PAT) for loneliness

I developed an intervention protocol for the PAT (see Appendix A: PAT Protocol), and utilized this protocol to administer the PAT to participants in the present study. The PAT was predicated on three aims: 1) to teach participants that an absence of specific thoughts and behaviors could lead to a deficiency of PA in social situations, 2) to teach participants how to notice positives in their social environment, and 3) to teach participants to develop a behavioral plan for engaging in kinds acts towards others. During the single-session intervention, participants received instructions for how to practice these two skills, i.e. “three good things” and “kind acts.” They were asked to practice these skills daily for the subsequent 13 days.

Study Overview

The primary aim of the proposed study was to examine the efficacy of the NAT and PAT, relative to an active control condition, for reducing loneliness among young adults. I compared the NAT and PAT to an active control condition in order to control for the effect of non-specific

intervention elements (e.g., expectancy, therapist attention). I developed an intervention protocol for the control condition (see Appendix A: Control protocol), and utilized this protocol to administer the control intervention in the present study. Procedures for the control condition were based on procedures used in similar studies (see Alden & Trew, 2013; Sheldon & Lyubomirsky, 2006). Specifically, the control intervention had three aims: 1) to provide participants with a plausible rationale for the intervention (i.e. that the fast pace of modern life leads to social disconnection, and that daily mindfulness exercises can counteract this process), 2) to teach participants to perform a daily check-in regarding their activity level, and 3) to teach participants to create an objective list of their daily activities. During the single-session intervention, participants received instructions for how to practice to these skills, i.e. “a daily check-in” and “recording life details”. They were asked to practice these skills daily for the subsequent 13 days.

I evaluated the efficacy of the NAT and PAT, relative to the active control intervention, via a randomized controlled trial (RCT). Specifically, I recruited young adults who endorsed loneliness or a desire to increase their social connections to participate in four-week study on “building social connections.” Participants came to the lab and completed screening measures and baseline questionnaires before being randomly assigned to the NAT, PAT, or active control condition. I then administered the intervention protocols to participants in a single, skills-training session. Participants then practiced their assigned skills for the subsequent 13 days, while completing daily measures of treatment adherence, NA, PA, and social connection. On day 14, participants completed endpoint questionnaires via online survey. On day 28, they completed follow-up questionnaires via online survey.

The primary outcome measures for the present study were assessments of participants' social connection and social behavior. Specifically, I utilized assessments of loneliness, perceived social support, relationship satisfaction, and social behavior, to measure participants' social wellbeing at baseline, endpoint, and follow-up. In addition to these primary outcome measures, I also examined the impact of the interventions on secondary outcomes, including depression symptoms, quality of life, physical activity, and sleep quality. Participants also completed measures of these secondary outcomes at baseline, endpoint, and follow-up.

A third aim of the present study was to evaluate mediators of loneliness change from baseline to follow-up. The NAT and PAT were designed to target specific psychological mechanisms that have been implicated in the development and persistence of loneliness (NA and PA, respectively). I therefore examined whether change in NA mediated the effect of the NAT on change in loneliness, and also examined whether change in PA mediated the effect of the PAT on change in loneliness. Fourth, I explored whether participants' baseline personality traits (neuroticism, extraversion, BIS, BAS drive, BAS fun-seeking, and BAS reward responsiveness) moderated response to the NAT and PAT. Finally, I collected quantitative and qualitative feedback regarding participants' impressions of the intervention conditions, in order to inform potential future revisions of the intervention protocols.

Hypotheses

Aim 1. Examining the effect of the NAT and PAT on primary outcome variables.

H1. Participants randomized to the PAT and the NAT will demonstrate greater reductions in loneliness during the study, compared to participants randomized to the active control condition. Change in loneliness will not differ between the PAT and NAT.

H2: Participants randomized to the PAT and NAT will demonstrate greater improvements in social support during the study, compared to participants randomized to the active control condition. Change in social support will not differ between the PAT and NAT.

H3: Participants randomized to the PAT and NAT will demonstrate greater improvements in relationship satisfaction during the study period, compared to participants randomized to the active control condition. Change in relationship satisfaction will not differ between the PAT and NAT.

H4: Participants randomized to the NAT and PAT will demonstrate greater increases in self-initiated positive social behaviors during the study, compared to participants randomized to the active control condition. Change in self-initiated positive social behaviors will not differ between the NAT and PAT.

H5. Participants randomized to the NAT and PAT will demonstrate greater decreases in self-initiated negative social behaviors during the study, compared to participants randomized to the active control condition. Change in self-initiated negative social behaviors will not differ between the NAT and PAT.

H6: Participants randomized to the NAT and PAT will demonstrate greater increases in other-initiated positive social behaviors during the study, compared to participants randomized to the active control condition. Change in other-initiated positive social behaviors will not differ between the NAT and PAT.

H7. Participants randomized to the NAT and PAT will demonstrate greater decreases in other-initiated negative social behaviors during the study, compared to participants randomized to the active control condition. Change in other-initiated negative social behaviors will not differ between the NAT and PAT.

Aim 2. Examining the effect of the NAT and PAT on secondary outcome variables.

H8: Participants randomized to the PAT and NAT will demonstrate greater improvements in depression symptoms during the study, compared to participants randomized to the active control condition. Change in depression symptoms will not differ between the PAT and NAT.

H9: Participants randomized to the PAT and NAT will demonstrate greater improvements in quality of life during the study, compared to participants randomized to the active control condition. Change in quality of life will not differ between the PAT and NAT.

H10: Participants randomized to the PAT and NAT will demonstrate greater reductions in sleep disturbance during the study, compared to participants randomized to the active control condition. Change in sleep disturbance will not differ between the PAT and NAT.

H11: Participants randomized to the PAT and NAT will demonstrate larger increases in physical activity during the study, compared to participants randomized to the active control condition. Change in physical activity will not differ between the PAT and NAT.

Aim 3. Examining mediators of change of the NAT and PAT.

H12. Change in NA will mediate response to the NAT. Change in NA will not mediate response to the PAT or active control condition.

H13. Change in PA will mediate response to the PAT. Change in PA will not mediate response to the NAT or active control condition.

Aim 4. Examining moderators of the NAT and PAT

H14. Neuroticism will moderate response to the NAT. Participants with high neuroticism will show a larger response to the NAT than participants with low neuroticism. Neuroticism will not moderate response to the PAT or active control condition.

H15. Extraversion will moderate response to the PAT. Participants with low extraversion will show a larger response to the PAT than participants with high extraversion. Extraversion will not moderate response to the NAT or active control condition.

H16: BIS will moderate response to the NAT. Participants with high BIS will show a larger response to the NAT than participants with low BIS. BIS will not moderate response to the PAT or active control condition.

H17. BAS drive will moderate response to the PAT. Participants with low BAS drive will show a larger response to the PAT than participants with high BAS drive. BAS drive will not moderate response to the NAT or active control condition.

H18. BAS fun-seeking will moderate response to the PAT. Participants with low BAS fun-seeking will show a larger response to the PAT than participants with high BAS fun-seeking. BAS fun-seeking will not moderate response to the NAT or active control condition.

H19. BAS reward responsiveness will moderate response to the PAT. Participants with low BAS reward responsiveness will show a larger response to the PAT than participants with high BAS reward responsiveness. BAS reward responsiveness will not moderate response to the NAT or active control condition.

Aim 5. Examining intervention satisfaction and feedback

Aim 5 was exploratory and therefore I did not form a priori hypotheses regarding participants' intervention satisfaction and feedback.

4. Method

Participants

Sample size. Sample size was selected a priori to ensure adequate power for the proposed primary outcome analysis: a one-way ANOVA of residual change in loneliness at Day 14. Sample size was calculated by using G*Power statistical software version 3.1. I specified a one-way ANOVA with 3 groups, power = .80, α = .05, and a medium expected effect size (Cohen's F = .26). These parameters indicated a required sample size of 147 (49 in each study group). The expected effect size was based on a study by Alden and Trew (2013), who observed a Cohen's F of 0.26 for residual change in relationship satisfaction across their three treatment conditions: kind acts, behavioral experiments, and active control.

I ultimately randomized 180 participants (n = 60 per intervention condition). With attrition, the final sample included 161 participants who completed all time-points (control n = 54, NAT n = 54, PAT n = 53; see **Figure 1**). Thus, the study remained adequately powered to detect a medium treatment effect. Given participant attrition, I chose to use Multilevel Modeling (MLM) to examine the effect of intervention condition on primary and secondary outcome variables (see Data Analysis section). Unlike ANOVA, MLM allows for the inclusion of participants with partial data and therefore maximizes power.

Recruitment. Study recruitment occurred from October 2016 to August 2017. Participants were recruited from the Harvard University Department of Psychology study pool as well as from Craigslist. Study advertisements called for individuals who were “lonely” or “feeling disconnected” to participate in a research study on “building social connections.” Interested individuals contacted the research team by phone or email, and were scheduled for an initial phone screen. Phone screening was used to ensure that prospective participants understood the nature of the study and met provisional eligibility criteria. To be eligible at phone screen,

participants were required to 1) be 18-30 years of age, 2) be willing and able to complete the 4-week study (2-hour lab visit, 13 days of study activities, and 2 follow-up surveys), and 3) endorse current loneliness (defined as a score of ≥ 5 on the Three Item Loneliness Scale; Hughes, Waite, Hawkley, & Cacioppo, 2004) OR a desire to increase their level of social connection. In addition, prospective participants were assessed with screening questions for current major depression, mania, hypomania, and psychosis. Individuals answering affirmatively to any of these screening questions were ineligible. Ineligible individuals were thanked and given mental health referral information (as appropriate). Eligible individuals received information about how to sign up for the study. A total of 289 individuals completed phone screening (see **Figure 1**). Of these, 3 were not interested, 49 were ineligible. Of those who were interested and eligible, 188 came for the laboratory visit.

Inclusion and exclusion criteria. Inclusion/exclusion criteria were re-assessed during the initial laboratory visit (see Appendix B: Inclusion/Exclusion checklist). Inclusion criteria were 1) age 18-30 years, 2) willingness to complete the study procedures (2-hour lab visit, 13 days of study activities, and 2 follow-up surveys), and 3) current loneliness (defined as a score of ≥ 5 on the Three Item Loneliness Scale; Hughes et al., 2004) OR a desire to increase one's social connections. Exclusion criteria were current major depressive episode (MDE), past month suicidal thoughts or behaviors, current manic episode, current hypomanic episode, or current psychosis (all assessed with the MINI 7.0; Sheehan et al., 1998). A total of 188 participants consented to participate and were assessed for eligibility (see **Figure 1**). Of those who consented, 6 were excluded for recent suicidal thoughts and 2 for current MDE. Thus 180 participants were randomized to condition and comprised the final sample for analysis.

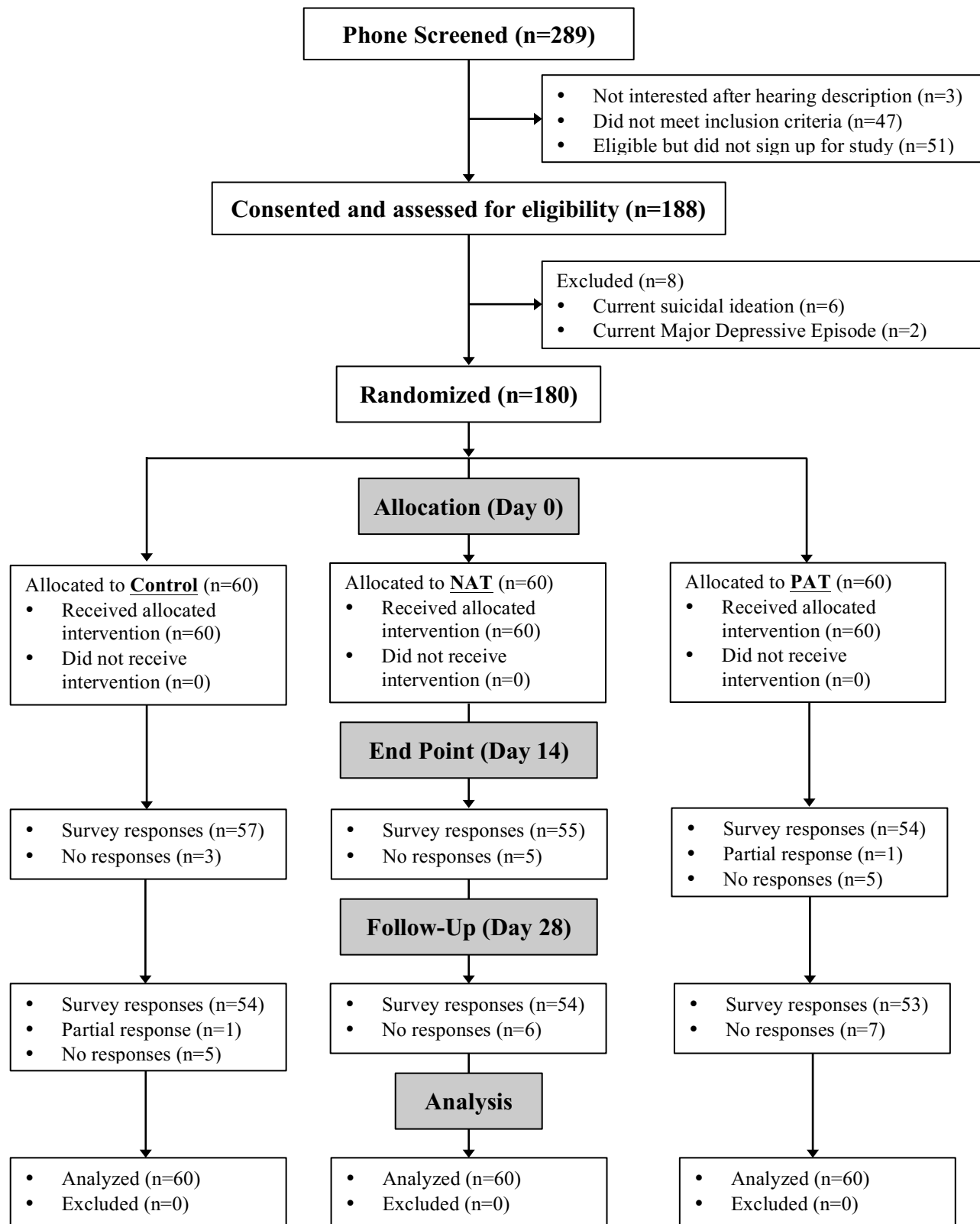


Figure 1. CONSORT Diagram

Procedure

The Harvard University Committee on the Use of Human Subjects approved all study procedures.

Laboratory visit (Day 0).

Eligibility screening. Participants who met provisional eligibility criteria at phone screen were scheduled for a 2-hour laboratory visit. The laboratory visit took place in a private testing room on the Harvard University campus. Participants first provided informed consent and then completed a demographics questionnaire via Qualtrics survey. I then administered the MINI 7.0 (Sheehan et al., 1998) and the inclusion/exclusion checklist to assess for study eligibility. I audio-recorded all eligibility interviews. Ineligible participants were debriefed and paid \$20 or 2 study pool credits. Ineligible participants also received mental health referral information and a suicide risk assessment (as appropriate). Eligible participants proceeded to the next study phase.

Baseline assessment. Participants next completed baseline questionnaire via Qualtrics survey. Baseline questionnaires assessed loneliness, social support, relationship satisfaction, social behavior, depression symptoms, quality of life, physical activity, sleep disturbance, positive and negative affect, and personality characteristics.

Randomization and experimental manipulation. I randomly assigned eligible to participants to one of the three interventions: active control, NAT, or PAT. I then administered the assigned intervention to each participant. I audio-recorded all intervention sessions.

Active control intervention. See Appendix A: Control Protocol for the complete intervention procedures. The active control intervention was adapted from control conditions used in similar studies (Alden & Trew, 2013; Sheldon & Lyubomirsky, 2006). The ostensible rationale for the active control condition was that the intervention would help participants

increase their social interactions by increasing mindfulness of daily activities. The intervention consisted of eight modules.

1. **Discussion of motivation:** In order to increase participants' engagement with the intervention, I first asked them to describe their motivation for increasing their social connections. I then provided reflective listening and validation.
2. **Incremental theory prime:** Research suggests that lonely individuals tend to endorse an entity theory of social abilities (Anderson et al., 1983). In order to increase engagement with the intervention, I therefore presented participants with information to support an incremental theory (see Dweck & Leggett, 1988) of social abilities.
3. **Overview of the treatment model:** I explained that social disconnection might be exacerbated by the fast pace of modern life, which limits time for daily social interactions. I illustrated this model by using a hypothetical example as well as an example from participants' lives. I explained that the study intervention would counteract this process by teaching skills to increase participants' mindfulness of their daily activities.
4. **Teach skill – A Daily Check-in:** I explained that one way to increase mindfulness of daily activities is to make a rating of how busy/overwhelmed one feels each day. I showed participants how to make this rating using a 1-10 scale. I asked participants to practice this skill in session by using a worksheet. I then encouraged them to practice the skill once daily for the subsequent 13 days.
5. **Teach skill – Recording Life Details:** I explained that another way to increase mindfulness of daily activities is to write an objective list of one's daily activities. I showed participants how to write an objective list of their daily activities within 6-hour

time blocks (12AM- 6AM, 6AM- 12PM, 12PM- 6PM, and 6PM- 12AM). I asked participants to practice this skill in session using a worksheet. I then encouraged them to practice the skill once daily for the subsequent 13 days.

6. **Treatment review:** I asked participants to repeat the treatment rationale and the procedures for each skill. I used this opportunity to correct any inaccuracies.
7. **Discuss implementation intentions:** In order to increase participants' compliance, I asked them to brainstorm and record implementation intentions plans for when they would engage in daily skills practice. Implementation intentions are 'if-then' plans for enacting goal directed behavior (see Toli, Webb, & Hardy, 2016).
8. **Instructions for daily practice:** Finally, I gave participants instructions for daily skills practice and adherence ratings. Participants had the option to complete adherence ratings via the RealLife Exp application (Life Data LLC, Marion, IN) or paper-and-pencil diary. Participants who chose the first option received the RealLife Exp Instructions (see Appendix C. Real Life Exp instructions) and downloaded the Real Life Exp application to their phones in session. Participants who chose the paper-and-pencil format received the Practice Instructions (see Appendix D: Practice instructions) and a packet of questionnaires.

Negative Affect Treatment (NAT). See Appendix A: NAT Protocol for the complete intervention procedures. The protocol was based on treatment strategies described in the UP manual (Barlow, Ellard, et al., 2011; Barlow, Farchione, et al., 2011), as the UP explicitly targets the reduction of maladaptive thoughts and behaviors that maintain NA. The intervention consisted of eight modules. Modules 1, 2, 6, 7, and 8 were identical to the active control protocol. Modules 3, 4 and 5 were unique to the NAT intervention.

1. **Discussion of motivation:** Same as active control.
2. **Incremental theory prime:** Same as active control.
3. **Overview of the treatment model:** I explained that social disconnection might develop if an individual becomes stuck in a cycle of thoughts, feeling, and behaviors that leads to high levels of negative emotion in social situations. I illustrated the three-component model by using a hypothetical example as well as an example from participants' lives. Finally, I explained that the study intervention would counteract this process through skills that target specific thinking and behavioral patterns.
4. **Teach skill – Reappraisal:** I explained that one way to make social situations less distressing is to identify and reappraise negative interpretations in these situations. To teach reappraisal, I asked participants to first think of a recent time when they experienced a negative emotion in a social situation. I then asked them to identify 1) their initial negative interpretation and 2) a more positive reinterpretation. I asked participants to practice reappraisal for another recent social situation, and to record their practice on a worksheet. Finally, I encouraged participants to practice reappraisal once per day for the subsequent 13 days.
5. **Teach skill – Avoidance Reduction:** I explained that another strategy to make social interactions less distressing is to practice eliminating emotional avoidance behaviors in social situations. I explained that emotional avoidance takes multiple forms including overt behavioral avoidance, cognitive avoidance (e.g., distraction, mental checking), and safety behaviors (e.g., carrying cellphone). I then explained that these behaviors reinforce the belief that social situations are threatening as well as the belief that one cannot cope without avoidance. I asked participants to identify two ways that they might be engaging

in emotional avoidance in social situations. I then helped participants design a behavioral plan for how to replace avoidance behaviors with avoidance-reduction behaviors (e.g., eating in the cafeteria instead of alone in dorm room). Participants recorded their behavioral plan on a worksheet. I then encouraged them to perform one avoidance-reduction behavior daily for the subsequent 13 days.

6. **Treatment review:** Same as active control.
7. **Discuss implementation intentions:** Same as active control
8. **Instructions for daily practice:** Same as active control.

Positive Affect Treatment (PAT). See Appendix A: PAT Protocol for the complete intervention procedures. The protocol draws from positive psychology interventions (e.g., Lyubomirsky et al., 2005; Seligman et al., 2005; Sheldon & Lyubomirsky, 2006) as well as from BA for MDD (Dimidjian et al., 2008) and kind acts treatment for SAD (Alden & Trew, 2013). The intervention consisted of eight modules. Modules 1, 2, 6, 7, and 8 were identical to the active control protocol. Modules 3, 4 and 5 were unique to the PAT intervention.

1. **Discussion of motivation:** Same as active control.
2. **Incremental theory prime:** Same as active control.
3. **Overview of the treatment model:** I explained that social disconnection might develop if an individual becomes stuck in a cycle of thoughts, feeling, and behaviors that leads to low levels of positive emotions in social situations. I then illustrated the three-component model by using one hypothetical example as well as one example from participants' lives. Finally, I explained that the study intervention would counteract this process through skills that target specific thought and behavioral patterns.

4. **Teach skill – Three Good Things:** I explained that one way to make social interactions feel rewarding and meaningful is to savor positive social experiences in daily life, no matter how small. To achieve this aim, I instructed participants to write down three good social experiences that happened each day and their role in causing these good experiences (see Seligman et al., 2005). I then asked participants to practice this skill in session using a worksheet. Finally, I encouraged participants to practice the skill once daily for the subsequent 13 days.
5. **Teach skill – Kind Acts:** I explained that a reliable way to generate positive emotions in social situations is to perform kind acts for others. I defined kind acts as “acts that benefit others or make others happy, typically at some cost to oneself” (Alden & Trew, 2013, p. 67). I then gave participants a list of example kind acts and asked them to brainstorm additional ideas for kind acts by using a worksheet. Finally, I encouraged participants to perform one kind act a day for the subsequent 13 days, using ideas from the worksheet. I emphasized that the kind acts should be varied (see Lyubomirsky & Layous, 2013) and should ideally occur face-to-face with the recipient.
6. **Treatment review:** Same as active control.
7. **Discuss implementation intentions:** Same as active control.
8. **Instructions for daily practice:** Same as active control.

Post-Intervention Assessment. Participants completed intervention credibility and expectancy questionnaires via Qualtrics survey.

Visit wrap-up. Finally, participants were paid \$20 or 2 study pool credits for the laboratory visit. Participants also received a suicide risk assessment and mental health treatment referral information (as appropriate).

Daily Skills Practice (Days 1-13). During the laboratory visit, I instructed participants to practice their assigned skills once daily for the subsequent 13 days. Participants were given the option of downloading the RealLife Exp application and using the application to access intervention instructions and adherence questionnaires. Alternatively, participants could elect to receive intervention instructions and adherence questionnaires on paper. I offered participants both options so that those who did not own a smart phone could still participate. Of the 180 randomized participants, n=16 chose the paper-and-pencil format for daily questions (8.8%).

RealLife Exp Application. I helped participants to set-up the RealLife Exp application during the initial laboratory visit. Participants then received RealLife Exp prompts on their smartphones for the subsequent 13 days. At 12 PM each day, participants received a ‘daily reminder’ to practice skills (see Appendix E: Daily Reminder). In addition, at 6 PM each day, participants received daily questions, which assessed positive and negative affect, social connectedness, and skills practice adherence for that day (see Appendix F. Daily Questions).¹ Participants had 6 hours to answer these daily questions. Finally, at any time, participants could access instructions for their assigned skills via the application (see Appendix G: Intervention Instructions). Participants who completed at least 12 of the 13 daily question sets received \$10 or 1 study pool credit, regardless of their self-reported skills practice adherence.

Paper-and-pencil. If participants chose the paper-and-pencil format, I gave them paper versions of all materials available through the RealLife Exp application. First, I gave participants the daily reminder text and encouraged them to create a daily reminder on their phone or personal calendar (see Appendix E: Daily Reminder). Second, I gave participants a packet containing the 13 days of daily questions and asked them to fill out one set of questions each

¹ Due to a programming error, the first 18 participants in the control condition received their daily question alert at 4 PM instead of 6 PM.

night (see Appendix F: Daily Questions). Third, I gave participants a paper copy of the intervention instructions (see Appendix G: Intervention instructions). I asked participants to return the packet of daily questions to the lab after completing this phase of the study.

Participants who returned their packets and completed at least 12 of the 13 daily question sets received \$10 or 1 study pool credit, regardless of their self-reported skills practice adherence.

Endpoint (Day 14). At 9 AM on Day 14, participants received an email with a hyperlink to complete endpoint questionnaires via Qualtrics survey. Endpoint questionnaires assessed loneliness, social support, relationship satisfaction, social behavior, depression symptoms, quality of life, physical activity, sleep disturbance, and positive and negative affect. Participants had 72 hours to complete the endpoint survey, and received daily reminder emails during this period until they completed the survey. At the end of the survey, participants received instructions that they could continue to practice their intervention skills as much or as little as they liked (see Appendix H: Endpoint Instructions). Participants received \$10 or 1 study pool credit for completing the endpoint survey.

Follow-up (Day 28). At 9 AM on Day 28, participants received an email with a hyperlink to complete follow-up questionnaires via Qualtrics survey. Follow-up questionnaires assessed loneliness, social support, relationship satisfaction, social behavior, depression symptoms, quality of life, physical activity, sleep disturbance, positive and negative affect, treatment continuation, treatment satisfaction, treatment acceptability, and qualitative feedback. Participants had 72 hours to complete the follow-up survey, and received daily email reminders during this period until they completed the survey. The final page of the follow-up survey contained debriefing information. Participants received \$20 or 2 study pool credits for completing the follow-up survey. For an overview of the procedures, see **Figure 2**.

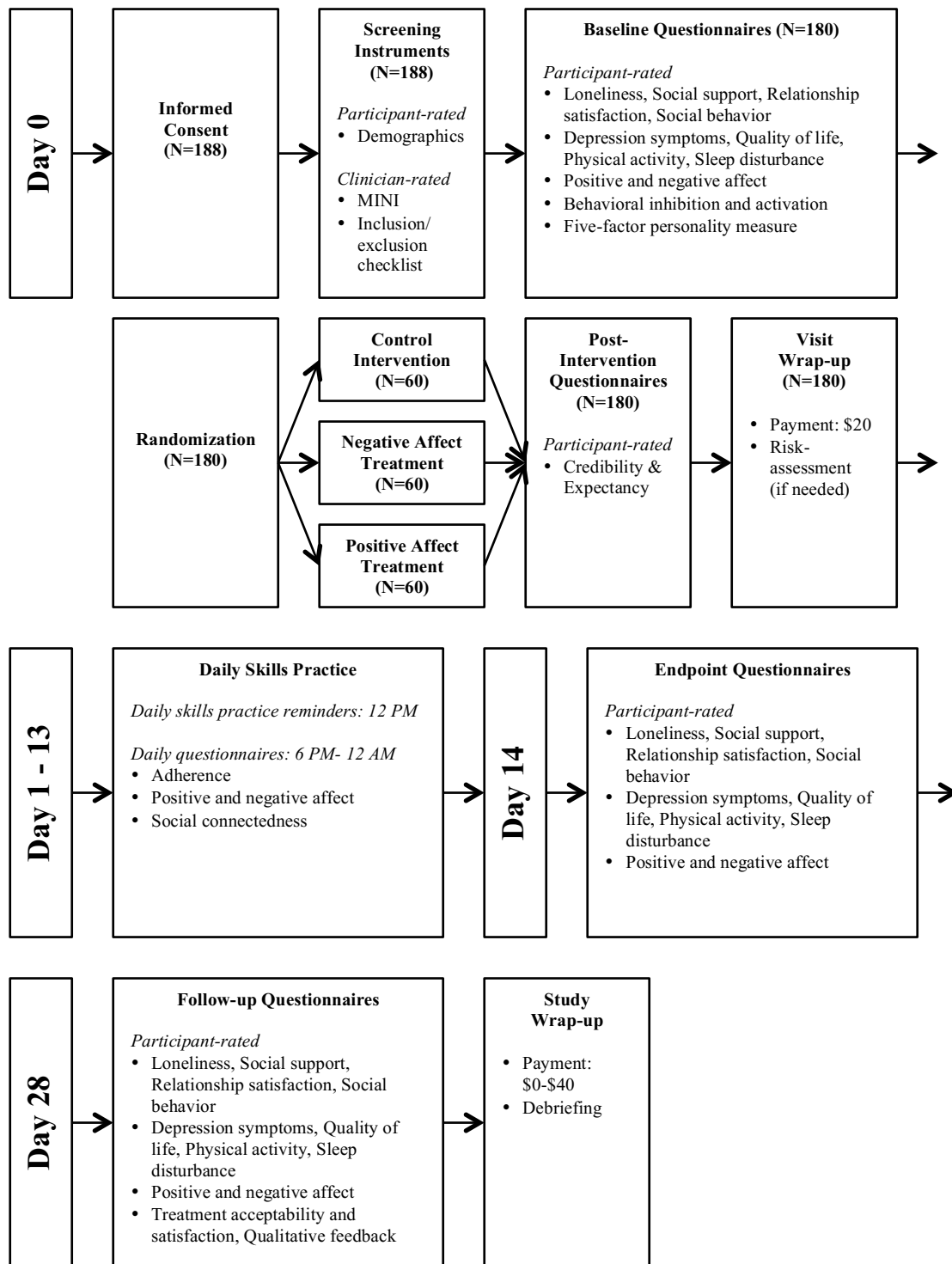


Figure 2. Overview of study procedures

Measures

See Appendix I for questionnaires developed for the present study.

Demographics. Participant demographics were assessed with a brief questionnaire that included questions about age, gender, race, highest level of education, current employment status, religious beliefs, study referral source, and current mental health treatment status.

The Mini International Neuropsychiatric Interview 7.0 (MINI; Sheehan et al., 1998). The MINI 7.0 is a clinician-administered assessment of some current and lifetime DSM-5 and ICD-10 disorders. In the present study, the MINI was used to characterize the study sample and to screen for study exclusion criteria. A prior version of the MINI demonstrated good inter-rater reliability and adequate diagnostic concordance with the Structured Clinical Interview for DSM-III-R – Patient Edition (Sheehan et al., 1998). Psychometric data are not yet published for the MINI 7.0.

UCLA Loneliness Scale – Version 3 (ULS-3; Russell, 1996). The ULS-3 is a 20-item self-report measure of current loneliness. In the present study, the ULS-3 was used to assess participants' loneliness at baseline, endpoint, and follow-up. To complete the scale, respondents specify how often they experience 20 indices of loneliness on a 4-point Likert scale that ranges from 1 (never) to 4 (always). Items are summed to yield a ULS-3 total score, with higher scores reflecting greater loneliness. The ULS-3 has demonstrated excellent internal consistency in prior studies (α 's range = .89 - .94; Russell, 1996). In the present study, the ULS-3 demonstrated excellent internal consistency: baseline α = .94, endpoint α = .92, follow-up α = .93.

Multidimensional Scale of Perceived Social Support (MSPSS; Zimet, Dahlem, Zimet, & Farley, 1988). The MSPSS is a 12-item self-report measure of perceived social support from family, friends, and a significant other. In the present study, the MSPSS was used to assess participants' level of perceived social support at baseline, endpoint, and follow-up. To complete the measure, respondents rate their agreement with various items on a 7-point Likert

scale that ranges from 1 (very strong disagree) to 7 (very strong agree). The 12-items are averaged to yield total social support score, with higher scores reflecting greater perceived support. The MSPSS has demonstrated good internal consistency in prior research ($\alpha = .88$; Zimet et al., 1988). In the present study, the MSPSS demonstrated excellent internal consistency: baseline: $\alpha = .89$, endpoint $\alpha = .91$, follow-up $\alpha = .94$.

Relationship satisfaction (RS). In the present study, RS was assessed at baseline, endpoint, and follow-up using methods described by Alden and Trew (2013). Specifically, participants were asked to respond to the following questions, “During the past week, how satisfied were you with your relationships with ____ [acquaintances, coworkers/classmates, friends, and close friends]?” Participants rated their satisfaction with each relationship type on a 7-point Likert scale that ranged from 1 (not at all satisfied) to 7 (very satisfied). These four items were summed to yield a total RS score, with higher scores indicating greater satisfaction. This measure has demonstrated good internal consistency (α 's range .72 - .75) and sensitivity to change following treatment (Alden & Trew, 2013). In the present study, the RS measure demonstrated good internal consistency: baseline $\alpha = .80$, endpoint $\alpha = .81$, follow-up $\alpha = .84$.

Social Interaction and Initiation Scale (SIIS; Masland, S., Unpublished Scale). The SIIS is a 47-item measure of social behavior over the past week. In the present study, the SIIS was used to assess participants' past-week social behavior at baseline, endpoint, and follow-up. To complete the SIIS, respondents indicate the frequency with which they have engaged in various social behaviors using the following response options: 0, 1, 2, 3, 4, or 5+ (scored as 5). SIIS items assess social behavior across four domains: self-initiated positive social behaviors (e.g., made a new friend), self-initiated negative social behaviors (e.g., had an argument with someone you are close to), other-initiated positive social behaviors (e.g., received socially related

emails or text-messages), and other-initiated negative social behaviors (e.g., had someone cancel plans your initiated). Scores for the relevant items are summed to create a total score for each domain. In pilot testing on Mechanical Turk, the SIIS subscales demonstrated good internal consistency (self-initial positive $\alpha = .80$, self-initiated negative $\alpha = .93$, other-initiated positive $\alpha = .77$, and other-initiated negative $\alpha = .80$; Masland, S., personal communication, July 7, 2016). In the present study, the SIIS Self Positive subscale demonstrated good internal consistency: baseline $\alpha = .85$, endpoint $\alpha = .82$, follow-up $\alpha = .83$; the SIIS Self Negative subscale demonstrated good internal consistency: baseline $\alpha = .81$, endpoint $\alpha = .91$, follow-up $\alpha = .95$; the SIIS Other Positive subscale demonstrated acceptable internal consistency: baseline $\alpha = .71$, endpoint $\alpha = .70$, follow-up $\alpha = .77$; and the SIIS Other Negative subscale demonstrated acceptable internal consistency: baseline $\alpha = .68$, endpoint $\alpha = .87$, follow-up $\alpha = .91$.

The Patient Health Questionnaire Depression Scale – 8-item version (PHQ-8; Kroenke & Spitzer, 2002). The PHQ-8 is an 8-item self-report measure of depression symptom severity over the past 2 weeks. In the present study, the PHQ-8 was used to assess participants' depression symptoms at baseline, endpoint, and follow-up. To complete the PHQ-8, respondents rate the frequency with which they have experienced 8 depression symptoms over the past two weeks on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The total score is the sum of the 8 items. Higher scores indicate greater depression symptom severity and a cutting score of 10 indicates probable MDD. The PHQ-8 is a shortened version of the more commonly used PHQ-9. The PHQ-8 and PHQ-9 are identical except that the PHQ-9 includes a 9th item that assesses suicidal ideation. I chose to use the PHQ-8 in the present study due to ethical concerns about assessing suicidal ideation via Internet survey at endpoint and follow-up, when further risk assessment and intervention are not possible. The PHQ-8 has comparable

operating characteristics to the PHQ-9, likely due to the low base rate of suicidal ideation (Kroenke & Spitzer, 2002). In past research, the PHQ-9 has demonstrated excellent internal consistency (α 's range = .86 - .79; Kroenke, Spitzer, & Williams, 2001) and sensitivity to change with treatment (Kroenke & Spitzer, 2002). In the present study, the PHQ-8 demonstrated acceptable internal consistency: baseline $\alpha = .72$, endpoint $\alpha = .82$, follow-up $\alpha = .87$.

Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form (QLESQ-SF; Endicott, Nee, Harrison, & Blumenthal, 1993). The QLESQ-SF is a 16-item self-report measure of quality of life over the past week. In the present study, the QLESQ-SF was used to assess participants' quality of life at baseline, endpoint, and follow-up. To complete the QLESQ-SF, respondents rate their quality of life in different domains over the past week on a 5-point Likert scale ranging from 1 (very poor) to 5 (very good). The QLESQ-SF score is computed according to the following formula: (sum of items 1-14 – 14)/56. Higher scores indicate better quality of life. The QLESQ-SF also includes two stand-alone items that assess medication-related quality of life (item 15) and global life satisfaction (item 16). The QLESQ-SF has demonstrated excellent internal consistency ($\alpha = .90$; Stevanovic, 2011). In the present study, the QLESQ-SF demonstrated good internal consistency: baseline $\alpha = .85$, endpoint $\alpha = .89$, follow-up $\alpha = .90$.

Sleep.

Patient-Reported Outcomes Measurement Information System Sleep Disturbance Short Form (PROMIS-SD; Yu et al., 2012). The PROMIS-SD is an 8-item assessment of sleep disturbance over the past week. In the present study, the PROMIS-SD was used to assess participants' sleep disturbance at baseline, endpoint, and follow-up. To complete the PROMIS-SD, respondents indicate the degree to which they have experienced various indices of sleep

disturbance over the past week on a 5-point Likert scale (variable anchors). The total PROMIS-SD score is the sum of the relevant items. The PROMIS-SD has demonstrated excellent test information (*cf.* reliability) within two SDs of θ (Yu et al., 2012). In the present study, the PROMIS-SD demonstrated good internal consistency: baseline $\alpha = .89$, endpoint $\alpha = .89$, follow-up $\alpha = .89$

Pittsburg Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Select items from the PSQI were used to further assess participants' subjective sleep quality, sleep duration, and sleep efficiency, at baseline, endpoint, and follow-up. Items were adapted from the original PSQI so that they referenced the past week rather than the past month. The following items were administered: 1) "During the past week, when have you usually gone to bed at night?" 2) "During the past week, what have you usually gotten up in the morning?" 3) During the past week, how many hours of actual sleep did you get at night?" and 4) During the past week, how would you rate your sleep quality overall (participants respond on a 4-point Likert scale)?"

International Physical Activity Questionnaire – Short Format (IPAQ-SF; www.ipaq.ki.se). The IPAQ-SF is a 7-item self-report measure of physical activity. In the present study, the IPAQ-SF was used to assess participants' physical activity at baseline, endpoint, and follow-up. To complete the IPAQ-SF, respondents indicate the time (in days per week and minute per day) that they have spent engaging in vigorous physical activity, moderate physical activity, walking, and sitting, over the past week. Respondents' physical activity on each task can then be converted to Metabolic Equivalence of Task (MET) – min/week values (see www.ipaq.ki.se). MET – min/week values for each task can then be summed to generate a total MET – min/week value, which represents respondents' total energy expenditure for the

week (in proportion to sitting).

Affect.

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS is a 20-item self-report measure of positive and negative mood states. In the present student, the PANAS was used to assess participants' past-week PA and NA at baseline, endpoint, and follow-up. To complete the PANAS, respondents indicate the degree to which they have experienced different emotions over the past week on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). Total scores for the PA and NA subscales are calculated by summing the relevant items. The PANAS subscales have demonstrated excellent internal consistency (PA α 's range = .86 - .90, NA α 's range = .84 - .87; Watson et al., 1988). In the present study, the PANAS PA subscales demonstrated excellent internal consistency: baseline α = .91, endpoint α = .90, follow-up α = .91; and the PANAS NA subscale demonstrated good internal consistency, baseline α = .83, endpoint α = .88, follow-up α = .89.

Additional affect items. The PANAS primarily assesses high arousal emotions (Kuppens, Tuerlinckx, Russell, & Feldman Barrett, 2013). I therefore chose to supplement the PANAS with items that assess past-week medium arousal/positive emotions (happy, satisfied), low arousal/positive emotions (calm, relaxed), medium arousal/negative emotions (sad, disappointed), and low arousal/negative emotions (sleep, sluggish) at baseline, endpoint, and follow-up (see Feldman Barrett, 1998 for similar methods). To complete these additional items, respondents indicated the degree to which they had experienced each emotion over the past week on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). I then calculated average positive affect as the mean of six positive emotions that varied on arousal: calm, relaxed, happy, satisfied, enthusiastic, and excited. I also calculated average negative affect

as the mean of six negative emotions that varied on arousal: sleepy, sluggish, sad, disappointed, nervous, and afraid. In the present study, the average positive affect measure demonstrated good internal consistency: baseline $\alpha = .88$, endpoint $\alpha = .88$, follow-up $\alpha = .90$; and the average negative affect measure demonstrated acceptable internal consistency: baseline $\alpha = .74$, endpoint $\alpha = .82$, follow-up $\alpha = .86$.

The Big Five Inventory (BFI; John, Naumann, & Soto, 2008). The BFI is a 44-item self-report measure of the Big Five dimensions of personality (extraversion, agreeableness, conscientiousness, neuroticism, and openness). In the present study, the BFI was used to assess participants' personality traits at baseline. To complete the BFI, respondents rate the degree to which they identify with 44 different trait descriptors on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Relevant items are then averaged to calculate the Big Five dimension scores. The BFI dimension subscales have demonstrated good internal consistency (α 's range = .79 - .87) and excellent convergent validity with other Big Five measures including the NEO Five-Factor Inventory (John et al., 2008). In the present study, the BFI subscales demonstrated acceptable internal consistency: extraversion $\alpha = .86$, agreeableness $\alpha = .77$, conscientiousness $\alpha = .83$, neuroticism $\alpha = .85$, and openness to experiences $\alpha = .79$.

BIS/BAS Scale (Carver & White, 1994). The BIS/BAS scale is a 20-item self-report measure of BIS and BAS sensitivity. In the present study, the BIS/BAS scale was used to assess participants' BIS and BAS sensitivity at baseline. To complete the BIS/BAS scale, respondents indicate their agreement with 24 self-descriptors on a 4-point Likert scale anchored at 1 (very true for me) and 4 (very false for me). All items except for 2 and 22 are reverse scored. Items 1, 6, 11, and 17 are filler items and are dropped from scoring. The following subscales are then computed by calculating the mean of the relevant items: BIS, BAS Drive, BAS Fun seeking, and

BAS Reward responsiveness. The BIS/BAS subscales have demonstrated acceptable internal consistence (α 's range = .66 - .76; Carver & White, 1994). In the present study, the BIS/BAS subscales demonstrated acceptable internal consistency: BIS α = .82, BAS drive α = .77, BAS fun-seeking α = .68, BAS reward responsiveness α = .67.

Credibility/Expectancy Questionnaire (Devilley & Borkovec, 2000). The Credibility/Expectancy Questionnaire is a 6-item measure of treatment credibility and expectancy. In the present study, the Credibility/Expectancy questionnaire was used to assess participants' views of their assigned intervention immediately post-intervention. In order to complete the credibility/expectancy questionnaire, respondents are asked to answer six questions regarding how much they believe right now that the treatment they just received will be helpful. Respondents rate their responses on a series of Likert scales, with higher ratings reflecting greater confidence in the treatment. Ratings on each item are standardized and then the relevant items are averaged to yield the credibility and expectancy scores. In prior studies, the expectancy subscale has demonstrated acceptable internal consistency (α 's range .53 - .85) and the credibility subscale has demonstrated acceptable internal consistency (α 's range .62 - .78; Devilly & Borkovec, 2000). In the present study, the credibility subscale demonstrated good internal consistency, α = .82, and the expectancy subscale demonstrated excellent internal consistency, α = .92.

Daily Questions. Participants completed daily questions during the skills practice phase of the study (days 1-13). The daily questions were used to assess participants' homework compliance, daily positive and negative affect, and daily level of social connection. Participants completed the daily questions via the RealLife Exp application or paper-and-pencil packet.

Homework compliance.

Active control. Participants responded to the following two questions: 1) “Did you practice a DAILY CHECK-IN today?” and 2) “Did you practice RECORDING LIFE DETAILS today?” Participants indicated their response to each question by selecting YES or NO.

Negative Affect Treatment. Participants responded to the following two questions: 1) “Did you practice REAPPRAISAL today?” and 2) “Did you practice AVOIDANCE REDUCTION today?” Participants indicated their response to each question by selecting YES or NO. Participants who indicated YES to question 2 received the following question: “If you practiced AVOIDANCE REDUCTION today, which of the following best describes your avoidance reduction behavior?” Participants indicated their responses by selecting FACE-TO-FACE (i.e. you interacted directly with another person), SPOKEN COMMUNICATION (i.e. you interacted with another person via phone, video chat, etc.), WRITTEN COMMUNICATION (i.e. you interacted with another person via letter, text message, email, social media, etc.), or REMOTE (i.e. you did not interact with another person).

Positive Affect Treatment. Participants responded to the following two questions: 1) “Did you practice THREE GOOD THINGS today?” and 2) “Did you practice KIND ACTS today?” Participants indicated their response to each question by selecting YES or NO. Participants who indicated YES to question 2 received the following question: “If you practiced KIND ACTS today, which of the following best describes your kind act?” Participants indicated their responses by selecting FACE-TO-FACE (i.e., you interacted with the recipient in person), SPOKEN COMMUNICATION (i.e., you interacted with the recipient via phone, video chat, etc.), WRITTEN COMMUNICATION (i.e., you interacted with the recipient via letter, text message, email, social media, etc.), or REMOTE (i.e., you did not interact with the recipient).

Positive and Negative Affect. Daily positive and negative affect were assessed using 12 questions, which were structured in the format of the PANAS (Watson et al., 1988). Specifically, participants answered the following question: “How ____ did you feel today?” A different emotion term occupied the blank for each of the twelve questions (calm, relaxed, happy, satisfied, enthusiastic, excited, sleepy, sluggish, sad, disappointed, nervous, and afraid). Participants indicated their response to each question on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). I calculated average positive affect as the mean of six positive emotions: calm, relaxed, happy, satisfied, enthusiastic, and excited; and I calculated average negative affect as the mean of six negative emotions: sleepy, sluggish, sad, disappointed, nervous, and afraid.

Social connection. Daily perceived social connection was assessed with the following question: “How socially connected did you feel today?” Participants indicated their response on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely).

Intervention feedback.

Treatment Continuation. Treatment continuation was assessed at follow-up with the following question, “Over the past two weeks, did you continue to perform activities that you learned in the training?” Participants indicated their response by selecting from the following options: No, Yes – once or twice, Yes - regularly.

Treatment satisfaction and acceptability. Treatment satisfaction and acceptability were assessed at follow-up. Treatment satisfaction was assessed with the following question: “How satisfied are you with the training?” Participants indicated their satisfaction on a 10-point Likert scale anchored at 1 (not at all satisfied) and 10 (very satisfied). Treatment acceptability was assessed with the following question: “How acceptable was the training as an intervention to

increase your social connections?” Participants rated treatment acceptability on a 10-point Likert scale anchored at 1 (not at all acceptable) to 10 (very acceptable). I also sought qualitative feedback from participants through the use of open-ended questions. Participants were asked to provide text responses to the following questions: 1) “What aspects of the training did you find most helpful?” 2) What aspects of the training did you find least helpful?” 3) “What, if anything, about the training was confusing?” and 4) “How could we improve the training?”

Data Analysis

Subject-level missing data. Participant attrition is summarized in **Figure 1. CONSORT Diagram**. N=180 participants met inclusion/exclusion criteria and completed the laboratory visit, including baseline questionnaires. Of these 180 participants, 167 completed endpoint questionnaires (attrition = 7.2%). Three participants completed endpoint questionnaires outside of the specified 72-hour window, but were retained in all analyses. Participants who did not complete endpoint questionnaires were considered lost to follow-up and were sent a final debriefing email.² Of the original 180 participants, 162 completed the follow-up questionnaires (attrition = 10.0%). Three participants completed follow-up questionnaires outside of the specified 72-hour window, but were retained in all analyses. Participants who did not complete the follow-up questionnaires were considered lost to follow-up and were sent a final debriefing email. Thus attrition in the present study was 10.0% overall, which is below the usual rate of approximately 20% observed in typical RCTs (Kendall, Comer, & Chow, 2013).

In order to determine the appropriate method for handling subject-level missing data, I first explored possible explanations for study attrition. Missing data due to attrition can be

² Three participants who dropped at endpoint erroneously received and completed the follow-up survey. As other participants who dropped at endpoint did not receive the follow-up survey, I excluded follow-up data for these three participants.

characterized as Missing Completely at Random (MCAR), Missing at Random (MAR), or Missing Not at Random (MNAR; Rubin, 1976; West, Aiken, Cham, & Liu, 2013). MCAR denotes that unobserved values are missing from the dataset at random, and that missingness is unrelated to participant characteristics (Rubin, 1976; West et al., 2013). MAR denotes that missingness is conditional on one or more variables observed in the dataset (Rubin, 1976; West et al., 2013). Finally, MNAR denotes that missingness is conditional on unobserved variables (Rubin, 1976; West et al., 2013). In order to determine the appropriate assumption, I explored predictors of study attrition at the final study time-point (i.e. follow-up).

Participants who dropped out of the study did not differ from participants who completed with regard to experimental condition, $X^2(2, N=180) = 0.12, p = .943$; participant age, $t(178) = 1.13, p = .261$; participant gender (male, vs. female vs. other), $X^2(2, N=180) = 3.37, p = .185$; participant race (White vs. Asian vs. other) $X^2(2, N=180) = 0.62, p = .733$; participant highest level of education (less than Bachelor degree vs. Bachelor degree vs. more than Bachelor degree), $X^2(2, N=180) = 3.88, p = .144$; participant employment status (employed vs. unemployed vs. student), $X^2(2, N=180) = 2.52, p = .284$; participant religious beliefs (atheist/agnostic vs. religious), $X^2(1, N=180) = 0.28, p = .594$; study referral source (study pool vs. other), $X^2(1, N=180) = 0.51, p = .476$; or current mental health treatment status (yes vs. no), $X^2(1, N=180) = 1.25, p = .264$.

Similarly, participants who dropped out of the study did not differ from participants who completed with regard to baseline mental health measures, including loneliness, $t(178) = .27, p = .785$; social support, $t(178) = 0.69, p = .489$; relationship satisfaction, $t(178) = 0.71, p = .482$; self-initiated positive behaviors, $t(178) = 0.09, p = .928$; self-initiated negative behaviors, $t(178) = 0.02, p = .984$; other-initiated positive behaviors, $t(178) = 0.23, p = .820$; other-initiated

negative behaviors, $t(178) = 0.05, p = .963$; depression symptoms, $t(178) = 1.94, p = .054$ ³; quality of life, $t(175) = 0.65, p = .520$; sleep disturbance, $t(178) = 1.42, p = .158$; PA, $t(178) = 0.94, p = .348$; or NA, $t(177) = 0.56, p = .575$.

However, those who dropped out of the study differed from completers on two personality characteristics measured at baseline: conscientiousness, $t(177) = 2.32, p = .022$, and BAS reward responsiveness $t(178) = 2.04, p = .043$. For conscientiousness, those who dropped out had lower levels of conscientiousness $M(SD) = 3.35(0.77)$ compared to those who completed the study $M(SD) = 3.74(0.70)$. For BAS reward responsiveness, those who dropped out had higher reward responsiveness $M(SD) = 18.21(1.84)$, compared to those who completed the study $M(SD) = 17.24(1.97)$. Other personality characteristics did not differ by completion status, including extraversion, $t(178) = 0.53, p = .596$; agreeableness, $t(177) = 1.73, p = .086$; neuroticism, $t(178) = 0.40, p = .689$; openness to experiences, $t(178) = 0.51, p = .608$, BIS, $t(177) = 0.48, p = .632$; BAS drive, $t(178) = 1.11, p = .271$, or BAS fun-seeking, $t(178) = 1.06, p = .292$.

Given that two personality characteristics were associated with attrition, the MAR assumption appears reasonable. When data are MAR, methods such as a listwise deletion, mean imputation, or last observation carried forward, are not recommended, as these approaches tend to yield biased estimates (Buhi, Goodson, & Neilands, 2008; Little et al., 2012). In contrast, simulations studies demonstrate that more advanced methods, including multiple imputation and full information maximum likelihood (FIML) estimation, yield unbiased estimates under the

³ The association between attrition and baseline depression symptoms was significant at a trend level ($p = .054$). I therefore conducted supplementary analyses to examine the effect of time and condition on primary and secondary outcome measures, controlling for baseline depression symptoms. The findings from these supplementary analyses were the same as the findings from those MLMs that did not control for baseline depression symptoms.

MAR assumption (Buhi et al., 2008; Witkiewitz et al., 2014). In the present study, I therefore chose to use multilevel modeling (MLM) with FIML estimation to evaluate hypotheses regarding the relative efficacy of the NAT, PAT, and active control conditions (Aims 1 and 2). The FIML estimation procedure utilizes all cases, including partial cases, to calculate optimal parameter estimates (Buhi et al., 2008; West et al., 2013), and is implemented in SPSS Mixed.

Item-level missing data. I next screened questionnaire responses for item-level missing data. For all questionnaires except the IPAQ-SF, item-level missing data affected < 5% of responses and therefore did not require further missing data treatment (McKnight & McKnight, 2013). However, for the IPAQ-SF, I observed item-level missing data in 20.6% of responses at baseline, 20.5% of responses at endpoint, and 18.0% of responses at follow-up. High rates of item-level missing data were likely caused by the “Don’t Know” response option included in the IPAQ-SF. Examining the effect of condition on change in physical activity was a secondary research question, and I therefore decided to drop the IPAQ-SF from further analysis.

Aim 1. Examining the effect of the NAT and PAT on primary outcome variables.

I utilized MLM (SPSS Mixed) to examine the effect of condition on change in primary outcomes variables (i.e. loneliness, social support, relationship satisfaction, and social behavior). MLM is the preferred method for examining change in repeated measures data, as it can accommodate cases with missing data, does not require the sphericity assumption, and can estimate change as a randomly varying parameter (Heck, Thomas, & Tabata, 2014; Chapter 5). In the present study, three observations for each outcome variable were nested within participants (i.e. observations at baseline, endpoint, and follow-up). Time was a Level 1 predictor, while intervention condition was a Level 2 predictor. In order to evaluate hypotheses pertaining to Aim 1, I evaluated the significance of the cross-level interaction between time and condition for each outcome variable.

MLM analysis proceeded in steps, according to procedures outlined by Heck et al. (2014; Chapter 5). For each outcome variable, I first evaluated the appropriate structure for the Level 1 covariance matrix. I specified a null model (i.e. model with no predictors) as well as a random intercept. I then evaluated four Level 1 covariance matrices: identity, autoregressive, diagonal, and unstructured; and selected the most appropriate covariance matrix by comparing the $-2 * \text{Log Likelihood} (-2LL)$, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) values for each model. The best-fitting Level 1 covariance structure was retained for all subsequent models for that outcome variable.

For each outcome variable, I then examined the linear effect of time. Each model included a random intercept, fixed effect of time, random effect of time, select demographic covariates (gender and race), and predictors of attrition (mean-centered conscientiousness and mean-centered BAS reward responsiveness). Each model was estimated with FIML to account for missing data. I examined the fixed effect of time to evaluate change in each outcome variable during the study. Finally, I calculated an estimate of the effect size for change from baseline to follow-up according to the following formula: $\text{Cohen's } d = (B_{\text{Time}} * \text{time duration}) / SD_{\text{baseline}}$ (see Feingold, 2013).

For each outcome variable, I then examined the interaction between intervention condition and time. Each model included a random intercept, fixed effect of time, random effect of time, select demographic covariates (gender and race), and predictors of attrition (mean-centered conscientiousness and mean-centered BAS reward responsiveness). Each model also included a dummy coded variable to indicate NAT, a dummy coded variable to indicate PAT, the time by NAT interaction, and the time by PAT interaction. Each model was estimated using FIML to account for missing data. I examined the time by condition interaction terms to evaluate

group differences in change in each outcome variable during the study. Finally, I calculated an estimate of the effect size for the NAT, relative to the control condition, and the PAT, relative to the control condition. The effect size for the NAT was calculated according to the following formula: Cohen's $d = (B_{\text{TimeXNAT}} * \text{time duration}) / SD_{\text{baseline}}$ (see Feingold, 2013). The effect size for the PAT was calculated according to the following formula: Cohen's $d = (B_{\text{TimeXPAT}} * \text{time duration}) / SD_{\text{baseline}}$ (see Feingold, 2013).

Aim 2. Examining the effect of the NAT and PAT on secondary outcome variables.

I utilized MLM (SPSS Mixed) to examine the effect of condition on change in secondary outcomes variables (i.e. depression symptom, quality of life, and sleep disturbance). Analysis procedures were identical to those specified for Aim 1.

Aim 3. Examining mediators of the NAT and PAT. The NAT and PAT were hypothesized to target distinct emotional processes implicated in the development and maintenance of loneliness. Specifically, the NAT was expected to reduce loneliness via reductions in NA, whereas the PAT was expected to reduce loneliness via increases in PA. In order to examine these proposed causal pathways, I first examined change in NA and PA during the study period. Procedures for testing change in NA and PA were identical to those used to examine change in primary and secondary outcome variables (see aims 1 and 2).

I then conducted mediation analyses to examine Day 14 change in NA as a mediator of the effect of treatment condition on Day 28 change in loneliness. Similarly, I tested Day 14 change in PA as a mediator of the effect of treatment condition on Day 28 change in loneliness. I tested these mediation models using the PROCESS macro for SPSS (Hayes, 2013). This macro utilizes OLS regression-based path analysis to estimate the indirect effect of X on Y through M.

Paths in this model include the effect of X on M (a), the effect of M on Y (b), the effect of X on Y (c), effect of X on Y, controlling for M (c'), and the indirect effect of X on Y through M (ab).

According to recommendations by Hayes (2013), I tested mediation models in full, regardless of the significance of individual paths. It is now widely accepted that ab may be significant, even when c is not significant. (Hayes, 2013). Furthermore, it is also possible for ab to be significant, even if a and/or b are not significant (Hayes, 2013). Thus the proper test of the indirect effect of X on Y through M is to directly test path ab (Hayes, 2013). In the present study, I used bias-corrected bootstrap confidence intervals (10,000 bootstrap samples) to test the hypothesis that $ab \neq 0$. This is the preferred method for testing indirect effects, as it is more powerful than the normal theory approach and does not rely on the assumption that the sampling distribution of ab is normal (Hayes, 2013). If the bias-corrected bootstrap confidence interval does not contain zero, the results support M as a mediator of the effect of X on Y.

Aim 4. Examining moderators of the NAT and PAT. The present study was underpowered to test moderation. I therefore conducted exploratory analyses to examine potential predictors of change in loneliness, as well as moderators of the impact of intervention condition on change in loneliness. All moderation analyses were conducted via MLM, with ULS-3 scores as the outcome variable. For the base model, I specified a random intercept, fixed effect of time, and random effect of time. All models were estimated using FIML.

Moderators of interest included select personality characteristics (mean-centered neuroticism, mean-centered extraversion, mean-centered BIS, mean centered-BAS drive, mean-centered BAS fun-seeking, mean-centered BAS reward responsiveness), demographic variables (mean-centered age, gender, and race), and baseline loneliness (dichotomized as Low = at or below the median of 43, High = above the median of 43). For each of these variables, I first

examined the interaction between the variable and time. A significant variable by time interaction indicated that the variable predicted differential change in loneliness during the study. For each of these variables, I then evaluated the three-way interaction between the variable, time, and intervention condition. A significant three-way interaction indicated that the variable moderated the effect of intervention condition on change in loneliness during the study. Models evaluating interactions included associated lower-order interactions.

Aim 5. Intervention satisfaction and feedback. At the end of the follow-up survey, participants answered four open-ended feedback questions regarding their experience of their assigned intervention. To analyze participants' responses to feedback questions, I adapted methods described by Creswell and Poth (2018) for analyzing data from a phenomenological study (p. 210). Creswell and Poth (2018) write that, "a phenomenological study describes the common meaning for several individuals of their lived experience of a concept or a phenomenon (p. 75). Given that my goal was to reduce participants' feedback responses to common themes, the phenomenological study approach was most appropriate.

Two volunteer research assistants, blind to study hypotheses, completed qualitative data analysis for the present study. Qualitative analysis proceeded according to a series of steps, which were completed separately for each of the four feedback questions and for each of the three intervention conditions. First, the analyst read all responses to the feedback question. Second, the analyst identified and coded significant statements within each participant's responses. Significant statements were defined as "any statement that reveals the participant's view." Third, the analyst compiled these significant statements in to a list. Fourth, the analyst grouped the significant statements under common themes. Fifth, the analyst reviewed the significant statements under each theme and highlighted common descriptor words or phrases.

Sixth the analyst revised the common themes based the descriptor words. Last, the analyst wrote a composite description of participants' responses, summarizing the common themes.

5. Results

Sample characteristics

Demographic characteristics. Demographic characteristics for the full baseline sample ($N=180$) are presented in **Table 1**. Participants ranged in age from 18-30 years, with a $M(SD)$ age of 23.37(3.03) years. Approximately half of participants identified as female (52.8%), 46.1% identified as male, and 1.1% reported non-binary gender identity. With regard to race, 50.0% of participants identified as Asian, 35.5% as White, 5.6% as Latino, 5.0% as Black, and 3.9% as Multiracial. The majority of participants were students (65.0%), while 16.1% were employed part-time, 11.7% were employed full-time, 6.7% were unemployed, and 0.6% identified as homemakers. Participants reported varying levels of education, including secondary school (0.6%), some college (31.7%), 2-year college degree (0.6%), 4-year college degree (33.9%), some graduate school (12.8%), 2-year graduate degree (18.3%), and doctorate degree (2.2%). With regard to religion, 42.8% identified as Atheist/Agnostic, 28.3% as Hindu, 8.9% as Catholic, 8.9% as Protestant, 2.2% as Jewish, 2.2% as Muslim, 1.7% as Buddhist, and 5.0% as other religions. The majority of participants were recruited via the Harvard University Psychology Study Pool (93%), with 7% reporting other recruitment sources (e.g., Craigslist).

Table 1. Demographic characteristics for the full baseline sample

Characteristic	All (N=180)	Group			Group Comparison	
		Control (N=60)	NAT (N=60)	PAT (N=60)	Test Statistic	P value
Age; M(SD)	23.37(3.03)	23.93(2.99)	22.97(2.88)	23.22(3.18)	F(2,177)=1.66	.193
Gender; %(n)					X ² (4)=5.00	.287
Male	46.1% (83)	56.7% (34)	43.3% (26)	38.3% (23)		
Female	52.8% (95)	43.3% (26)	55.0% (33)	60.0% (36)		
Non-binary	1.1% (2)	0.0% (0)	6.7% (1)	6.7% (1)		
Race; %(n)					X ² (8)=16.69	.034
White	35.5% (64)	26.7% (16)	31.7% (19)	48.3% (29)		
Black	5.0% (9)	10.0% (6)	0.0% (0)	5.0% (3)		
Hispanic	5.6% (10)	10.0% (6)	5.0% (3)	1.7% (1)		
Asian	50.0% (90)	48.3% (29)	58.3% (35)	43.3% (26)		
Multiracial	3.9% (7)	5.0% (3)	5.0% (3)	1.7% (1)		
Employment status; %(n)					X ² (8)=4.49	.811
Full-time	11.7% (21)	11.7% (7)	8.3% (5)	15.0% (9)		
Part-time	16.1% (29)	13.3% (8)	18.3% (11)	16.7% (10)		
Student	65.0% (117)	68.3% (41)	66.7% (40)	60% (36)		
Homemaker	0.6% (1)	0.0% (0)	1.7% (1)	0.0% (0)		
Unemployed	6.7% (12)	6.7% (4)	5.0% (3)	8.3% (5)		
Education level; % (n)					X ² (12)=12.80	.383
Secondary school (grades 9-12)	0.6% (1)	0.0% (0)	1.7% (1)	0.0% (0)		
Some college	31.7% (57)	23.3% (14)	31.7% (19)	40.0% (24)		
2-year degree (e.g. A.A.)	0.6% (1)	1.7% (1)	0.0% (0)	0.0% (0)		
4-year degree (e.g., B.A.)	33.9% (61)	43.3% (26)	36.7% (22)	21.7% (13)		
Some graduate	12.8% (23)	11.7% (7)	10.0% (6)	16.7% (10)		
2-year graduate (e.g., M.A.)	18.3% (33)	16.7% (10)	18.3% (11)	20.0% (12)		
Doctorate (e.g., Ph.D.)	2.2% (4)	3.3% (2)	1.7% (1)	1.7% (1)		
Religion; % (n)					X ² (14)=11.52	.645
Atheist or agnostic	42.8% (77)	40.0% (24)	38.3% (23)	50.0% (30)		
Buddhist	1.7% (3)	0.0% (0)	1.7% (1)	3.3% (2)		
Catholic	8.9% (16)	11.7% (7)	8.3% (5)	6.7% (4)		
Hindu	28.3% (51)	28.3% (17)	38.3% (23)	18.3% (11)		
Jewish	2.2% (4)	1.7% (1)	1.7% (1)	3.3% (2)		
Muslim	2.2% (4)	3.3% (2)	0.0% (0)	3.3% (2)		
Protestant	8.9% (16)	10.0% (6)	8.3% (5)	8.3% (5)		
Other	5.0% (9)	5.0% (3)	3.3% (2)	6.7% (4)		
Referral source; %(n)					X ² (2) = 1.61	.448
Harvard study pool	93% (168)	95% (57)	90% (54)	95% (57)		
Other (e.g., flyer, Craigslist)	7% (12)	5% (3)	10% (6)	10% (3)		

Clinical characteristics. At baseline, participants were assessed for some current and past DSM-5 psychiatric diagnoses via the MINI 7.0 (Sheehan et al., 1998). Rates of current and past psychiatric diagnoses are presented in **Table 2**. Overall, rates of current mental disorders were low, including 1.1% for current panic disorder, 3.9% for current generalized SAD, 2.2% for current performance-only SAD, 2.8% for current generalized anxiety disorder, 1.1% for current

obsessive-compulsive disorder, 7.2% for past-year alcohol use disorder, and 2.2% for past-year substance use disorder. Current MDE, suicidality, mania, and psychosis, were exclusionary, though some participants endorsed lifetime experience of some of these symptoms. Specifically, 21.7% reported a past MDE, 0.6% reported a past suicide attempt, 2.7% reported a past manic episode, 0.0% reported a past hypomanic episode,⁴ and 0.0% reported lifetime psychosis.

At baseline, participants also reported whether they were currently receiving treatment from a mental health profession (e.g., psychologist, psychiatrist, social worker, mental health counselor, etc.). A minority of participants (8.9%) reported current mental health treatment.

⁴ For past hypomanic episode, rate reflects participants not meeting criteria for a past episode as well as participants who were not assessed for a past episode due to a diagnosis of a past manic episode.

Table 2. Clinical characteristics for the full baseline sample.

Characteristic	All (N=180)	Group			Group Comparison	
		Control (N=60)	NAT (N=60)	PAT (N=60)	Test Statistic	P value
Current MDE; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Past MDE; % (n)	21.7% (39)	25.0% (15)	11.7% (7)	28.3% (17)	$X^2(2) = 5.50$	.064
Current suicidality; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Lifetime suicide attempt; % (n)	0.6% (1)	0.0% (0)	0.0% (0)	1.7% (1)	$X^2(2) = 2.01$	.366
Current mania; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Past mania; % (n)	2.7% (5)	5.0% (3)	3.3% (2)	0.0% (0)	$X^2(2) = 2.88$	.237
Current hypomania; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Past hypomania; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Current PD; % (n)	1.1% (2)	1.7% (1)	0.0% (0)	1.7% (1)	$X^2(2) = 1.01$	.603
Lifetime PD; % (n)	4.4% (8)	1.7% (1)	1.7% (1)	10.0% (6)	$X^2(2) = 6.54$	.038
Current AG; % (n)	0.6% (1)	1.7% (1)	0.0% (0)	0.0% (0)	$X^2(2) = 2.01$	.366
Current SAD-generalized; % (n)	3.9% (7)	5.0% (3)	0.0% (0)	6.7% (4)	$X^2(2) = 3.87$	.145
Current SAD-performance; % (n)	2.2% (4)	1.7% (1)	3.3% (2)	1.7% (1)	$X^2(2) = 0.51$	.774
Current GAD; % (n)	2.8% (5)	3.3% (2)	1.7% (1)	3.3% (2)	$X^2(2) = 0.41$	.814
Current OCD; % (n)	1.1% (2)	1.7% (1)	0.0% (0)	1.7% (1)	$X^2(2) = 1.01$	.603
Current PTSD; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Past 12 month AUD; % (n)	7.2% (13)	5.0% (3)	8.3% (5)	8.3% (5)	$X^2(2) = 0.66$	.718
Past 12 month SUD; % (n)	2.2% (4)	0.0% (0)	1.7% (1)	5.0% (3)	$X^2(2) = 3.58$	.167
Current psychosis; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Lifetime psychosis; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Current anorexia; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Current bulimia; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Current BED; % (n)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	--	--
Treatment status; % (n)					$X^2(2) = 7.13$	.028
Current mental health treatment	8.9% (16)	6.7% (4)	3.3% (2)	16.7% (10)		
Not in mental health treatment	91.1%(164)	93.3% (56)	96.7% (58)	83.3% (50)		

Note: For past hypomanic episode, rates reflect participants not meeting criteria for a past episode as well as participants who were not assessed for a past episode due to a diagnosis of a past manic episode.

Baseline descriptive statistics. Baseline descriptive statistics for study dependent variables and moderators are presented in **Table 3**. The $M(SD)$ ULS-3 score was 42.71(10.18), which is similar to the $M(SD)$ of 40.08(9.50) that was reported for a college student sample in the original ULS-3 validation paper (Russell, 1996). Similarly, the $M(SD)$ MSPSS total score was 5.54(0.92), which is similar to the $M(SD)$ of 5.80(0.86) that was reported for a college student sample in the original MSPSS validation paper (Zimet et al., 1988). Thus, with regard to indices of social connection and support, the present sample of young adults appears similar to unselected college student samples.

Table 3. Baseline descriptive statistics for dependent variables and moderators

Variable	All (N=180)	Group			Group Comparison	
		Control (N=60)	NAT (N=60)	PAT (N=60)	Test Statistic	P value
ULS-3; M(SD)	42.71 (10.18)	44.07 (9.44)	41.22 (9.86)	42.85 (11.14)	F(2,177)=1.19	.308
MSPSS Total; M(SD)	5.54 (0.92)	5.55 (0.98)	5.56 (0.81)	5.50 (0.96)	F(2,177)=0.09	.912
Relationship Satisfaction; M(SD)	19.59 (4.19)	19.53 (4.03)	19.95 (3.76)	19.28 (4.75)	F(2,177)=0.39	.681
SIIS, Self, Positive; M(SD)	23.95 (10.49)	23.27 (11.54)	24.75 (9.46)	23.83 (10.48)	F(2,177)=0.30	.739
SIIS, Self, Negative; M(SD)	9.07 (7.54)	9.10 (7.26)	8.58 (7.01)	9.53 (8.38)	F(2,177)=0.24	.790
SIIS, Other, Positive; M(SD)	12.21 (6.37)	12.02 (7.27)	12.23 (5.27)	12.38 (6.50)	F(2,177)=0.05	.951
SIIS, Other, Negative; M(SD)	5.21 (4.72)	4.68 (4.29)	5.22 (4.49)	5.72 (5.32)	F(2,177)=0.72	.489
PHQ-8; M(SD)	2.11 (2.50)	2.15 (2.51)	1.82 (2.02)	2.37 (2.91)	F(2,177)=0.73	.482
Q-LES-Q; M(SD)	0.69 (0.13)	0.67 (0.12)	0.70 (0.14)	0.71 (0.13)	F(2,174)=1.14	.324
SDS; M(SD)	16.53 (5.84)	17.35 (6.50)	15.62 (4.58)	16.62 (6.21)	F(2,177)=1.34	.265
PANAS Positive; M(SD)	33.67 (7.67)	34.02 (7.63)	33.12 (7.83)	33.88 (7.65)	F(2,177)=0.24	.788
PANAS Negative; M(SD)	15.93 (5.06)	16.02 (5.09)	15.58 (4.73)	16.20 (5.40)	F(2,176)=0.23	.792
BFI Extraversion; M(SD)	3.24 (0.84)	3.19 (0.73)	3.28 (0.89)	3.26 (0.89)	F(2,177)=0.19	.828
BFI Agreeableness; M(SD)	3.98 (0.62)	4.02 (0.62)	3.95 (0.55)	3.96 (0.68)	F(2,176)=0.24	.786
BFI Conscientious; M(SD)	3.70 (0.71)	3.72 (0.71)	3.70 (0.71)	3.68 (0.73)	F(2,176)=0.05	.955
BFI Neuroticism; M(SD)	2.60 (0.81)	2.51 (0.78)	2.62 (0.74)	2.66 (0.89)	F(2,177)=0.55	.577
BFI Openness; M(SD)	3.70 (0.63)	3.64 (0.65)	3.66 (0.60)	3.80 (0.66)	F(2,177)=1.11	.332
BIS; M(SD)	20.93 (3.85)	20.58 (3.88)	21.27 (3.32)	20.93 (4.30)	F(2,176)=0.48	.622
BAS Drive; M(SD)	11.42 (2.21)	11.30 (2.32)	11.37 (2.41)	11.58 (1.91)	F(2,177)=0.27	.767
BAS Fun-seeking; M(SD)	11.93 (2.13)	12.10 (1.89)	11.77 (2.29)	11.93 (2.20)	F(2,177)=0.37	.695
BAS Reward responsive; M(SD)	17.34 (1.97)	17.47 (1.90)	17.43 (1.89)	17.13 (2.13)	F(2,177)=0.52	.597

Note: ULS-3 = UCLA Loneliness Scale Version 3; MSPSS = Multidimensional Scale of Perceived Social Support; SIIS = Social Initiation Interaction Scale; PHQ-8 = Patient Health Questionnaire – 8; QLESQ-SF = Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form; SDS = Sleep Disturbance Scale; PANAS = Positive and Negative Affect Scale; BFI = Big Five Inventory; BIS = Behavioral Inhibition System; BAS = Behavioral Approach System.

Baseline bivariate associations. Associations between demographic characteristics and baseline dependent variables are presented in Appendix J: Supplementary tables. Age was not significantly associated with any dependent variable at baseline (p s range .082 - .839). However, several baseline dependent variables differed by participant gender. Specifically, men reported lower loneliness ($p = .019$), higher relationship satisfaction ($p < .001$), more self-initiated positive social behaviors ($p = .005$), and higher positive affect ($p = .020$), compared to women. In addition, men reported lower sleep disturbance compared to participants who identified as non-binary gender ($p = .035$). Accordingly, gender was included as a covariate in MLMs for aims 1 and 2. Participants who identified as non-binary gender comprised a very small group ($n=2$) and did not differ from female participants on baseline dependent variables. Non-binary gender was therefore grouped with female gender for subsequent analyses. Finally, several baseline dependent variables differed by participant race. Specifically, Black participants reported lower levels of social support compared to Latino ($p = .018$) and Asian participants ($p = .036$). In addition, White participants reported lower relationship satisfaction compared to Asian participants ($p = .004$). Accordingly, participant race was also included as a covariate in all MLMs for aims 1 and 2.

Zero-order correlations between baseline dependent variables and moderators are presented in Appendix J: Supplementary tables. At baseline, loneliness was positively associated with self-initiated negative social behaviors, other-initiated negative social behaviors, depression, sleep disturbance, NA, neuroticism and BIS. Furthermore, loneliness was negatively associated with social support, relationship satisfaction, self-initiated positive social behaviors, other-initiated positive social behaviors, quality of life, PA, extraversion, agreeableness,

conscientiousness, BAS-drive, and BAS-fun-seeking. Loneliness was not significantly associated with openness to experiences or BAS-reward responsiveness.

Baseline group differences. Tests for baseline group differences in demographic characteristics are presented in **Table 1**. The study groups did not differ at baseline with regard to age, gender, employment status, education level, religious identify, or referral sources. However, the groups did differ with regard to participants' race. As noted, race was also associated with baseline differences in some dependent variables, and was therefore included as a covariate in MLMs for aims 1 and 2.

Tests for baseline group differences in clinical characteristics are presented in **Table 2**. The groups did not differ at baseline with regard to current mental disorder diagnoses, past MDE, lifetime suicide attempt, past manic episode, past hypomanic episode, or lifetime psychosis. The groups did differ with regard to current mental health treatment status. However, treatment status was not significantly associated with loneliness scores at baseline, $t(178) = 1.23$, $p = .22$, endpoint, $t(165) = 0.99$, $p = .32$, or follow-up, $t(160) = 0.55$, $p = .59$. Treatment status was therefore not included as a covariate in MLMs for aims 1 and 2.

Finally, tests for baseline group differences in dependent variables and moderators are presented in **Table 3**. The study groups did not differ at baseline on any of the dependent variables or moderator variables. Randomization was therefore considered successful.

Aim 1. Examining the effect of NAT and PAT on primary outcome variables.

Loneliness. See **Table 4** for the results of MLMs predicting participants' loneliness scores during the study. In model 1, there was a significant negative effect of Time on loneliness, which indicated participants' loneliness scores decreased during the study (Cohen's $d = -0.19$). In model 2, neither the Time by NAT interaction term, nor Time by PAT interaction term was

significant (Cohen's d NAT = 0.15; Cohen's d PAT = 0.02). Thus, change in loneliness did not differ significantly by intervention condition. See **Figure 3** for a visual of the effect of time and intervention condition on loneliness. Observed marginal means are presented in Appendix J:

Supplementary tables.

Table 4. MLMs examining the effect of time and intervention condition on loneliness.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	42.25	1.44	< .001	44.31	1.72	< .001
Sex (ref = Male)						
Female	2.48	1.34	.07	2.85	1.33	.03
Race (ref = White)						
Black	3.51	3.09	.26	2.51	3.10	.42
Latino	-4.35	2.87	.13	-5.35	2.89	.07
Asian	-1.93	1.44	.18	-2.00	1.43	.17
Multiracial	5.05	3.43	.14	4.70	3.42	.17
NEO Conscientiousness	-3.63	0.91	<.001	-3.67	0.90	<.001
BAS Reward responsiveness	-0.16	0.33	.62	-0.18	0.32	.59
Time	-0.97	0.32	.003	-1.26	0.55	.03
Treatment (ref = Control)						
NAT				-3.42	1.66	.04
PAT				-2.85	1.68	.09
Time x NAT				0.74	0.78	.35
Time x PAT				0.11	0.79	.89

Note. Dependent variable = ULS-3; covariance for repeated measures = diagonal.

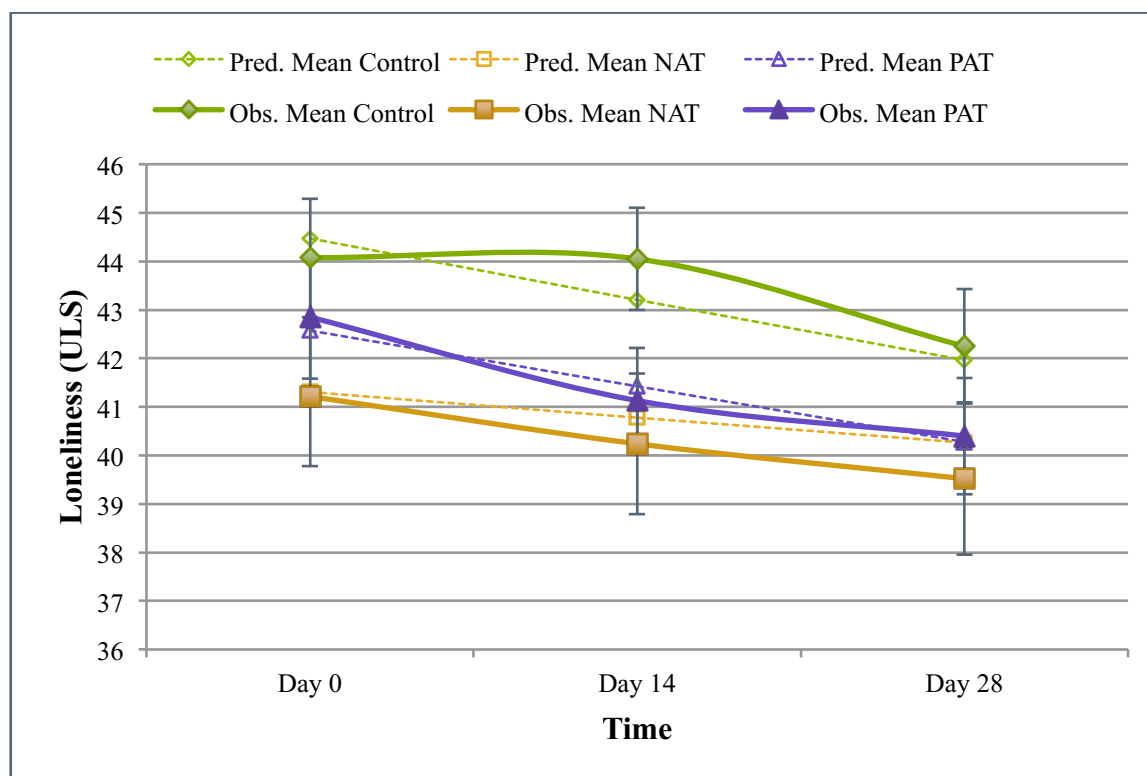


Figure 3. The effect of time and intervention condition on loneliness

Figure 3 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Social support. See **Table 5** for the results of MLMs predicting participants social support scores during the study. In model 1, the effect of Time was not significant (Cohen's $d = 0.04$). Thus participants' perceived social support did not change across the study time points. In model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.15; Cohen's d PAT = -0.04). Thus change in social support did not differ by intervention condition. See **Figure 4** for a visual of the effect of time and intervention condition on social support. Observed marginal means are presented in Appendix J: Supplementary tables.

Table 5. MLMs examining the effect of time and intervention condition on social support.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	5.52	0.13	<.001	5.47	0.16	<.001
Sex (ref = Male)						
Female	-0.17	0.12	.18	-0.18	0.12	.15
Race (ref = White)						
Black	-0.80	0.29	.01	-0.78	0.29	.01
Latino	0.72	0.27	.01	0.76	0.27	.01
Asian	0.23	0.13	.09	0.24	0.13	.08
Multiracial	0.01	0.32	.96	0.05	0.32	.89
NEO Conscientiousness	0.27	0.08	.002	0.27	0.08	.002
BAS Reward responsiveness	0.08	0.03	.01	0.08	0.03	.01
Time	0.02	0.03	.59	-0.001	0.06	.98
Treatment (ref = Control)						
NAT				0.02	0.15	.91
PAT				0.13	0.15	.41
Time x NAT				0.07	0.08	.36
Time x PAT				-0.02	0.08	.84

Note. Dependent variable = MSPSS Total; Covariance for repeated measures = diagonal.

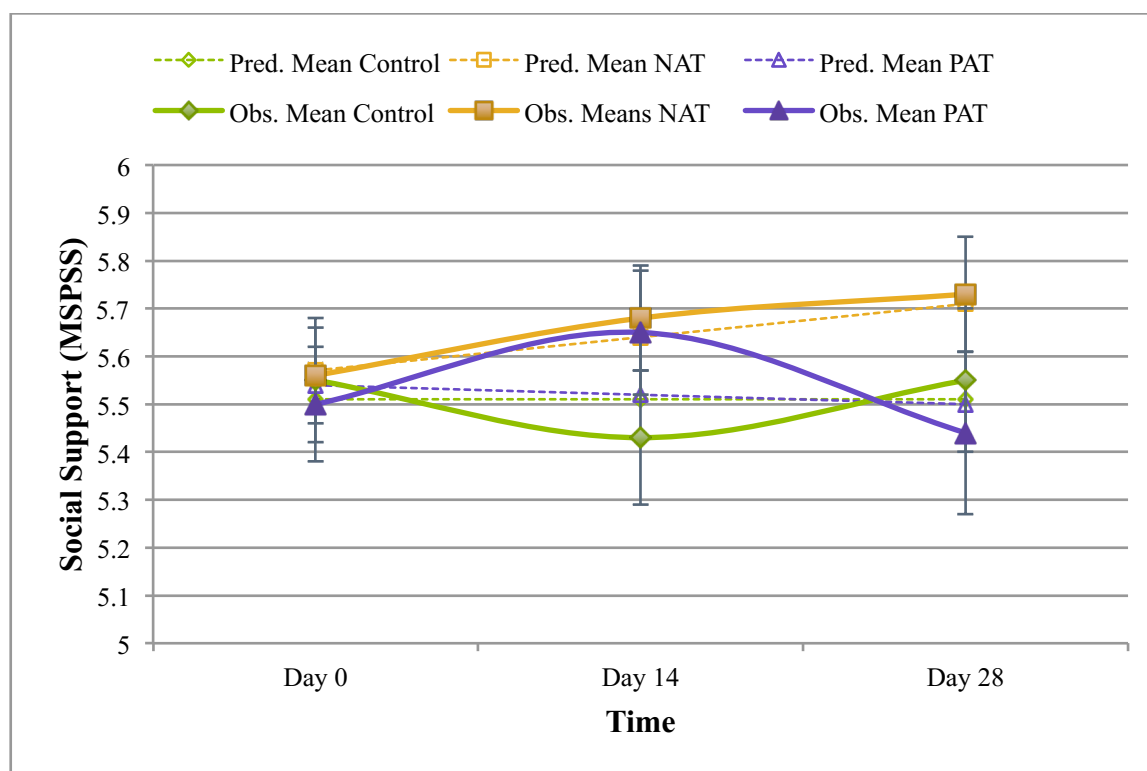


Figure 4. The effect of time and intervention condition on social support

Figure 4 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Relationship satisfaction. See **Table 6** for the results of MLMs predicting participants' relationship satisfaction scores during the study. In model 1, Time was a significant positive predictor of relationship satisfaction (Cohen's $d = 0.21$). This result indicated that, on average, participants' relationship satisfaction improved during the study. However, in model 2, neither the Time by NAT nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.08; Cohen's d PAT = 0.10). These results indicate that change in relationship satisfaction did not differ by intervention condition. See **Figure 5** for a visual of the effect of time and intervention

condition on relationship satisfaction. Observed marginal means are presented in Appendix J:

Supplementary tables.

Table 6. MLMs examining the effect of time and intervention condition on relationship satisfaction.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	19.78	0.57	<.001	19.40	0.69	<.001
Sex (ref = Male)						
Female	-1.36	0.53	.01	-1.45	0.53	.01
Race (ref = White)						
Black	-1.57	1.22	.20	-1.32	1.23	.28
Latino	0.80	1.13	.48	1.04	1.15	.37
Asian	1.19	0.57	.04	1.20	0.57	.04
Multiracial	-1.11	1.35	.41	-1.02	1.35	.45
NEO Conscientiousness	1.53	0.36	<.001	1.53	0.36	<.001
BAS Reward responsiveness	0.27	0.13	.04	0.28	0.13	.03
Time	0.45	0.15	.003	0.33	0.25	.19
Treatment (ref = Control)						
NAT				0.65	0.68	.34
PAT				0.54	0.68	.43
Time x NAT				0.17	0.36	.65
Time x PAT				0.20	0.36	.59

Note. Dependent variable = Relationship Satisfaction; Covariance for repeated measures = autoregressive.

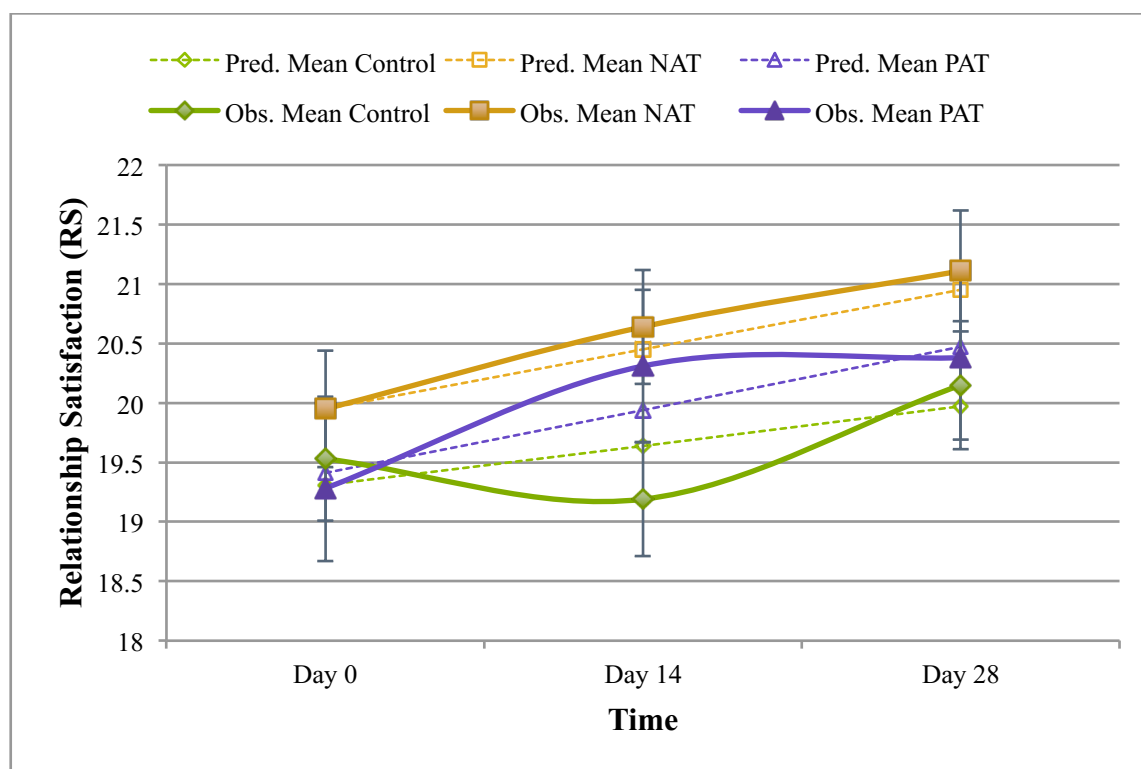


Figure 5. The effect of time and intervention condition on relationship satisfaction.

Figure 5 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Self-Initiated Positive Social Behaviors. See **Table 7** for the results of the MLMs predicting participants' self-initiated positive social behaviors during the study. In model 1, Time was a significant positive predictor of behaviors (Cohen's $d = 0.25$). On average, participants engaged in more self-initiated positive social behaviors over the course of the study. However, in model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.04; Cohen's d PAT = 0.03). These results indicated that change in self-initiated positive social behaviors did not differ by intervention condition. See **Figure 6** for a visual of the effect of time and intervention condition on self-initiated positive social behaviors. Observed marginal means are presented in Appendix J: Supplementary tables.

Table 7. MLMs examining the effect of time and intervention condition on self-initiated positive social behaviors.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	26.77	1.39	<.001	25.27	1.69	<.001
Sex (ref = Male)						
Female	-3.70	1.27	.004	-3.97	1.26	.002
Race (ref = White)						
Black	-5.48	2.94	.06	-4.74	2.94	.11
Latino	1.09	2.73	.69	2.03	2.75	.46
Asian	1.40	1.37	.31	1.56	1.36	.26
Multiracial	-5.86	3.27	.07	-5.29	3.25	.11
NEO Conscientiousness	2.01	0.87	.02	2.04	0.86	.02
BAS Reward responsiveness	0.85	0.31	.01	0.86	0.31	.01
Time	1.31	0.31	<.001	1.20	0.55	.03
Treatment (ref = Control)						
NAT				1.79	1.69	.29
PAT				2.62	1.70	.13
Time x NAT				0.20	0.77	.80
Time x PAT				0.17	0.78	.83

Note. Dependent variable = SIIS Self Positive; Covariance for repeated measures = diagonal.

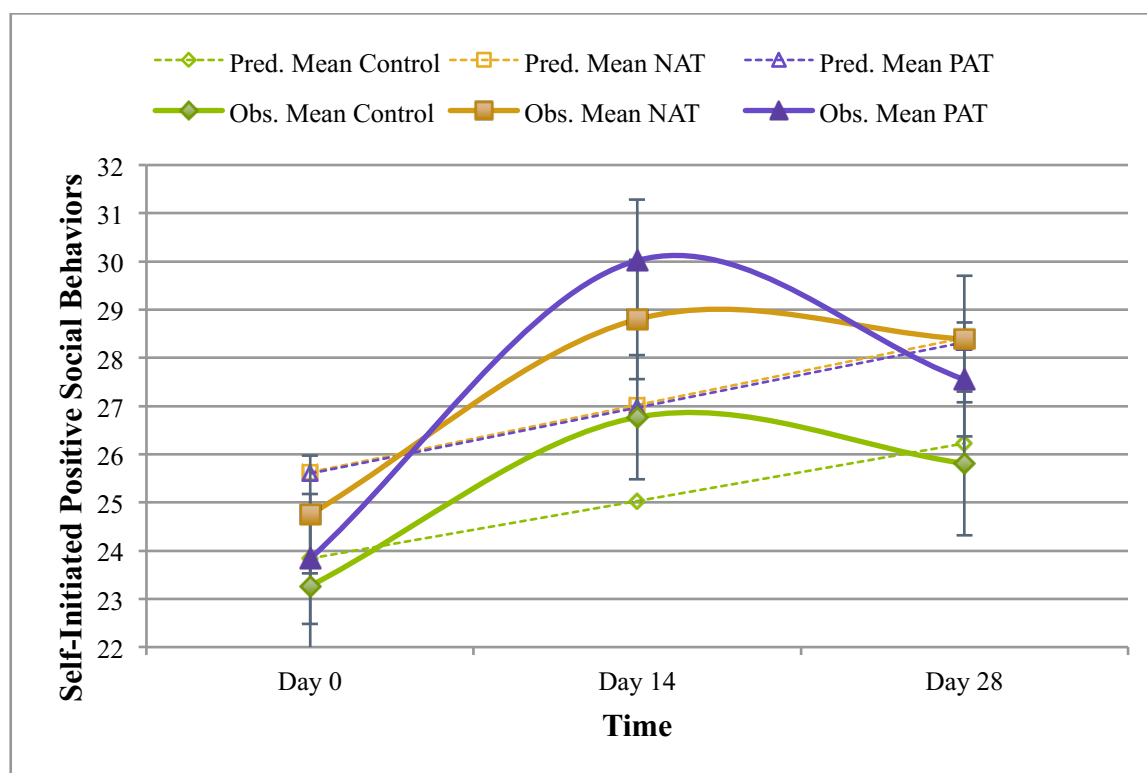


Figure 6. The effect of time and intervention condition on self-initiated positive social behaviors.

Figure 6 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Self-Initiated Negative Social Behaviors. See **Table 8** for the results of MLMs predicting participants' self-initiated negative social behaviors by time and intervention condition. In model 1, the effect of Time was not significant, which suggests that participants' self-initiated negative social behaviors did not change during the study (Cohen's $d = 0.17$). Furthermore, in model 2, the Time by NAT and Time by PAT interaction terms were not significant (Cohen's d NAT = 0.41; Cohen's d PAT = 0.32). Thus change in self-initiated negative social behaviors did not differ significantly by intervention condition. See **Figure 7** for

a visual of the effect of time and intervention condition on self-initiated negative social behaviors. Observed marginal means are presented in Appendix J: Supplementary tables.

Table 8. MLMs examining the effect of time and intervention condition on self-initiated negative social behaviors.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	9.78	1.21	<.001	10.00	1.47	<.001
Sex (ref = Male)						
Female	-0.88	1.13	.43	-0.90	1.14	.43
Race (ref = White)						
Black	-1.81	2.61	.49	-1.86	2.64	.48
Latino	-1.12	2.42	.65	-0.99	2.46	.69
Asian	0.37	1.21	.76	0.43	1.22	.73
Multiracial	2.15	2.90	.46	2.29	2.91	.43
NEO Conscientiousness	-2.74	0.77	<.001	-2.75	0.77	<.001
BAS Reward responsiveness	0.23	0.28	.40	0.24	0.28	.39
Time	0.63	0.53	.23	-0.28	0.92	.76
Treatment (ref = Control)						
NAT				-0.70	1.42	.620
PAT				-0.04	1.43	.975
Time x NAT				1.55	1.29	.232
Time x PAT				1.21	1.30	.354

Note. Dependent variable = SIIS Self Negative; Covariance for repeated measures = Identity.

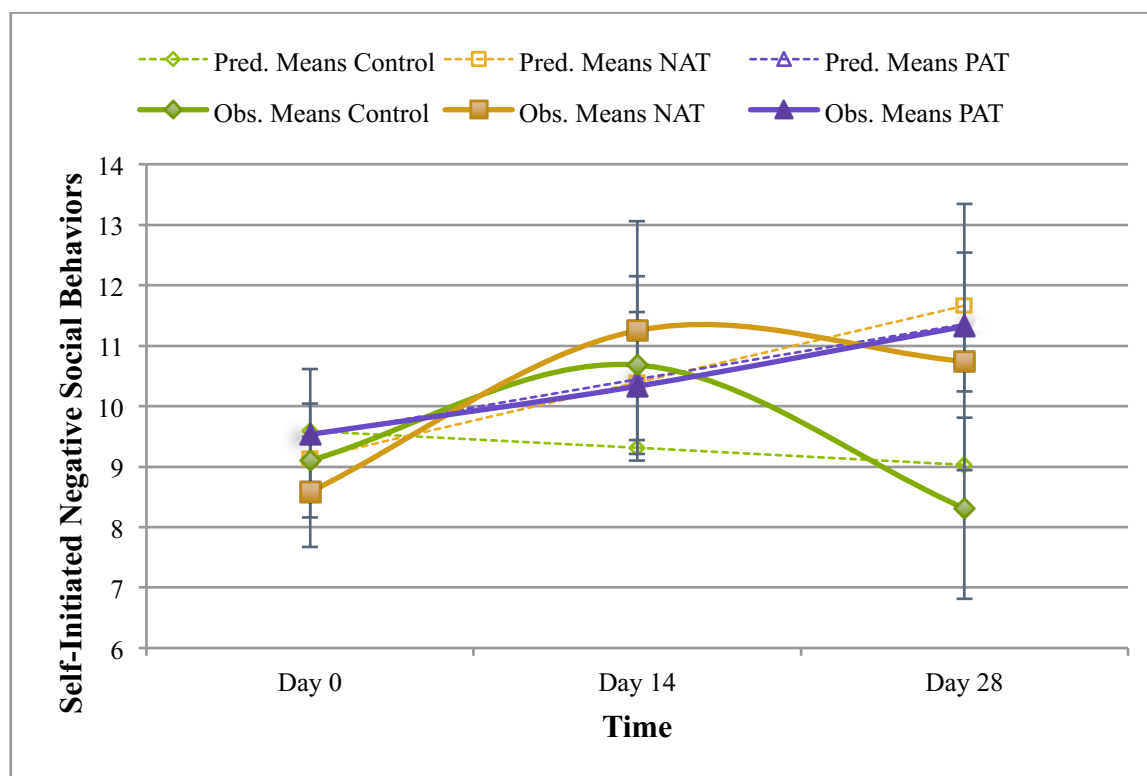


Figure 7. The effect of time and intervention condition on self-initiated negative social behaviors.

Figure 7 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Other-Initiated Positive Social Behaviors. See Table 9 for the results of MLMs predicting participants' other-initiated positive social behaviors by time and intervention condition. In model 1, the effect of Time was a significant positive predictor of other-initiated positive social behaviors (Cohen's $d = 0.25$). This finding indicates that on average, participants experienced increasing levels of other-initiated positive acts during the study. However, in model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.05; Cohen's d PAT = 0.07). Thus change in other-initiated positive social behaviors did not differ by intervention condition. See Figure 8 for a visual of the

effect of time and intervention condition on other-initiated positive social behaviors. Observed marginal means are presented in Appendix J: Supplementary tables.

Table 9. MLMs examining the effect of time and intervention condition on other-initiated positive social behaviors.

	Model 1			Model 2		
	B	SE	p	B	SE	p
Intercept	13.36	0.89	<.001	12.66	1.09	<.001
Sex (ref = Male)						
Female	-1.78	0.82	.03	-1.92	0.83	.02
Race (ref = White)						
Black	-2.19	1.91	.25	-1.84	1.92	.34
Latino	0.77	1.77	.67	1.24	1.80	.49
Asian	0.12	0.89	.89	0.19	0.89	.83
Multiracial	-1.97	2.12	.35	-1.71	2.12	.42
NEO Conscientiousness	0.90	0.56	.11	0.92	0.56	.10
BAS Reward responsiveness	0.37	0.20	.070	0.38	0.20	.06
Time	0.80	0.23	<.001	0.68	0.40	.10
Treatment (ref = Control)						
NAT				0.84	1.08	.44
PAT				1.20	1.08	.27
Time x NAT				0.17	0.57	.77
Time x PAT				0.21	0.57	.72

Note. Dependent variable = SIIS Other Positive; Covariance for repeated measures = Identity.

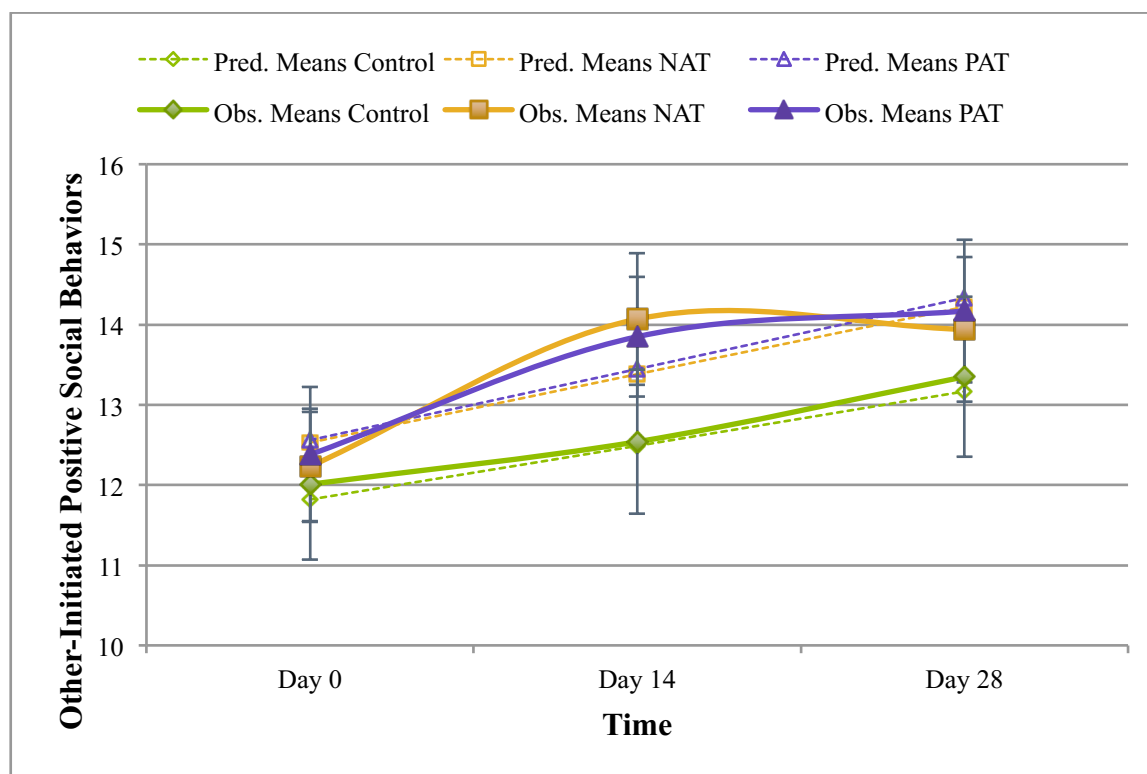


Figure 8. The effect of time and intervention condition on other-initiated positive social behaviors.

Figure 8 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Other-Initiated Negative Social Behaviors. See **Table 10** for the results of MLMs predicting participants' other-initiated negative social behaviors by time and intervention condition. In model 1, the effect of Time is not significant (Cohen's $d = 0.08$). This finding suggests that other-initiated negative social behaviors did not change during the study. Furthermore, in model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.12; Cohen's d PAT = -0.03). These results indicate that change in other-initiated negative social behaviors did not differ by intervention condition. See **Figure 9** for a visual of the effect of time and intervention condition on other-

initiated negative social behaviors. Observed marginal means are presented in Appendix J:

Supplementary tables.

Table 10. MLMs examining the effect of time and intervention condition on other-initiated negative social behaviors.

	Model 1			Model 2		
	B	SE	p	B	SE	p
Intercept	5.81	0.75	<.001	5.45	0.90	<.001
Sex (ref = Male)						
Female	0.07	0.70	.93	-0.004	0.71	1.00
Race (ref = White)						
Black	-1.89	1.63	.25	-1.73	1.64	.30
Latino	-1.76	1.52	.25	-1.51	1.55	.33
Asian	-0.84	0.76	.27	-0.79	0.76	.30
Multiracial	1.88	1.80	.30	2.02	1.81	.27
NEO Conscientiousness	-1.15	0.48	.02	-1.14	0.48	.02
BAS Reward responsiveness	0.18	0.17	.29	0.19	0.17	.28
Time	0.18	0.30	.54	0.11	0.51	.83
Treatment (ref = Control)						
NAT				0.36	0.85	.68
PAT				0.69	0.86	.42
Time x NAT				0.29	0.73	.69
Time x PAT				-0.06	0.73	.93

Note: Dependent variable = SIIS Other Negative; covariance for repeated measures = diagonal.

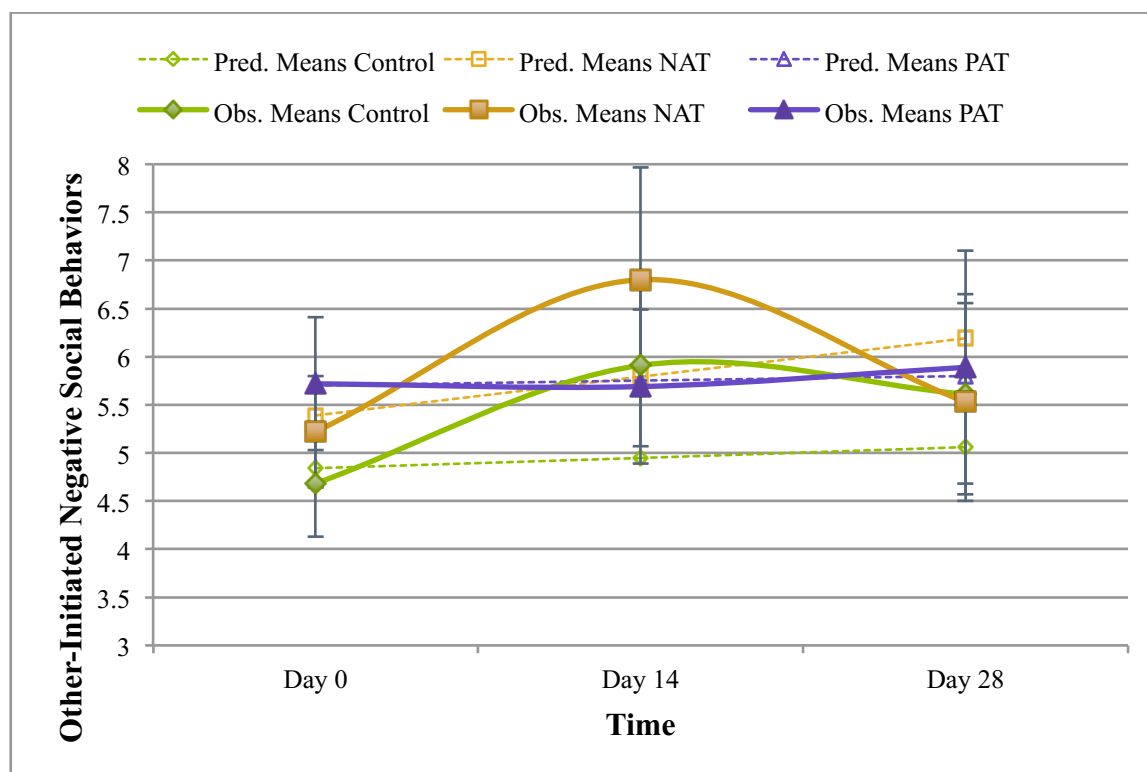


Figure 9. The effect of time and intervention condition on other-initiated negative social behaviors.

Figure 9 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Aim 2. Examining the effect of NAT and PAT on secondary outcome variables.

Depression. See **Table 11** for the results of MLMs predicting participants' depression symptoms by time and intervention condition. In model 1, Time emerged as a significant positive predictor of depression symptoms (Cohen's $d = 0.40$). These results indicate that on average, participants' depression symptoms increased during the study. In model 2, neither the Time by NAT interaction term nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.09; Cohen's d PAT = 0.003). Thus change in depression symptoms did not differ by intervention condition. See **Figure 10** for a visual of the effect of time and intervention condition

on depression symptom scores. Observed marginal means are presented in Appendix J:

Supplementary tables.

Table 11. MLMs examining the effect of time and intervention condition depression.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	2.58	0.36	<.001	2.68	0.44	<.001
Sex (ref = Male)						
Female	-0.19	0.34	.58	-0.18	0.34	.61
Race (ref = White)						
Black	-0.68	0.79	.39	-0.74	0.80	.36
Latino	-1.23	0.74	.10	-1.26	0.75	.09
Asian	-0.43	0.37	.25	-0.42	0.37	.26
Multiracial	-0.56	0.88	.53	-0.56	0.89	.53
NEO Conscientiousness	-1.15	0.23	<.001	-1.15	0.23	<.001
BAS Reward responsiveness	0.02	0.08	.86	0.02	0.08	.86
Time	0.50	0.13	<.001	0.46	0.22	.04
Treatment (ref = Control)						
NAT				-0.22	0.41	.56
PAT				-0.09	0.41	.82
Time x NAT				0.11	0.31	.73
Time x PAT				0.004	0.32	.99

Note: Dependent variable = PHQ-8; Covariance for repeated measures = autoregressive.

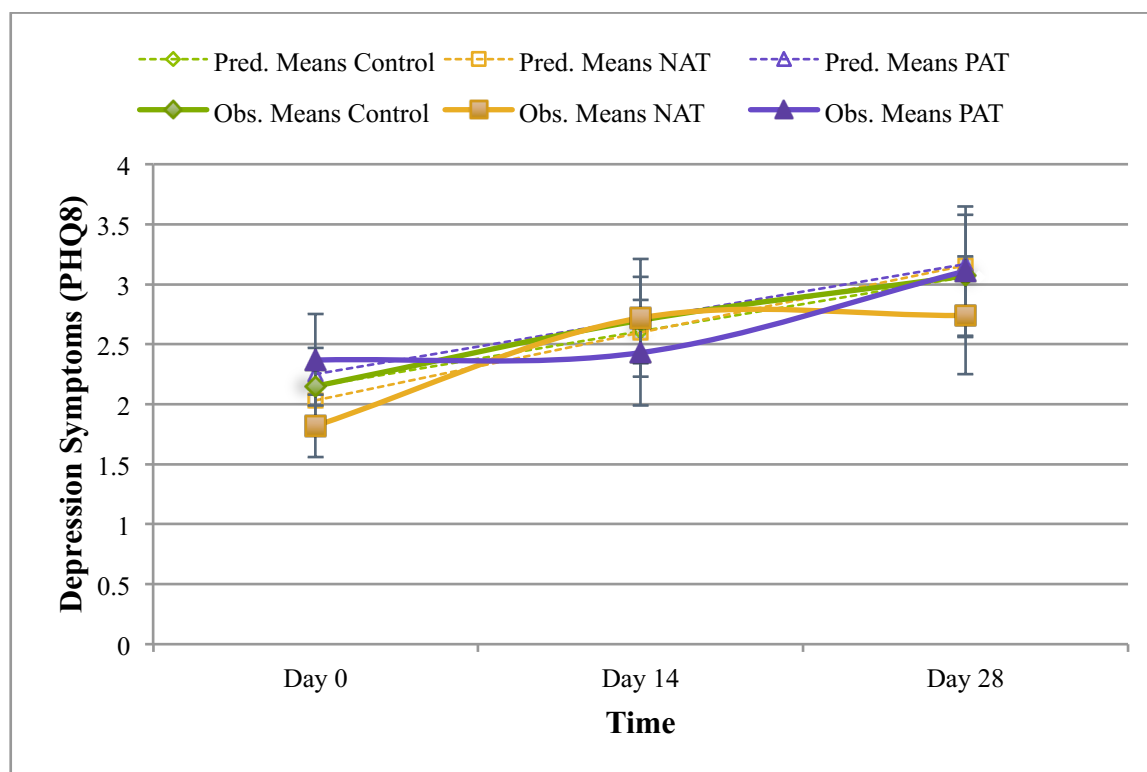


Figure 10. The effect of time and intervention condition on depression.

Figure 10 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Quality of life. See **Table 12** for the results of MLMs predicting participants' quality of life ratings by time and intervention condition. In model 1, the effect of Time was positive and trending towards significant ($p = .07$; Cohen's $d = 0.15$). This result suggests that on average, participants' may have experienced an increase in quality of life during the study. However, in model 2, the Time by NAT interaction and Time by PAT interaction terms were not significant (Cohen's d NAT = -0.03; Cohen's d PAT = 0.02). These findings indicated that change in quality of life did not differ by intervention condition. See **Figure 11** for a visual of the effect of time and intervention condition on quality of life ratings. Observed marginal means are presented in Appendix J. Supplementary tables.

Table 12. MLMs examining the effect of time and intervention condition on quality of life.

	Model 1			Model 2		
	B	SE	p	B	SE	p
Intercept	0.67	0.02	<.001	0.64	0.02	<.001
Sex (ref = Male)						
Female	-0.0004	0.02	.98	-0.01	0.02	.67
Race (ref = White)						
Black	-0.02	0.04	.64	-0.004	0.04	.91
Latino	0.05	0.04	.14	0.07	0.04	.04
Asian	0.03	0.02	.07	0.04	0.02	.04
Multiracial	-0.03	0.04	.48	-0.02	0.04	.66
NEO Conscientiousness	0.07	0.01	<.001	0.07	0.01	<.001
BAS Reward responsiveness	0.01	0.004	.03	0.01	0.004	.02
Time	0.01	0.005	.07	0.01	0.01	.26
Treatment (ref = Control)						
NAT				0.03	0.02	.09
PAT				0.06	0.02	.01
Time x NAT				-0.002	0.01	.84
Time x PAT				0.001	0.01	.94

Note: Dependent variable = QLESQ-SF; Covariance for repeated measures = autoregressive.

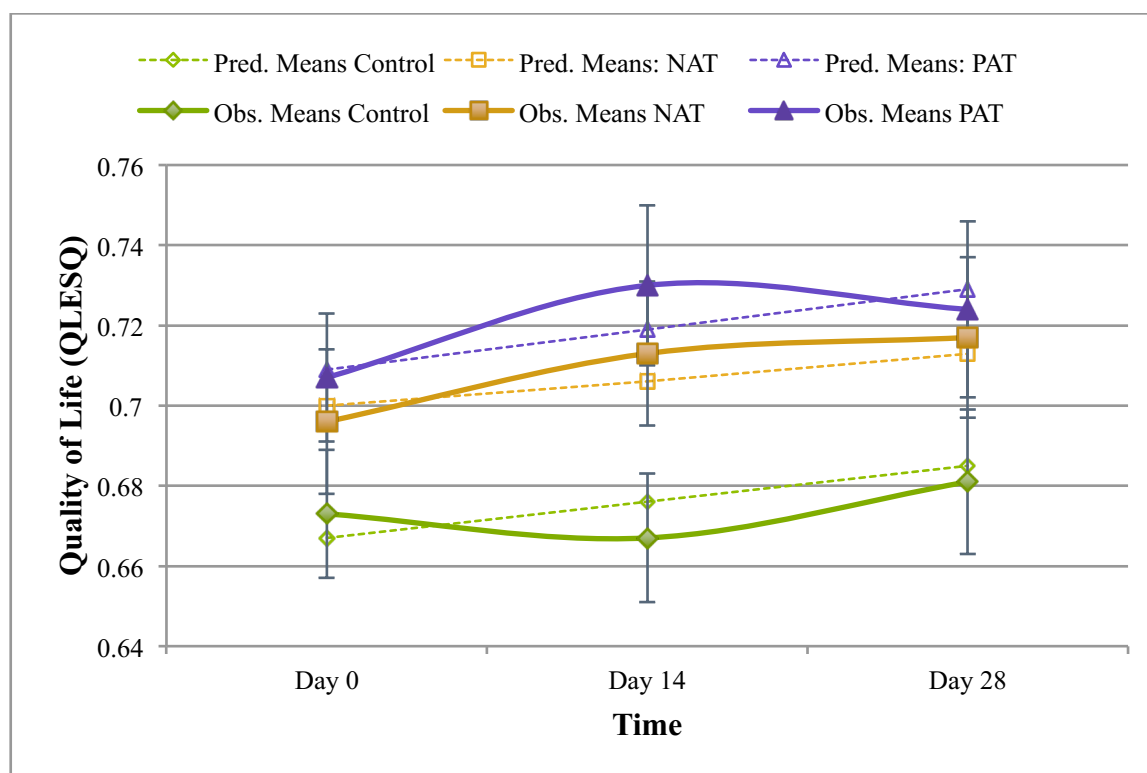


Figure 11. The effect of time and intervention condition on quality of life.

Figure 11 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Sleep Disturbance. See **Table 13** for the results of MLMs predicting participants' sleep disturbance levels by time and intervention condition. In model 1, the effect of Time was not significant. Thus sleep disturbance did not change during the study period (Cohen's $d = 0.09$). Furthermore, in model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.002; Cohen's d PAT = 0.09). These findings indicate that change in sleep disturbance did not differ by intervention condition. See **Figure 12** for a visual of the effect of time and intervention condition on sleep disturbance. Observed marginal means are presented in Appendix J: Supplementary tables.

Table 13. MLMs examining the effect of time and intervention condition on sleep disturbance.

	Model 1			Model 2		
	<i>B</i>	SE	<i>p</i>	<i>B</i>	SE	<i>p</i>
Intercept	17.04	0.83	<.001	18.19	1.01	<.001
Sex (ref = Male)						
Female	0.97	0.76	.20	1.16	0.75	.13
Race (ref = White)						
Black	-2.95	1.76	.10	-3.65	1.75	.04
Latino	-3.74	1.64	.02	-4.17	1.64	.01
Asian	-1.61	0.82	.05	-1.54	0.81	.06
Multiracial	2.02	1.96	.30	1.95	1.93	.32
NEO Conscientiousness	-1.31	0.52	.01	-1.31	0.51	.01
BAS Reward responsiveness	-0.10	0.19	.58	-0.10	0.18	.57
Time	0.27	0.23	.24	0.18	0.39	.64
Treatment (ref = Control)						
NAT				-2.23	1.01	.03
PAT				-1.44	1.02	.16
Time x NAT				0.005	0.55	.99
Time x PAT				0.25	0.55	.66

Note: Dependent variable = SDS; Covariance for repeated measures = autoregressive.

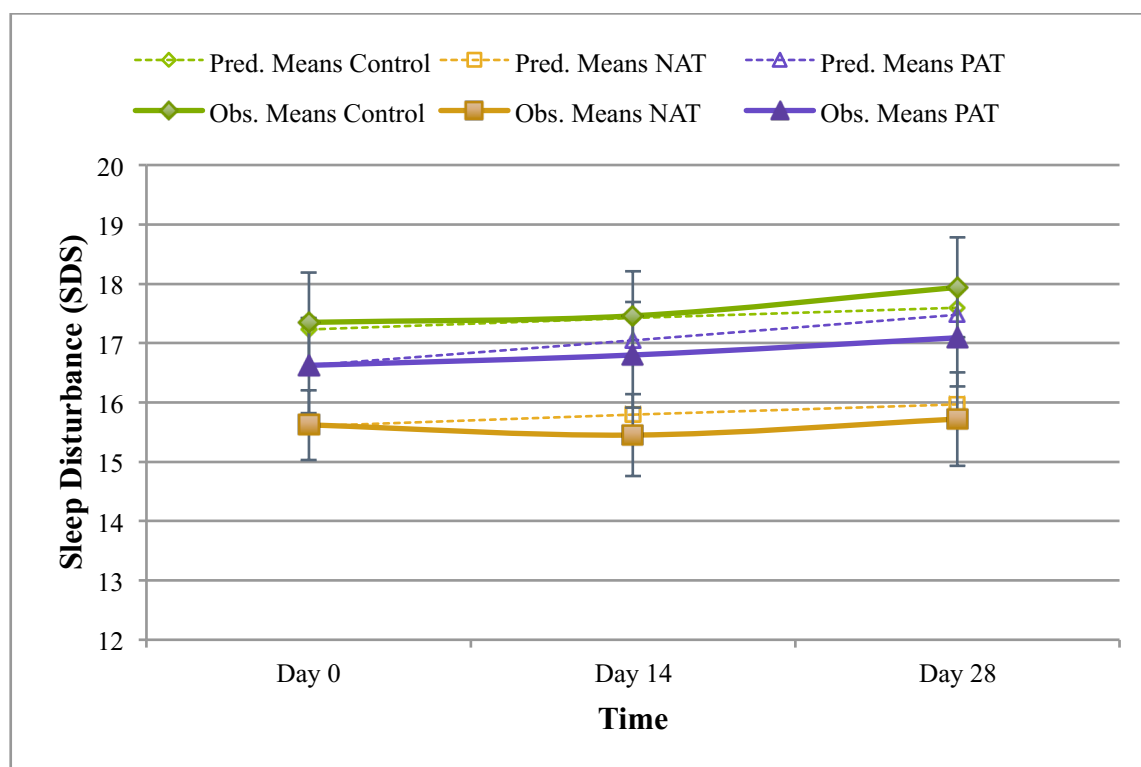


Figure 12. The effect of time and intervention condition on sleep disturbance.

Figure 12 note. Predicted means were calculated from MLM predicted values. Observed means were calculated from observed data. Error bars reflect +/- 1 SE.

Aims 1 and 2. Supplementary Analyses

Examining the role of treatment credibility and expectancy. After receiving the intervention instructions on Day 0, participants completed measures of intervention credibility and expectancy. Descriptive statistics for these measures are presented in **Table 14**. The intervention groups differed with regard to treatment credibility, such that participants in the two active conditions found their assigned intervention more credible than participants in the control condition. However, the groups did not differ with regard to treatment expectancy.

Table 14. Intervention credibility and expectancy by treatment group

	Group			Group Comparison	
	Control	NAT	PAT	Test Statistic	P value
Intervention credibility; M (SD)	-0.83 ^a (2.88)	0.42 ^b (2.26)	0.46 ^b (2.34)	$F(2,176)=5.07$	.007
Intervention expectancy; M (SD)	-0.42 ^a (2.98)	0.45 ^a (2.84)	-0.03 ^a (2.45)	$F(2,177)=1.47$	.232

Note. Scores for treatment credibility and expectancy are standard scores. Means that do not share a superscript are significantly different at $p < .05$ per Tukey's post-hoc test.

I next conducted bivariate correlations between change in loneliness from Day 0 to Day 28 and treatment credibility and expectancy scores. Treatment credibility was not associated with loneliness change, $r = .09$, $p = .279$. On the other hand, treatment expectancy was associated with increasing loneliness over time, $r = .16$, $p = .04$. Finally, I conducted a step-wise linear regression model to explore the effect of intervention credibility and expectancy as predictors of change in loneliness from baseline to follow-up, over and above baseline loneliness level. Change in loneliness from Day 0 to Day 28 served as the dependent variable. Baseline loneliness was entered in the first step of the regression model, and credibility and expectancy scores were entered in the second step. See **Table 15** for the results of the final step of the model. Neither intervention credibility nor intervention expectancy predicted change in loneliness, above and beyond baseline loneliness. Together, credibility and expectancy accounted for only 1.3% of the variance in change in loneliness.

Table 15. Regression model predicting change in loneliness by treatment credibility and expectancy.

	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>R</i> ² change
Baseline loneliness	-0.41	0.06	<.001	.218
Treatment credibility	-0.53	0.35	.125	.013
Treatment expectancy	0.46	0.31	.145	

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Examining the role of homework compliance. During the skills practice phase of the study, (Days 1-13), participants completed daily measures of homework compliance. See **Table 16** for descriptive statistics for homework compliance. In general, compliance was excellent. Of the 180 randomized participants, 178 completed at least one daily question set and 177 practiced at least one skill. Of the 13 possible daily question sets, participants completed a mean of 9.91 (*SD* = 3.29) sets. Daily question completion did not differ by intervention condition. Of the 26 possible skills practice sessions, participants completed a mean of 18.16 (*SD* = 6.90) skills. Skills practice did not differ by condition. Participants in the NAT were encouraged to complete as many of their “avoidance reduction” behaviors face-to-face with other individuals, and they appear to have generally followed these instructions. Specifically, participants in the NAT reported completing 64.5% of “avoidance reduction” behaviors face-to-face with another person, 16.5% via spoken communication (e.g., phone, video chat), 16.3% via written communication (e.g., text message, social media), 1.8% remotely (i.e. did not interact with another person), and 1.0% missing modality. Participants in the PAT were also encouraged to complete as many of their “kind acts” face-to-face with other individuals, and they appear to have followed these instructions. Specifically, participants in the PAT reported completing 60.9% of “kind acts” face-to-face with another person, 18.0% via spoken communication (e.g., phone, video chat), 15.3%

via written communication (e.g., text message, social media), and 5.9% remotely (i.e. did not interact with another person).

Table 16. Homework compliance by treatment group

	All (N=180)	Group			Test for group difference	
		Control (N=60)	NAT (N=60)	PAT (N=60)	Test Statistic	<i>P</i> value
Completed question sets; M(SD)	9.91 (3.29)	10.23 (2.88)	10.05 (3.32)	9.43 (3.63)	$F(2,177)=$ 0.97	.381
Skills performed; M(SD)	18.16 (6.90)	19.73 (6.29)	17.05 (7.02)	17.68 (7.19)	$F(2,177)=$ 2.52	.083
Daily check-in; M(SD)		9.93 (3.10)				
Recording life details; M(SD)		9.80 (3.22)				
Reappraisal; M(SD)			8.55 (3.62)			
Avoidance reduction; M(SD)			8.50 (3.54)			
Three good things; M(SD)				8.87 (3.70)		
Kind acts; M(SD)				8.82 (3.62)		

I next conducted a series of step-wise linear regression models to examine the effect of homework compliance on change in loneliness. I conducted models separately for each intervention condition. Change in loneliness from Day 0 to Day 28 served as the dependent variable. Baseline loneliness was entered in the first step and skills practice frequency was entered in the second step.

Control condition. Skills practice frequencies for “daily check-in” and “recording life details” were highly correlated ($r = .98, p < .001$). I therefore conducted separate regression models for each skill to avoid problems associated with multicollinearity. See **Table 17** for the results of the final step of the regression model predicting change in loneliness by baseline loneliness and “daily check-in” practice. “Daily check-in” practice did not predict loneliness

change above and beyond baseline loneliness, and accounted for only 0.1% of the variance in loneliness change. See **Table 18** for the results of the final step of the regression model predicting change in loneliness by baseline loneliness and “recording life details” practice. “Recording life details” practice did not predict loneliness change above and beyond baseline loneliness, and accounted for only 0.5% of the variance in loneliness change.

Table 17. Regression model predicting loneliness outcome by daily check-in skills practice

	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>R</i> ² change
Baseline loneliness	-0.35	0.10	.001	.202
Daily check-in practice	0.08	0.31	.788	.001

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Table 18. Regression model predicting loneliness outcome by recording life details practice

	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>R</i> ² change
Baseline loneliness	-0.35	0.10	.001	.202
Recording life details practice	0.17	0.29	.558	.005

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Negative Affect Treatment. Skills practice frequencies for “reappraisal” and “avoidance reduction” were highly correlated ($r = .92, p < .001$). I therefore conducted separate regression models for each skill to avoid problems associated with multicollinearity. See **Table 19** for the results of the final step of the regression model predicting change in loneliness by baseline loneliness and “reappraisal” practice. “Reappraisal” practice did not predict change in loneliness above and beyond baseline loneliness, and accounted for less than 0.1% of the variance in change in loneliness. See **Table 20** for the results of the final step of the regression model predicting change in loneliness by baseline loneliness and “avoidance reduction practice.” “Avoidance reduction” practice did not predict change in loneliness above and beyond baseline loneliness, and accounted for less than 0.1% of the variance in change in loneliness.

Table 19. Regression model predicting loneliness outcome by reappraisal practice

	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>R</i> ² change
Baseline loneliness	-0.44	0.11	<.001	.239
Reappraisal practice	0.05	0.29	.875	<.001

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Table 20. Regression model predicting loneliness outcome by avoidance reduction practice

	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>R</i> ² change
Baseline loneliness	-0.45	0.11	<.001	.239
Avoidance reduction practice	-0.01	0.30	.981	<.001

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Positive Affect Treatment. Skills practice frequencies for “three good things” and “kind acts” were highly correlated ($r = .93, p < .001$). I therefore conducted separate regression models for each skill to avoid problems associated with multicollinearity. See **Table 21** for the results of the final step of the regression model predicting change in loneliness by baseline loneliness and “three good things” practice. “Three good things” practice did not predict loneliness change above and beyond baseline loneliness, and accounted for only 0.4% of the variance in loneliness change. See **Table 22** for the results of the final step of the regression model predicting change in loneliness by baseline loneliness and “kind acts” practice. “Kind acts” practice did not predict change in loneliness above and beyond baseline loneliness, and accounted for only 0.8% of the variance in loneliness change.

Table 21. Regression model predicting loneliness outcome by three good things practice

	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>R</i> ² change
Baseline loneliness	-0.43	0.12	.001	.207
Three good things practice	0.20	0.40	.622	.004

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Table 22. Regression model predicting loneliness outcome by kind acts practice

	<i>B</i>	<i>SE B</i>	<i>p</i>	R² change
Baseline loneliness	-0.44	0.12	.001	.207
Kind acts practice	0.29	0.40	.477	.008

Note. Dependent variable = change in ULS-3 scores from baseline to follow-up.

Examining change in depression symptoms. The results of the MLM predicting change in depression symptoms indicated that, on average, participants' depression symptoms increased during the study. In order to understand this effect, I created a scatterplot examining the relationship between Day 28 change in loneliness and Day 28 change in depression symptoms (see **Figure 13**). This scatterplot revealed a positive correlation between change in loneliness and change in depression symptoms, $r = .44$, $p < .001$. Thus, depression and loneliness appear to have increased (and decreased) in tandem during the study period.

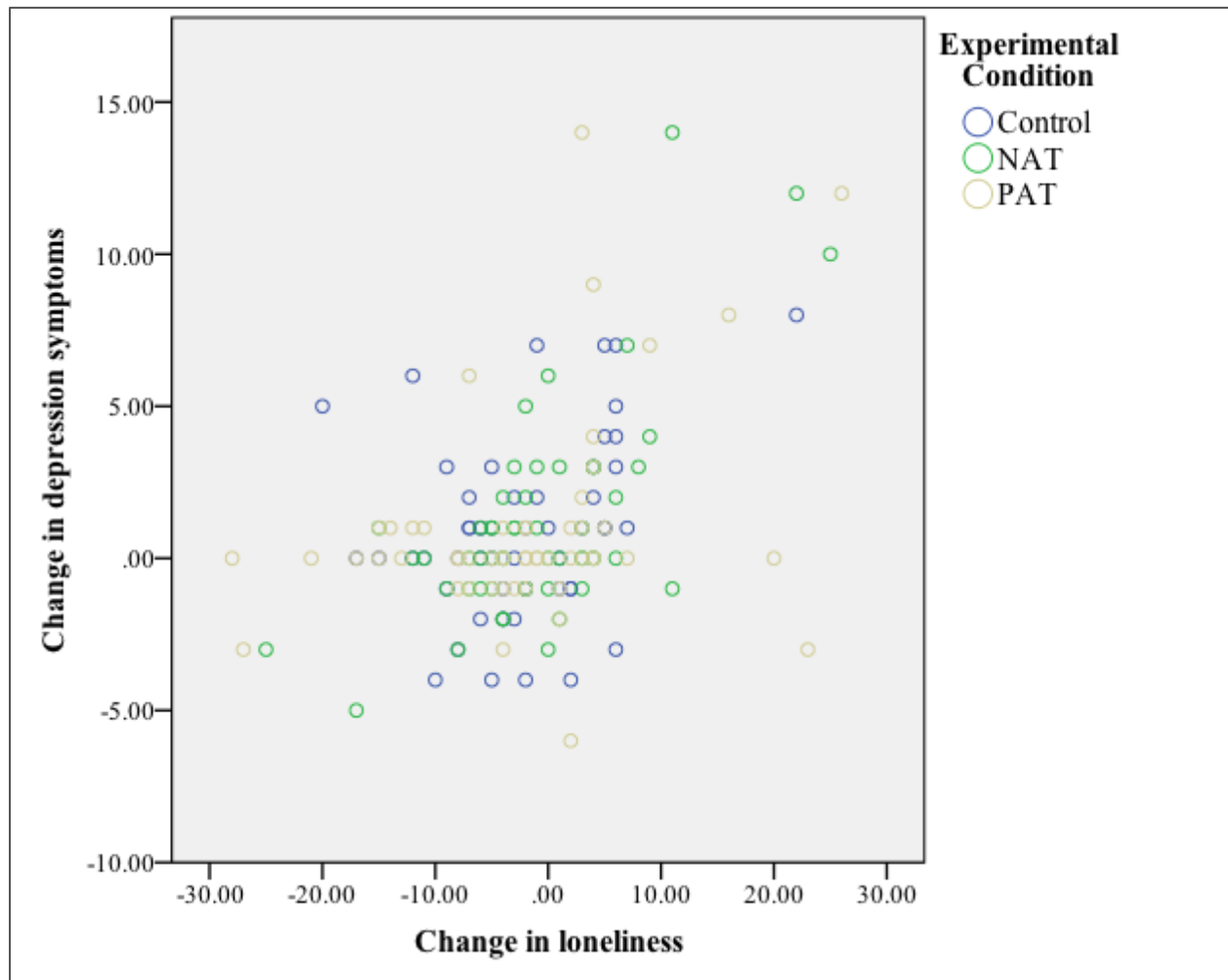


Figure 13. The association between change in loneliness and change in depression symptoms

Figure 13 Note. Change in ULS-3 scores from Day 0 to Day 28 is plotted on the x-axis, change in PHQ-8 scores from Day 0 to Day 28 is plotted on the y-axis.

I then conducted a time-lagged MLM to examine whether loneliness prospectively predicted change in depression symptoms, or vice versa, during the study. Time-lagged MLMs examine the effect of X_{T1} on Y_{T2} , while controlling for the effect of Y_{T1} on Y_{T2} . Models included a random intercept and were estimated using FIML to account for missing data. The first model examined the effect of lagged depression symptoms on loneliness, controlling for lagged

loneliness (see **Table 23**). Results indicated that depression symptoms at the prior time-point positively predicted loneliness, above and beyond variance accounted for by loneliness at the prior time-point. The second model examined the effect of lagged loneliness on depression symptoms, controlling for lagged depression symptoms (see **Table 24**). Results indicated that loneliness at the prior time-point was not a significant predictor of depression symptoms, above and beyond the variance accounted for by depression symptoms at the prior time-point. Taken together, these results suggest that depression symptoms prospectively predicted worsening loneliness during the study, but that loneliness did not predict worsening depression over the same time period.

Table 23. Time-lagged MLM predicting loneliness by lagged depression symptoms.

	<i>B</i>	<i>SE B</i>	<i>P</i>
Intercept	9.21	1.39	< .001
Lagged ULS-3	0.73	0.03	< .001
Lagged PHQ-8	0.58	0.11	< .001

Note. ULS-3 = UCLA Loneliness Scale; PHQ-8 = Patient Health Questionnaires – 8 (depression symptom measure).

Table 24. Time-lagged MLM predicting depression symptoms by lagged loneliness.

	<i>B</i>	<i>SE B</i>	<i>P</i>
Intercept	0.68	0.68	.315
Lagged PHQ-8	0.77	0.05	< .001
Lagged ULS-3	0.01	0.02	.617

Note. PHQ-8 = Patient Health Questionnaires – 8 (depression symptom measure); ULS-3 = UCLA Loneliness Scale.

Aim 3. Examining mediators of NAT and PAT

Change in Negative Affect (NA). See **Table 25** for the results of MLMs predicting participants NA scores during the study. In model 1, the effect of Time was significant (Cohen's $d = 0.30$). These results indicate an average increase in NA during the study period. In model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant

(Cohen's d NAT = 0.19; Cohen's d PAT = 0.21). Thus change in NA did not differ by intervention condition.

Table 25. MLMs examining the effect of time and intervention condition on negative affect.

	<i>Model 1</i>			<i>Model 2</i>		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
Intercept	16.22	0.77	<.001	16.26	0.94	<.001
Sex (ref = Male)						
Female	0.15	0.72	.84	0.12	0.72	.87
Race (ref = White)						
Black	-0.21	1.66	.90	-0.19	1.69	.91
Latino	-1.15	1.54	.46	-1.04	1.57	.51
Asian	-0.72	0.77	.35	-0.69	0.78	.38
Multiracial	2.05	1.84	.27	2.14	1.85	.25
NEO Conscientiousness	-2.23	0.49	<.001	-2.22	0.49	<.001
BAS Reward responsiveness	-0.12	0.18	.49	-0.12	0.18	.50
Time	0.77	0.25	.003	0.44	0.44	.37
Treatment (ref = Control)						
NAT				-0.20	-0.92	.83
PAT				0.05	0.92	.96
Time x NAT				0.47	0.61	.45
Time x PAT				0.54	0.62	.39

Note. Dependent variable = PANAS NA; Covariance for repeated measures = autoregressive.

Examining NA as a mediator. Although MLM analyses did not indicate a direct effect of NAT on NA during the study, I proceeded with mediation analyses given evidence that an indirect effect can emerge in the absence of a significant effect of X on M (Hayes, 2013, p. 166-170). For example, in the present study, mediation analyses can be used to explore whether the NAT led to improvement in loneliness only for those participants who experienced reductions in NA following the intervention. To test this hypothesis, I examined Day 14 change in NA as a mediator of the effect of intervention condition on Day 28 change in loneliness. See **Figure 14** for a visual depiction of the proposed mediation model and **Table 26** for path coefficients for the mediation model.

Mediation results NAT. Consistent with the MLM analyses, the direct effect of NAT on Day 28 change in loneliness was not significant and the effect of NAT on Day 14 change in negative affect was not significant. Day 14 reductions in positive affect significantly predicted Day 28 reductions in loneliness. However the indirect effect of NAT on Day 28 change in loneliness via Day 14 change in negative affect was not significant. Thus change in NA did not mediate the effect of NAT on change in loneliness.

Mediation results PAT. Results were similar for the PAT. Consistent with the MLM analyses, the direct effect of PAT on Day 28 change in loneliness was not significant and the effect of PAT on Day 14 change in negative affect was not significant. Day 14 reductions in negative affect significantly predicted Day 28 reductions in loneliness. However, the indirect effect of PAT on Day 28 change in loneliness via Day 14 change in negative affect was not significant. Thus change in NA did not mediate the effect of PAT on change in loneliness.

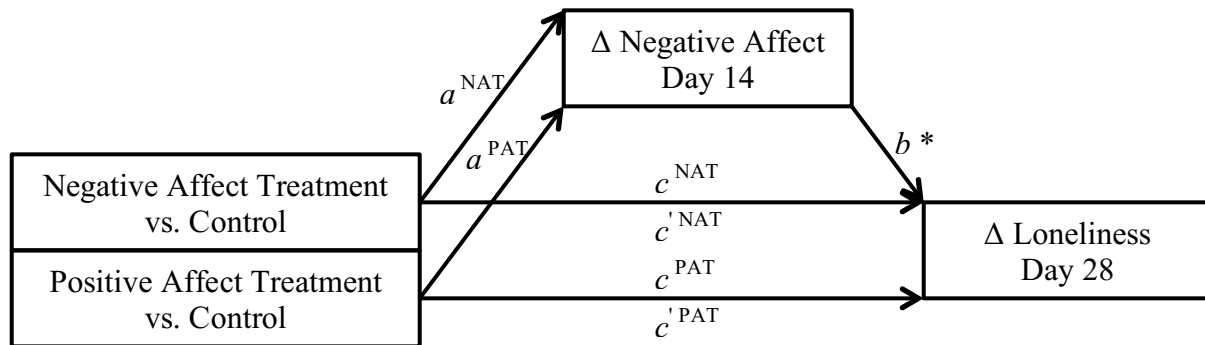


Figure 14. Proposed mediation model: Day 14 change in negative affect as a mediator of the effect of intervention condition on Day 28 change in loneliness.

Table 26. Path coefficients for mediation model: Day 14 change in negative affect as a mediator of the effect of intervention condition on Day 28 change in loneliness.

	c(se)	c'(se)	a(se)	b(se)	ab(se)	ab-LLCI	ab-ULCI
NAT	1.19 (1.71)	0.48 (1.61)	1.24 (1.03)	0.57* (0.13)	0.71 (0.62)	-0.32	2.21
PAT	0.35 (1.71)	0.08 (1.61)	0.47 (1.03)	0.57* (0.13)	0.27 (0.63)	-0.88	1.69

Note. * $p < .05$; NAT = Negative Affect Treatment; PAT = Positive Affect Treatment; LLCI = low limit bias-corrected bootstrap confidence interval; ULCI = upper limit bias-corrected bootstrap confidence interval.

Change in Positive Affect (PA). See Table 27 for the results of MLMs predicting participants PA scores during the study. In model 1, the effect of Time was not significant (Cohen's $d = 0.05$). These results suggest minimal change in PA during the study period. In model 2, neither the Time by NAT interaction term, nor the Time by PAT interaction term was significant (Cohen's d NAT = 0.17; Cohen's d PAT = 0.11). Thus change in PA did not differ by intervention condition.

Table 27. MLMs examining the effect of time and intervention condition on positive affect.

	<i>Model 1</i>			<i>Model 2</i>		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
Intercept	33.98	0.93	<.001	33.56	1.12	<.001
Sex (ref = Male)						
Female	-2.04	0.87	.02	-2.16	0.86	.01
Race (ref = White)						
Black	0.60	2.00	.77	0.68	2.01	.74
Latino	0.0003	1.86	1.00	0.54	1.87	.77
Asian	1.58	0.93	.09	1.78	0.93	.06
Multiracial	-1.48	2.22	.51	-1.04	2.22	.64
NEO Conscientiousness	4.24	0.59	<.001	4.25	0.58	<.001
BAS Reward responsiveness	0.90	0.21	<.001	0.92	0.21	<.001
Time	0.20	0.26	.45	-0.16	0.45	.72
Treatment (ref = Control)						
NAT				-0.35	1.09	.75
PAT				1.36	1.10	.22
Time x NAT				0.67	0.63	.29
Time x PAT				0.42	0.64	.53

Note. Dependent variable = PANAS PA; covariance for repeated measures = diagonal.

Examining PA as a mediator. Although change in PA did not differ by intervention condition, I proceeded with mediation analyses for reasons described above. Specifically, I examined Day 14 change in PA as a mediator of the effect of intervention condition on Day 28 change in loneliness. See **Figure 15** for a visual depiction of the proposed mediation model and **Table 28** for path coefficients for the mediation model.

Mediation results NAT. Consistent with the MLM analyses, the direct effect of NAT on Day 28 change in loneliness was not significant and the effect of NAT on Day 14 change in positive affect was not significant. Day 14 increases in positive affect significantly predicted Day 28 reductions in loneliness. However, the indirect effect of NAT on Day 28 change in loneliness via Day 14 change in positive affect was not significant. Thus change in PA did not mediate the effect of NAT on change in loneliness.

Mediation results PAT. Results were similar for the PAT. Consistent with the MLM analyses, the direct effect of PAT on Day 28 change in loneliness was not significant and the effect of PAT on Day 14 change in positive affect was not significant. Day 14 increases in positive affect significantly predicted Day 28 reductions in loneliness. However the indirect effect of PAT on Day 28 change in loneliness via Day 14 change in positive affect was not significant. Thus change in PA did not mediate the effect of the PAT on change in loneliness.

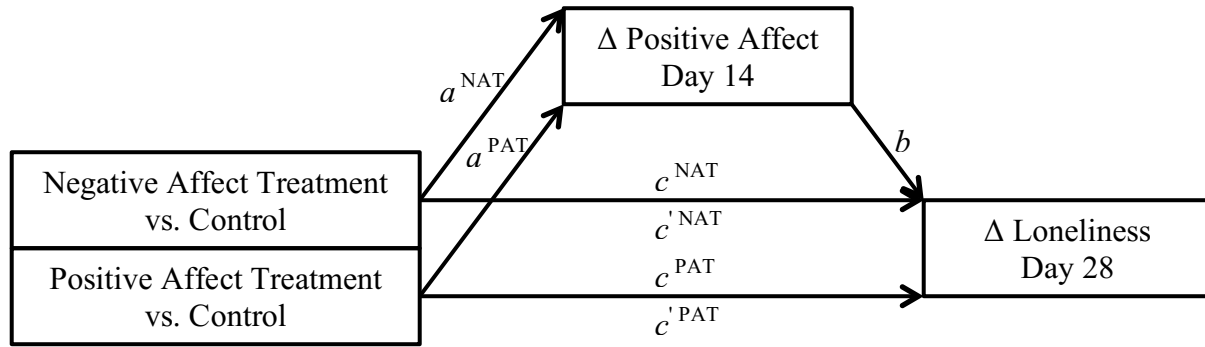


Figure 15. Proposed mediation model: Day 14 change in positive affect as a mediator of the effect of intervention condition on Day 28 change in loneliness.

Table 28. Path coefficients for mediation model: Day 14 change in positive affect as a mediator of the effect of intervention condition on Day 28 change in loneliness.

	c(se)	c'(se)	a(se)	b(se)	ab(se)	ab-LLCI	ab-ULCI
NAT	1.34 (1.68)	1.49 (1.62)	0.35 (1.11)	-0.43* (0.12)	-0.15 (0.52)	-1.29	0.83
PAT	0.32 (1.68)	0.70 (1.62)	0.88 (1.11)	-0.43* (0.12)	-0.38 (0.46)	-1.52	0.35

Note. * $p < .05$; NAT = Negative Affect Treatment; PAT = Positive Affect Treatment; LLCI = low limit bias-corrected bootstrap confidence interval; ULCI = upper limit bias-corrected bootstrap confidence interval.

Aim 4. Examining moderators of the NAT and PAT

Personality characteristics.

Neuroticism. The interaction between neuroticism and time was significant, $B(\text{se}) = -1.02(0.40)$, $p = .012$, indicating that neuroticism predicted differential change in loneliness during the study. I used simple slopes analysis to examine the effect of time at low (-1 SD), medium (mean), and high (+1 SD) neuroticism. Results indicated a nonsignificant effect of time at low neuroticism, $B(\text{se}) = -0.14(0.46)$, $p = .759$, a negative slope of time at medium neuroticism, $B(\text{se}) = -0.97(0.32)$, $p = .003$, and a negative slope of time at high neuroticism, $B(\text{se}) = -1.79(0.45)$, $p < .001$. These results suggest that loneliness decreased during the study period, but only for

participants at medium to high levels of neuroticism (see **Figure 16**). The three-way interaction between neuroticism, time, and NAT was not significant, $B(se) = 0.79(1.05)$, $p = .454$; nor was the three-way interaction between neuroticism, time, and PAT, $B(se) = 0.17(0.97)$, $p = .861$. Thus neuroticism did not moderate the effect of condition on change in loneliness.

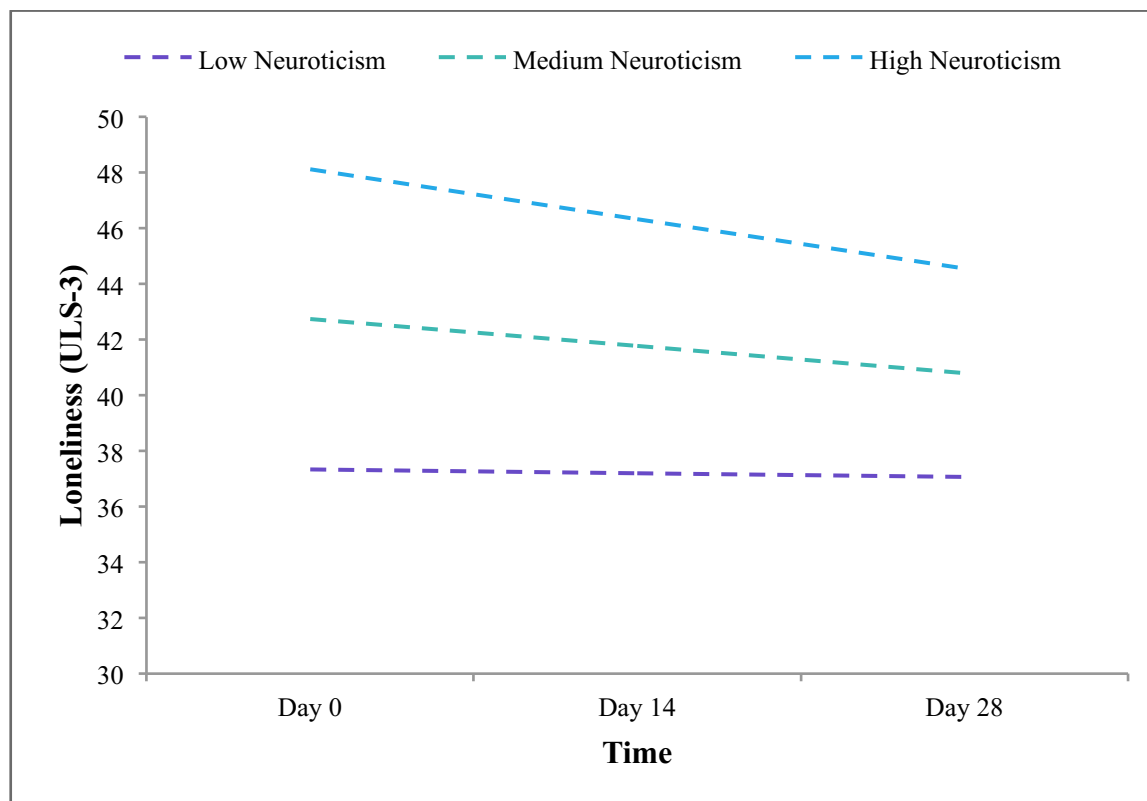


Figure 16. Slope of time at low (-1 SD), medium (mean), and high (+1 SD) neuroticism.

Behavioral Inhibition (BIS). The interaction between behavioral inhibition and time was significant, $B(\text{se}) = -0.22(0.09)$, $p = .012$, indicating that behavioral inhibition predicted differential change in loneliness across time. This two-way interaction was qualified by a significant three-way interaction between behavioral inhibition, time, and NAT, $B(\text{se}) = 0.50(0.23)$, $p = .032$. The three-way interaction between behavioral inhibition, time, and PAT was not significant, $B(\text{se}) = 0.16(0.20)$, $p = .445$. In order to parse the significant three-way interaction, I examined the two-way interaction behavioral inhibition and time separately for the three intervention conditions. These analyses revealed a significant interaction between behavioral inhibition and time for the control condition, $B(\text{se}) = -0.43(0.13)$, $p = .001$; but not for the NAT, $B(\text{se}) = 0.07(0.17)$, $p = .682$; or the PAT, $B(\text{se}) = -0.26(0.15)$, $p = .094$. I used simple

slopes analyses to examine the effect of time at low (-1 SD), medium (mean), and high (+1 SD) behavioral inhibition for participants in the control condition. These analyses indicated a non-significant effect of time at low behavioral inhibition, $B(\text{se}) = 0.32(0.65)$, $p = .628$, a negative slope of time at medium behavioral inhibition, $B(\text{se}) = -1.35(0.44)$, $p = .003$, and a negative slope of time at high behavioral inhibition, $B(\text{se}) = -3.01(0.65)$, $p < .001$ (see **Figure 17**). Taken together, these results suggest that medium to high behavioral inhibition predicted reductions loneliness during the study, primarily for participants in the control condition.

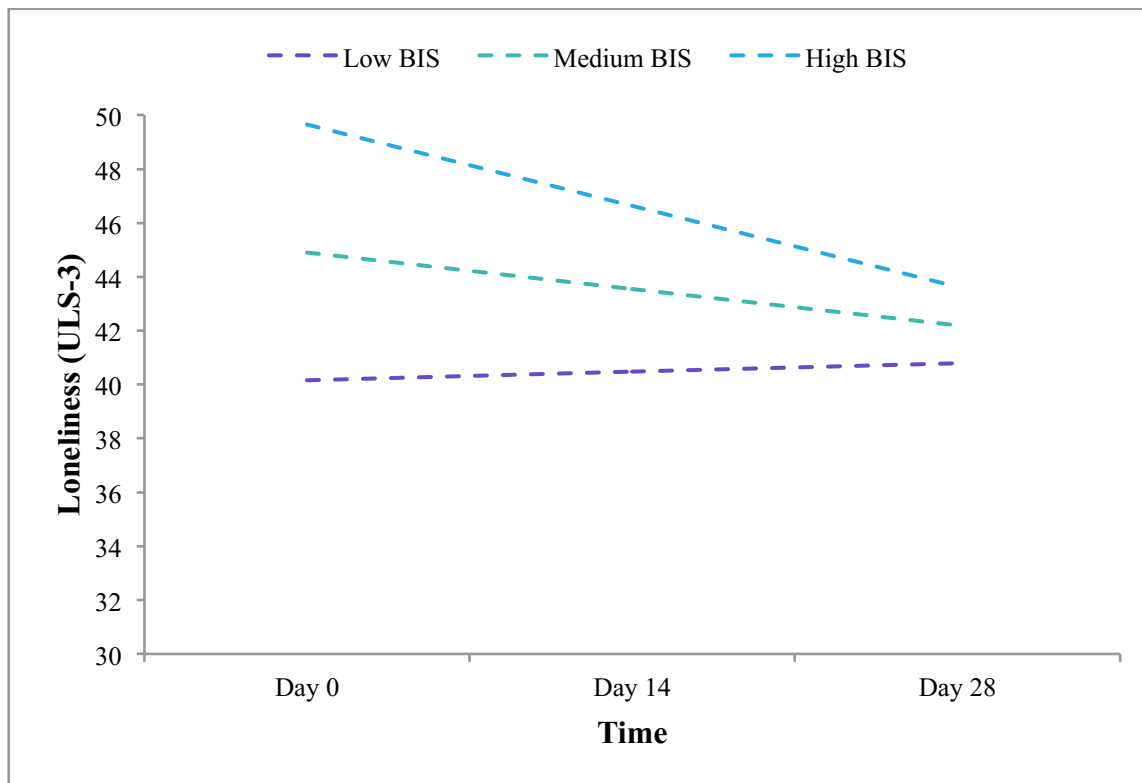


Figure 17. Control condition: Slope of time at low (-1 SD), medium (mean), and high (+1 SD) behavioral inhibition.

Extraversion. The interaction between extraversion and time was significant, $B(\text{se}) = 0.92(0.39)$, $p = .019$, indicating that extraversion predicted differential change in loneliness

during the study. I used simple slopes analysis to examine the effect of time at low (-1 SD), medium (mean), and high (+1 SD) extraversion. Results indicated a negative slope of time at low extraversion, $B(se) = -1.74(0.45)$, $p < .001$, a negative slope of time a medium extraversion, $B(se) = -0.97(0.32)$, $p = .003$, and a non significant effect of time at high extraversion, $B(se) = -0.20(0.46)$, $p = .661$. These results suggest that loneliness decreased during the study period, but only for participants at low to medium levels of extraversion (see **Figure 18**). The three-way interaction between extraversion, time, and NAT was not significant, $B(se) = -1.11(0.99)$, $p = .264$; nor was the three-way interaction between extraversion, time, and PAT, $B(se) = -1.11(0.99)$, $p = .265$. Thus extraversion did not moderate the effect of intervention condition on loneliness change.

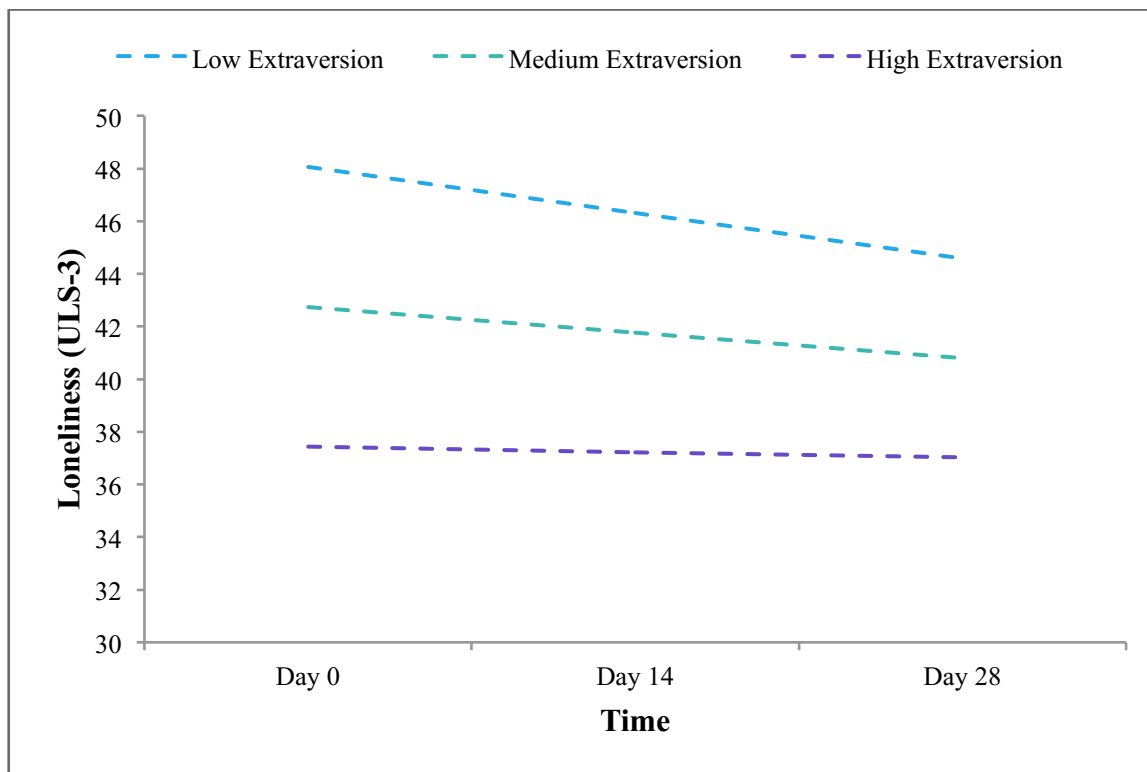


Figure 18. Slope of time at low (-1 SD), medium (mean), and high (+1 SD) extraversion.

Behavioral Activation Drive (BAS Drive). The interaction between behavioral activation drive and time was not significant, $B(\text{se}) = 0.05(0.15)$, $p = .716$, indicating that drive did not predict differential change in loneliness during the study. The three-way interaction between behavioral activation drive, time, and NAT was not significant, $B(\text{se}) = 0.50(0.34)$, $p = .146$; nor was the three-way interaction between behavioral activation drive, time, and PAT, $B(\text{se}) = -0.28(0.37)$, $p = .446$. These results suggest that drive did not moderate the effect of intervention condition on change in loneliness.

Behavioral Activation Fun-seeking (BAS Fun-seeking). The interaction between behavioral activation fun-seeking and time was not significant, $B(\text{se}) = 0.23(0.16)$, $p = .152$, indicating that fun-seeking did not predict differential change in loneliness during the study. The three-way interaction between behavioral activation fun-seeking, time, and NAT was not significant, $B(\text{se}) = -0.04(0.40)$, $p = .924$; nor was the interaction between behavioral activation fun-seeking, time, and PAT, $B(\text{se}) = -0.37(0.39)$, $p = .350$. These results suggest that fun-seeking did not moderate the effect of intervention condition on change in loneliness.

Behavioral Activation Reward Responsiveness (BAS Reward Responsiveness). The interaction between behavioral activation reward responsiveness was not significant, $B(\text{se}) = -0.07(0.16)$, $p = .682$. However, the three-way interaction between behavioral activation reward responsiveness, time, and NAT was significant, $B(\text{se}) = 0.86(0.42)$, $p = .041$, though the three way interaction between behavioral activation reward responsiveness, time, and PAT was not significant, $B(\text{se}) = 0.05(0.39)$, $p = .894$. In order to parse the significant three-way interaction, I examined the two-way interaction behavioral activation reward responsiveness and time separately for the three intervention conditions. These analyses revealed a non-significant interaction between reward responsiveness and time for the control condition, $B(\text{se}) = -$

0.32(0.24), $p = .191$; the NAT, $B(\text{se}) = 0.47(0.28)$, $p = .099$, and the PAT, $B(\text{se}) = -0.28(0.30)$, $p = 0.355$. Thus reward responsiveness did not emerge as a significant moderator of the effect of intervention condition on change in loneliness.

Demographic variables.

Participant gender. The interaction between female gender and time was significant, $B(\text{se}) = -2.32(0.63)$, $p < .001$, indicating that female gender predicted differential change in loneliness over time. I used simple slopes analyses to examine the effect of time separately for male participants, $B(\text{se}) = 0.28(0.46)$, $p = .537$, and female participants, $B(\text{se}) = -2.04(0.43)$, $p < .001$ (see **Figure 19**). These results suggest that loneliness decreased during the study, primarily for female participants. The three-way interaction between gender, time, and NAT was not significant, $B(\text{se}) = 2.23(1.52)$, $p = .145$; nor was the three-way interaction between gender, time, and PAT, $B(\text{se}) = -0.80(1.53)$, $p = .602$. These results indicate that participant gender did not moderate the effect of intervention condition on change in loneliness.

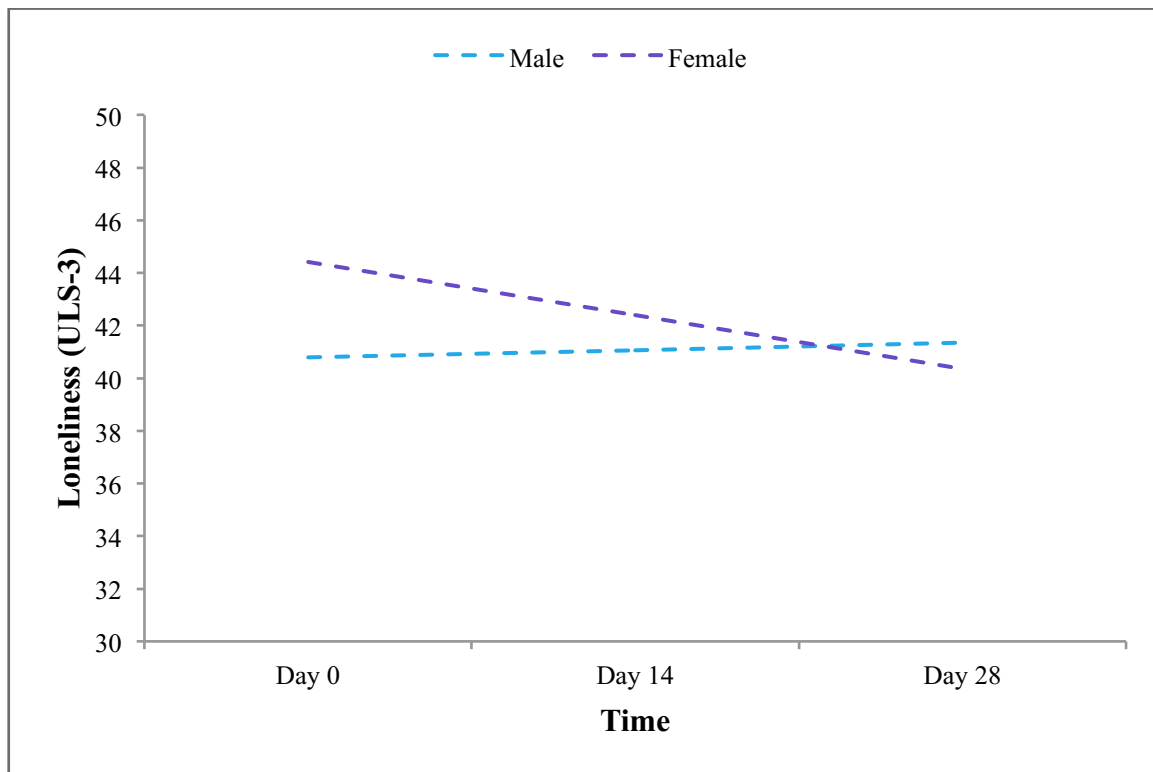


Figure 19. Slope of time for male and female participants.

Participant age. The interaction between age and time was not significant, $B(se) = 0.13(0.10)$, $p = .212$. Furthermore, the three-way interaction between age, time, and NAT was not significant, $B(se) = -0.12(0.27)$, $p = .641$, and the three-way interaction between age, time, and PAT, $B(se) = 0.19(0.25)$, $p = .441$ was not significant. These results indicate that participants' age did not predict differential change in loneliness during the study, nor did it moderate the effect of intervention condition on change in loneliness.

Participant race. For moderation analyses, participant race was recoded to create three groups: White participants, Asian participants, and Other participants (i.e. participants who identified as Black, Latino, or Multiracial). The interaction between Asian race and time was significant $B(se) = 1.69(0.70)$, $p = .017$, whereas the interaction between Other race and time was

not, $B(\text{se}) = 0.17(1.00)$, $p = .867$. I used simple slopes analyses to examine the effect of time separately for White participants, $B(\text{se}) = -1.84(0.54)$, $p = .001$; Asian participants $B(\text{se}) = -0.16(0.45)$, $p = .727$; and Other participants, $B(\text{se}) = -1.67(0.84)$, $p = .048$. (see **Figure 20**). These results suggest that Asian participants did not experience reductions in loneliness during the study, whereas participants identifying with other racial groups did experience improvement. The three-way interaction between Asian race, time, and NAT was not significant, $B(\text{se}) = 1.44(1.76)$, $p = .413$; and the three-way interaction between Asian race, time, and PAT, was not significant $B(\text{se}) = 2.03(1.72)$, $p = .241$. Furthermore, the three-way interaction between Other race, time, and NAT was not significant, $B(\text{se}) = 0.35(2.53)$, $p = .890$; and the three-way interaction between Other race, time, and PAT was not significant, $B(\text{se}) = -2.72(2.48)$, $p = .275$. These results indicate that participant race did not moderate the effect of intervention condition.

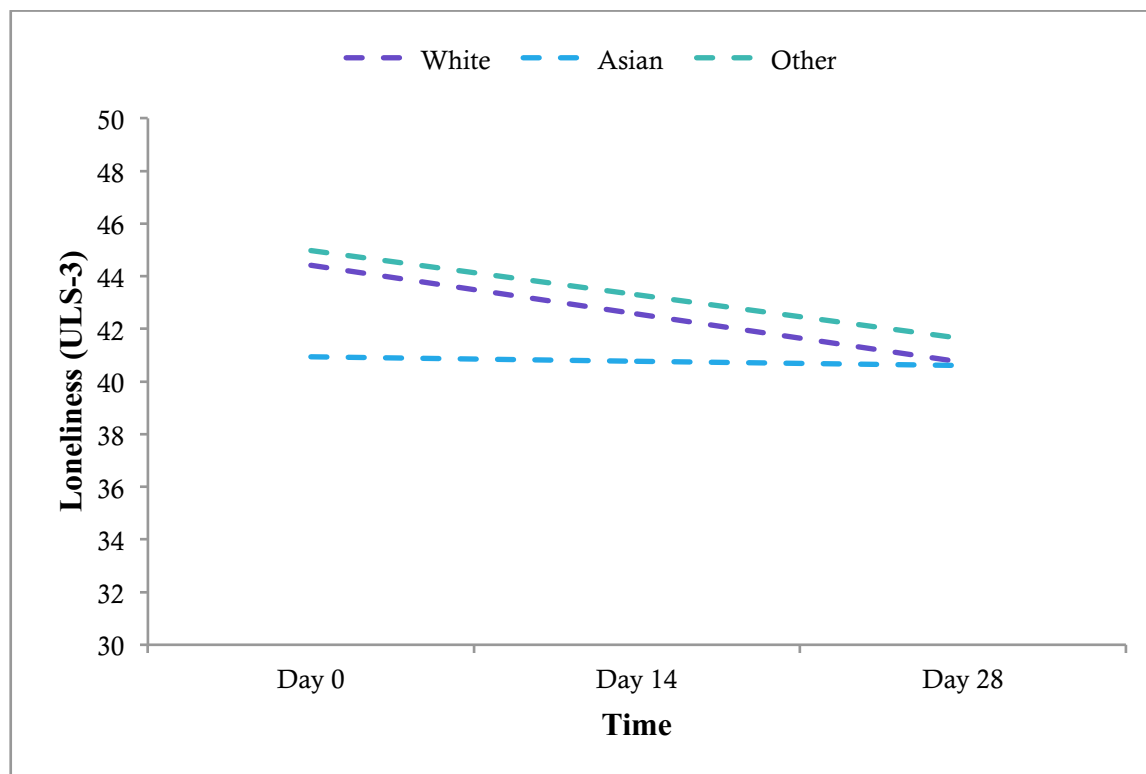


Figure 20. Slope of time for White, Asian, and Other race participants.

Baseline Loneliness.

For moderation analyses, baseline loneliness was recoded as a dichotomous variable: low loneliness (i.e. those at or below the median of 43 on the ULS-3) and high loneliness (i.e. those above the median of 43 on the ULS-3). Analyses indicated that the interaction between baseline loneliness and time was significant, $B(se) = -3.29, p < .001$. I used simple slopes analyses to examine the effect of time separately for participants at low baseline loneliness, $B(se) = 0.62(0.43), p = .146$, and high baseline loneliness $B(se) = -2.67(0.44), p < .001$. (see **Figure 21**). These results suggest that only those participants with high levels of baseline loneliness experienced improvement during the study. The three-way interaction between baseline loneliness, time, and NAT was not significant, $B(se) = -0.97(1.55), p = .533$; and the three-way

interaction between baseline loneliness, time, and PAT, was not significant $B(\text{se}) = -0.70(1.52)$, $p = .646$. These results indicate that baseline loneliness did not moderate the effect of intervention.

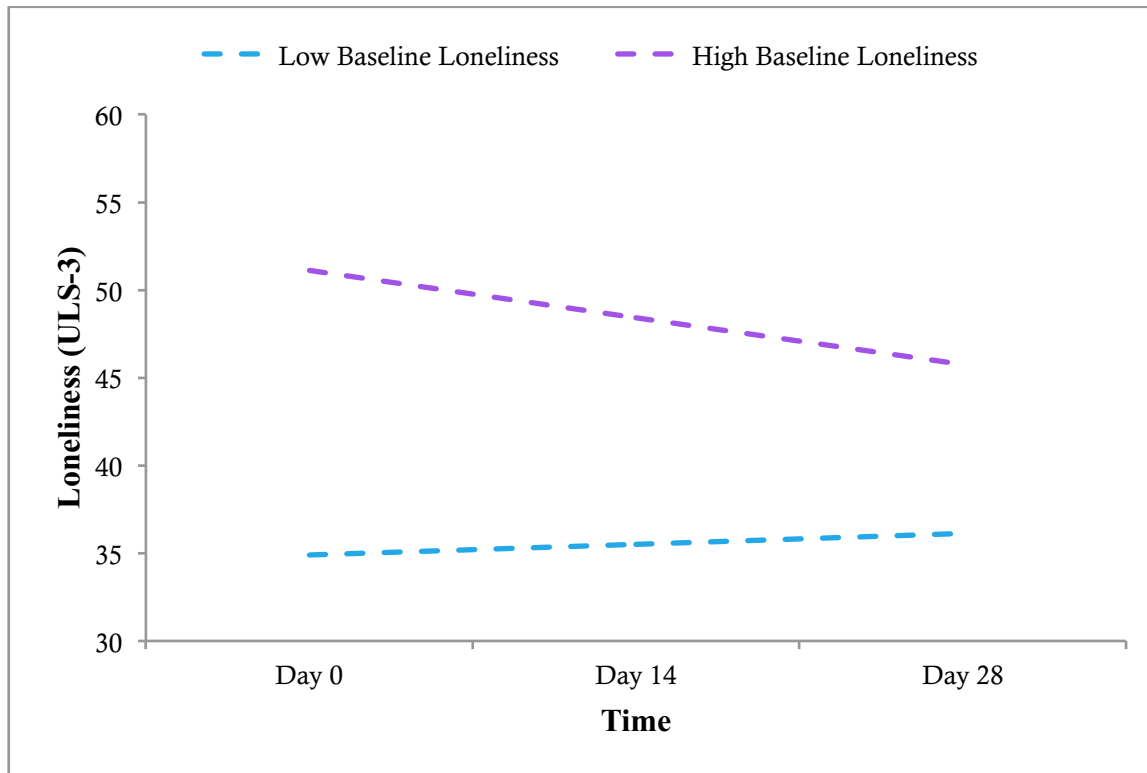


Figure 21. Slope of time for participants with low vs. high baseline loneliness.

Aim 5. Intervention satisfaction and feedback

Intervention satisfaction and acceptability. A final aim of the study was to examine whether participants found their assigned intervention to be a satisfactory and acceptable method for increasing social connections. At the end of the follow-up survey, participants rated their intervention satisfaction and acceptability on two, 10-point Likert scales ranging from 1 (not at all satisfied/acceptable) to 10 (very satisfied/acceptable). See **Table 29** for the mean satisfaction and acceptability scores for each intervention condition. In general, participants appear to have been fairly satisfied with their respective interventions. However, intervention satisfaction did

differ between the conditions. Post-hoc comparisons with the Tukey adjustment indicated that participants in the NAT reporting greater satisfaction than those in the control condition ($p = .015$). Intervention satisfaction did not differ between the PAT and control condition ($p = .160$) or between the NAT and PAT ($p = .601$). Participants also reported fairly high levels of intervention acceptability, which did not differ by condition.

Table 29. Intervention satisfaction and acceptability

	Group			Group Comparison	
	Control	NAT	PAT	Test Statistic	P value
Intervention satisfaction; M (SD)	6.50 ^a (1.72)	7.46 ^b (1.67)	7.13 ^{a,b} (1.93)	$F(2,158)=4.09$	.019
Intervention acceptability; M (SD)	6.33 (2.07)	7.13 (1.59)	7.04 (2.05)	$F(2,158)=2.80$	.064

Note. Means that do not share a superscript are significantly different at $p < .05$ per Tukey's post-hoc test.

Intervention continuation. At the end of the follow-up survey, participants also indicated the frequency with which they practiced their intervention skills during the two-week follow-up period (Days 15-28). See **Table 30** for descriptive statistics for participants' skills practice during the follow-up. Skills practice differed significantly by intervention condition. This difference appears to have been driven by more frequent skills practice for those in the NAT condition. Specifically, the NAT had the largest proportion of participants who regularly practiced their intervention skills (37.0%) and the smallest proportion of participants who did not practice their intervention skills (5.6%).

Table 30. Skills practice during follow-up phase (Days 15-28)

Skills practice	Group			Test for group difference	
	Control	NAT	PAT	Test Statistic	P value
Yes - regularly; %(N)	27.8% (15)	37.0% (20)	18.9% (10)	$\chi^2(4) = 13.58$	.009
Yes - once or twice; % (N)	42.6% (23)	57.4% (31)	60.4% (32)		
No; %(N)	29.6% (16)	5.6% (3)	20.8% (11)		

Qualitative feedback. At the end of the follow-up survey, participants were also asked to provide qualitative feedback regarding their assigned intervention. Specifically, participants were asked 1) “What aspects of the training did you find most helpful?” 2) “What aspects of the training did you find least helpful?” 3) “What, if anything, about the training was confusing?” and 4) “How could we improve the training?” Two research assistants then synthesized participants’ responses into composite summaries for each question (see Data Analysis for a complete description of analysis procedures). These composite summaries are provided in full in Appendix K: Qualitative feedback summaries. Below, I provide a brief summary of participants’ qualitative feedback.

Control condition. Participants in the control condition found that the intervention helped them to reflect on their daily schedule and to make more time for social interactions. Some participants also noted that the intervention helped them to gain a more positive perspective on the overall quality and quantity of their social interactions. However, participants also found the daily skills (i.e. a daily check-in and recording life details) repetitive, and suggested including more direct instructions for how to increase social interactions. With regard to potential ways to improve the training, participants suggested changes to the smartphone application, such as the option to add customizable reminders and to enter their skills practice directly in to the

application. Participants also thought that the training should include more strategies to increase motivation, such as goal setting.

Negative Affect Training. Participants in the NAT found both daily skills (i.e. reappraisal and avoidance reduction) to be helpful. With regard to reappraisal, participants mentioned that this skill helped them to maintain a positive mindset. With regard to avoidance reduction, participants noted that this skill helped them to get outside their comfort zones. However, participants also reported that they found it difficult to practice the skills every day, and that the skills were more applicable for building acquaintances vs. close friendships. With regard to potential improvements, participants suggested including more techniques for increasing social interactions. Participants also recommended extending the intervention by including additional examples, booster sessions, and/or an extended practice period.

Positive Affect Training. Participants in the PAT reported that both daily skills (i.e. three good things and kind acts) were helpful for improving mood. In addition, participants noted that the skills helped them to gain a more positive perspective on their social interactions and to increase their social engagement. Finally, participants appreciated that the daily skills were brief and easy to implement. However, some participants also reported that the mood boost associated with the activities was transient. In addition, some participants felt that the daily skills overlapped with behaviors they were practicing prior to the study, and therefore did little to increase their social connections. With regard to potential improvements, participants suggested including more examples during the training session. Participants also recommended including strategies to increase accountability, such as goal setting or the opportunity to log their three good things and kind acts directly in to the phone application.

6. Discussion

Loneliness describes the emotional pain that results from perceived social isolation (S. Cacioppo, Grippo, London, Goossens, & Cacioppo, 2015). Young adults appear especially vulnerable to experience loneliness (Hawthorne, 2008; Victor & Yang, 2012), perhaps due to the numerous social changes that occur during this developmental stage (Weiss, 1973, p. 76-77). Loneliness among young adults is a significant public health concern, as it predicts increased risk for depression (J. T. Cacioppo et al., 2010) and is associated with suicidal thoughts and behaviors (Stravynski & Boyer, 2001). However, we have limited evidence-based strategies to help young adults increase their social connections. The aim of this dissertation was therefore to examine whether brief, behavioral interventions could be effective for reducing loneliness among young adults. I developed two, single-session interventions to target affective mechanisms that have been implicated in the development and maintenance of loneliness. Specifically, the NAT was designed to teach cognitive-behavioral skills (reappraisal and avoidance reduction) to mitigate negative affect in social situations, whereas the PAT was designed to teach positive psychology skills (noticing positives, performing kind acts) to increase positive affect in social situations. I conducted an RCT to compare the efficacy of these interventions to an active control intervention over a one-month period. Primary outcome variables included loneliness, perceived social support, relationship satisfaction, and social behavior.

Results for primary outcome variables

The results fail to support the hypothesis that the NAT and PAT are more effective than the control intervention for reducing loneliness over a one-month time period. Instead, the findings indicated that participants experienced modest reductions in loneliness that did not differ by intervention condition. Similarly, participants demonstrated modest improvements in

relationship satisfaction, self-initiated positive social behaviors, and other-initiated positive social behaviors during the study, with no differences between conditions. Perceived social support, self-initiated negative social behaviors, and other-initiated negative social behaviors did not change during the study. Taken together, these results suggest that, on average, participants demonstrated improved social health from baseline to follow-up. However, in the absence of a non-intervention control condition, it is impossible to determine the mechanism(s) responsible for these effects. Improvement could be attributable to extra-therapeutic factors (e.g., regression to the mean, spontaneous remission), non-specific therapeutic factors (e.g., expectancy, effort justification, therapist attention), and/or specific but distinct mechanisms within each intervention condition (Lilienfeld, Ritschel, Lynn, Cautin, & Latzman, 2014). Each of these explanations is plausible in the context of the present study.

First, factors outside of the study could explain observed improvements. For example, regression to the mean might account for average reductions in loneliness from study baseline to follow-up. Regression to the mean is the statistical phenomenon that if a variable is extreme at first measurement, it will tend to be closer to the average for the population on the second measurement (Lilienfeld et al., 2014). If loneliness naturally waxes and wanes over time, and participants were most likely to enroll in the study when feeling particularly lonely, observed improvements in loneliness may be attributable to this random variation. Another possibility is that some individuals experienced spontaneous remission of loneliness during the one-month study period. Possible antecedents of spontaneous remission might include meeting a romantic partner, resolving an argument with a friend, or moving to a new living space. If some proportion of participants experienced events such as these during the study, average loneliness scores would have improved. Unfortunately, it is not possible to estimate the variance in improvement

attributable to these extra-therapeutic factors without a non-intervention control condition (e.g., a waitlist control group). However, the results of prior studies that included waitlist control conditions can provide clues as to typical loneliness change over time. Conoley and Garber (1985) compared two reappraisal interventions to a waitlist control condition in a study with depressed, female college students. They found modest improvement in participants' mean UCLA Loneliness Scale scores from baseline ($M = 49.63$) to 3-week follow-up ($M = 48.26$) for the waitlist control group (Conoley & Garber, 1985). On the other hand, Chiang et al. (2010) and Creswell et al. (2012) both observed small increases in UCLA Loneliness Scale scores among older adults randomized to 8-week waitlist control conditions. Taken together, the results of these studies indicate that loneliness can improve naturally over time, though it may also worsen among those not receiving treatment.

Another possibility is that non-specific therapeutic factors led to improvements in loneliness in the present study. For example, loneliness reductions could be explained by expectancy, or the tendency for a condition to improve when hope incites beneficial behavior change (Lilienfeld et al., 2014). In a recent meta-analysis, researchers estimated that the association between treatment expectations and psychotherapy outcomes is small but significant (meta-analytic $r = 0.12$; Constantino, Arnkoff, Glass, Ametrano, & Smith, 2011). Thus expectancy may have led to improvements in loneliness across conditions in the present study. This hypothesis is plausible given that all three conditions included elements that have been shown to increase patients' self-efficacy for change, including a compelling treatment rationale (e.g., Ahmed & Westra, 2009) and a growth mindset prime (e.g., Schleider & Weisz, 2018). However, I measured participants' treatment expectancy immediately after the intervention session and found that these expectancy scores were inversely related to improvement over time.

Thus expectancy is unlikely to account for observed loneliness change unless participants' lacked insight into their true treatment expectations. However, other non-specific therapeutic factors could explain the present findings, including effort justification (i.e., the tendency for individuals to rationalize their investment in a treatment by perceiving improvement) and therapist attention (i.e. improvement attributable to meeting with a validating professional). Given that improvement was comparable across the three study conditions, it is likely that these factors played a role in loneliness change.

A third possibility is that all three interventions were modestly effective at improving loneliness, but that each effected change via distinct mechanisms. With regard to the control intervention, it is possible that the self-monitoring activities prescribed in this condition (a daily check-in and recording life details) were actually beneficial for increasing participants' social connections. I selected these activities based on control conditions used in prior studies (see Alden & Trew, 2013; Sheldon & Lyubomirsky, 2006), and they were intended to have minimal salutatory effect. However, given the literature on the reactive effects of self-monitoring, it is quite plausible that 'a daily check-in' and 'recording life details' were effective for promoting social behavior change. Indeed, self-monitoring interventions have been shown to be beneficial for decreasing maladaptive behaviors (e.g., tics; Frank & Cavanna, 2013) and for increasing adaptive behaviors (e.g., healthful eating and exercise; Samdal, Eide, Barth, Williams, & Meland, 2017). Self-monitoring in the context of an ecological momentary assessment (EMA) study has even been shown to increase healthy social behaviors (talking) and decrease unhealthy social behaviors (time spent alone) among individuals with depression (Snippe et al., 2016).

The mechanisms by which self-monitoring promotes behavior change are not fully understood. One possibility is that self-monitoring allows individuals to effectively self-reinforce

behavior, either through self-praise of a self-administered reward (Nelson & Hayes, 1981). However, Goldiamond (1976) argued that self-reinforcement is logically impossible given that an individual will always have the opportunity to “cheat” when the reinforcement contingency is not independently defined. Indeed, self-administered reinforcement only seems to promote behavior change when “cheating” is punished (e.g., by social disapproval; Hayes et al., 1985). And in such cases, a true contingency is operative. An alternative possibility is that self-monitoring promotes behavior change because it increases the salience of environmental reinforcers (e.g., the long-term benefits of a behavior; Nelson & Hayes, 1981). Finally, Carver and Scheier (1982) proposed that self-monitoring is integral to behavior change because it enables an individual to effectively compare his or her current state to a self-defined criterion and to adjust behavior accordingly. Taken together, these theories suggest that the self-monitoring activities in the control condition may have increased participants’ awareness of the benefits of social interaction and enabled them to move closer towards their social goals. Qualitative feedback statements from participants in the control condition support this hypothesis. For example, when asked to identify the most helpful aspect of the control intervention, one participant wrote, “it made it a part of my routine to evaluate how my day was and, specifically, what social interactions I had.” Another participant wrote, “The aspect of the training that I found most helpful is simply the acknowledgement of the need/desire to change my social interactions. Naming that allowed me to be more intentional about the steps that I take to grow in my social impact.”

In summary, participants in the present study demonstrated modest improvements in social health (loneliness, relationship satisfaction, self-initiated positive social behaviors and other-initiated positive social behaviors) during the present study. These changes might be

attributable to extra-therapeutic factors, non-specific therapeutic factors, and/or specific mechanisms within each intervention condition. Future studies should include a non-intervention control condition in order to estimate the change attributable to the passage of time (e.g., regression to the mean, spontaneous remission) vs. the change attributable to treatment. Furthermore, more research is needed to identify the mediators of loneliness change over time. A better understanding of these mediators will enable researchers to develop more effective treatments. Mindfulness may be one important mechanism to explore in future studies.

Limited efficacy of the NAT and PAT

Improvement among participants in the control intervention was an unexpected result of the present study. More surprising, however, was the minimal improvement observed among participants in the two active intervention conditions. In particular, I was surprised by the limited improvement observed among participants who received the NAT, given that CBT intervention for loneliness have demonstrated efficacy in prior RCTs (Masi et al., 2011). However, mediation analyses indicated that the NAT did not engage its target mechanism of NA, likely explaining why it did not produce larger reductions in loneliness.

The present study was the first to evaluate the efficacy of a single CBT session for treating loneliness via reductions NA, and the observed results suggest that lonely individuals likely need additional support in the form of multiple treatment sessions to engage CBT skills effectively for loneliness change. Multi-session CBT may be more effective for loneliness as it would allow patients to learn multiple CBT skills and receive coaching in using these skills across contexts. Recent research in the field of emotion regulation (ER) has shown that emotional health is predicated on both the knowledge of ER strategies and the ability to flexibly employ those strategies in response to shifting contexts and goals. For example, cognitive

reappraisal is an effective ER strategy in response to uncontrollable stress, but is maladaptive in response to controllable stress (Troy, Shallcross, & Mauss, 2013). Aldao, Sheppes, and Gross (2015) suggest that therapists can help patients develop ER flexibility by supporting them in monitoring the efficacy of their ER strategies in reference to their short- and long-term goals. Importantly, this process would require multiple treatment sessions, during which patients would learn numerous strategies, practice them in real world contexts, and receive individualized feedback. This multi-session format would likely be helpful for lonely individuals who struggle with ER in social situations (Vanhalst, Luyckx, Petegem, & Soenens, 2018).

A related point is that the single-session NAT was insufficient to help participants identify and eliminate maladaptive ER strategies that serve to maintain NA in social situations. Interestingly, maladaptive ER strategies demonstrate stronger meta-analytic associations with psychopathology (avoidance $r = .38$, suppression $r = .34$, and rumination $r = .49$) than do adaptive strategies (problem solving $r = -.31$, reappraisal $r = -.14$, and acceptance, $r = -.19$; Aldao, Nolen-Hoeksema, & Schweizer, 2010). The NAT did not address either suppression or rumination, and therefore failed to mitigate behaviors that likely maintain loneliness. Post-event rumination, or the tendency to review and brood about social interactions, may be an especially important behavior to target in future loneliness interventions. This behavior is implicated in cognitive-behavioral models of SAD because it is thought to maintain negative beliefs about the self (e.g., the belief that one is socially inept; Brozovich & Heimberg, 2008). In the present study, post-event rumination may have rendered avoidance reductions behaviors ineffective, as participants may have negated the positive impact of ‘getting out of their comfort zone’ by subsequently brooding over social interactions. Thus, future CBT interventions for loneliness should address maladaptive ER strategies, in addition to promoting adaptive ER strategies.

The minimal improvement demonstrated by participants in the PAT was also quite surprising, as similar interventions have been shown to increase PA in prior studies (e.g., Alden & Trew, 2013; Sheldon & Lyubomirsky, 2006). Furthermore, Alden and Trew (2013) found that a similar intervention (performing kind acts for four weeks) was effective for increasing relationship satisfaction among individuals with social anxiety. The present results are inconsistent with these findings, as the PAT did not engage its target mechanism of PA, and did not effectively reduce loneliness in comparison to the control intervention. Small differences between the intervention protocols used in prior studies and the protocol used in the present study could explain the discrepant results. Specifically, Alden and Trew (2013) asked study participants to engage in three kind acts a day for two days each week for four weeks. In contrast, the present study protocol required that participants try to engage in one kind act a day for two weeks. The massed, spaced practice recommended by Alden and Trew (2013) may have been more effective than the daily practice recommended in the present study, as positive psychology activities may become boring with routine practice (see Lyubomirsky et al., 2005). In fact, Lyubomirsky et al. (2005) noted that positive psychology activities may have a refractory period, during which time their re-use ceases to impact mood. One way to preserve the efficacy of positive psychology activities during routine practice is to encourage individuals to vary the domain of practice (e.g., by instructing participants to notice positives in different life areas; Lyubomirsky et al., 2005). In the present study, participants were asked to vary the type of kind act but not the recipient. Furthermore, participants were not asked to vary the domain of ‘three good things.’ Future studies should therefore explore procedures for optimizing the efficacy of positive psychology activities for loneliness change.

It is also worth noting that positive psychology interventions have received mixed support in the literature. Bolier et al. (2013) conducted a meta-analysis of RCTs of positive psychology interventions, and found a medium pooled effect size for improvements in subjective well-being (Cohen's $d = 0.34$) and a small effect size for reductions in depression (Cohen's $d = 0.23$). However, the authors also rated the quality of each RCT in their meta-analysis by using the following criteria: adequacy of randomization concealment, participants blind to condition, participants comparable at baseline, adequate power, less than 50% attrition, and use of intent-to-treat analyses (Bolier et al., 2013). They found that pooled effect sizes for studies rated as high quality (those meeting 5-6 criteria) were non-significant (Bolier et al., 2013). In addition, a funnel plot analysis indicated a high likelihood of publication bias (i.e. a high likelihood of unpublished studies with null findings; Bolier et al., 2013). Taken together, these results indicate that empirical support for positive psychology interventions is tenuous. Furthermore, Gorlin, Lee, and Otto (2018) utilized data from the Bolier et al. (2013) meta-analysis to examine differences in the efficacy of various positive psychology activities. They found that activities focused on optimism and goal-pursuit demonstrated the strongest evidence, and that support was weaker for activities focused on gratitude, personal strengths, and processing of current or past events (Bolier et al., 2013). In light of these findings, the limited efficacy of 'three good things' and 'kind acts' for reducing loneliness in the present study is not altogether surprising.

Results for secondary outcome variables

A secondary aim of the present study was to explore the relative efficacy of the NAT and PAT for improving participants' general well-being. Indices of well-being included participants' self-reported depression symptoms, quality of life and sleep disturbance. Results indicated that participants' quality of life and sleep disturbance did not change during the study. Furthermore,

participants' average depression symptoms actually increased during the study, with no differences between the conditions. Loneliness is an established risk factor for depression (J. T. Cacioppo et al., 2010; Vanhalst, Luyckx, Teppers, & Goossens, 2012), and it is therefore plausible that persistent loneliness led to the development of depression symptoms in a subset of the sample. However, exploratory analyses indicated that loneliness was not a prospective predictor of depressed mood during the study period. Said another way, loneliness severity did not predict which participants went on to develop symptoms of depression. Instead, regression to the mean might better explain the increase in depression symptoms. I specifically selected a study sample that was extreme with regard to depression symptoms, as individuals experiencing current MDD were excluded at baseline. It is therefore possible that the observed increase in depression symptoms reflects the natural tendency for a subset of depression-free individuals to develop increasing depression symptoms over time.

Another possibility is that participation in the present study actually caused an increase in depression symptoms for some individuals. Participants who did not find the study interventions beneficial for loneliness improvement might have felt defeated and developed depression symptoms. Alternatively, social interactions prompted by the study interventions could have increased participants' social stress, which then caused depressed mood. Indeed, negative social events such as loss and humiliation events are known to predict the onset of MDD (Kendler, Hettema, Butera, Gardner, & Prescott, 2003). Thus if participants' social overtures were rebuffed and/or resulted in embarrassment, these experiences might have resulted in the onset of depression symptoms. Finally, it is possible that some participants engaged in rumination and/or self-criticism following neutral or positive social interactions, which led to depression symptoms. Vitkus and Horowitz (1987) found that lonely individuals tend to rate their social

interactions more negatively than non-lonely individuals, even when the objective quality of those interactions is equivalent. Thus the likelihood that lonely individuals ruminated following social interactions is high. Furthermore, rumination has been shown to mediate the association between peer loneliness and depression in college students (Vanhalst, Luyckx, Raes, & Goossens, 2012). Therefore, the study may have increased participants' social activities, which prompted rumination, and ultimately led to depression symptoms for some participants. Future studies should examine the possible iatrogenic effects of loneliness interventions by including non-intervention control conditions.

Results for mediation analyses

The NAT was designed to reduce loneliness via reductions in NA, whereas the PAT was designed to reduce loneliness via increases in PA. In order to explore whether each intervention engaged its target mechanism, I conducted MLMs to examine patterns of change in NA and PA over the course of the study. These analyses indicated an increase in NA from baseline to follow-up and no change in PA from baseline to follow-up. Neither effect differed by intervention condition. Thus the NAT did not effect reductions in NA relative to the control intervention, nor did the PAT effect increases in PA relative to the control intervention. The finding that NA increased during the study is consistent with the observed increase in depression symptoms. As noted above, it is possible that the stress and uncertainty associated with forming new social acquaintances led to an increase in NA for a subset of participants. Indeed, Hall (2018) recently demonstrated that it takes approximately 50-100 hours of interaction before an acquaintance transitions to become a casual friend. Thus the one-month study period may have captured a particularly stressful window in the process of relationship formation.

Next, although MLM analyses did not indicate a differential effect of intervention condition on affect, I proceeded with mediation analyses given evidence that a significant indirect effect can emerge in the absence of a significant effect of X on M (Hayes, 2013). Mediation analyses indicated that change in NA did not mediate the effect of the NAT on loneliness, nor did change in PA mediate the effect of the PAT on loneliness. However, these analyses indicated that reductions in NA from baseline to endpoint predicted reductions in loneliness from baseline to follow-up. Similarly, increases in PA from baseline to endpoint predicted reductions in loneliness from baseline to follow-up. These findings suggest that NA and PA remain important targets for future loneliness interventions. As discussed above, the single-session format may have rendered the NAT minimally effective for reducing NA. Future studies should therefore explore whether a more comprehensive CBT intervention would be effective for reducing NA in social situations. Furthermore, in light of evidence indicating that interventions targeting optimism and goal-pursuit are most effective for increasing PA (Gorlin et al., 2018), future studies should explore the efficacy of these strategies for increasing PA in social situations. In addition, much work remains to be done to identify other biological and psychological mechanisms that underlie the maintenance of loneliness.

Results for moderation analyses

Another aim of the present study was to explore whether participant characteristics predicted differential loneliness change over time and/or moderated response to a specific intervention. I first examined personality variables and found that extraversion and neuroticism both predicted loneliness change, but did not moderate response to a specific intervention. Simple slopes analyses revealed that loneliness tended to improve for participants reporting medium-high levels of neuroticism and for participants reporting low-medium levels of

extraversion. These findings are interesting in light of the fact that loneliness was positively associated with neuroticism ($r = .53$) and negatively associated with extraversion ($r = -.53$) in the present sample. Thus loneliness tended to improve among those participants who were particularly vulnerable to experiencing perceived social isolation – a conclusion that was further supported by moderation analyses demonstrating that those with high baseline loneliness showed the greatest reductions in loneliness. We know from past research that personality factors (e.g., neuroticism, extraversion; J. T. Cacioppo, Hawkley, et al., 2006) and situational factors (e.g., living environment, social network structure; Ernst & Cacioppo, 1999; Stokes, 1985) can both affect loneliness. The three intervention conditions in the present study were more likely to impact personality factors (i.e. participants' habitual thoughts and behaviors) than situational determinants of loneliness. This observation may explain why those with higher neuroticism and lower extraversion benefited most from the study activities.

I also explored participants' motivational sensitivities (i.e. participants' behavioral inhibition and behavioral activation) as possible predictors of change and/or moderators of intervention response. These analyses revealed that behavioral inhibition moderated response to the control intervention, but not the NAT and PAT, and that behavioral activation did not predict loneliness change or moderate intervention response. With regard to behavior inhibition, simple slopes analyses indicated that loneliness improved among those with medium-high behavioral inhibition who received the control intervention. Given that behavioral inhibition and neuroticism are closely related (Carver & White, 1994), it was surprising that this moderating effect was observed for behavioral inhibition but not neuroticism. However, one distinction between these constructs is that behavioral inhibition describes habitual responses to negative environmental stimuli (e.g., criticism, punishment; Carver & White, 1994), whereas neuroticism

describes habitual negative emotional states (e.g., depressed, moody, tense; John et al., 2008). The NAT and PAT protocols both required that participants engage directly with their social environments, either through avoidance reduction behaviors or kind acts, whereas the control intervention did not prescribe direct engagement with others. One possibility, therefore, is that participants who were particularly sensitive to criticism and rejection fared best in the control condition, which allowed them to approach social situations in a self-directed manner. However, this hypothesis is highly speculative and future studies should continue to explore the role of behavioral inhibition in moderating response to interventions for loneliness.

Finally, I examined demographic variables, including participants' age, gender, and race, as possible predictors of change and/or moderators of intervention response. These analyses indicated that gender and race predicted loneliness change during the study, but age did not. In addition, none of the demographic variables moderated response to a specific intervention. With regard to gender, simple slopes analyses indicated that improvement in loneliness was significant for women but not men. This finding may reflect gender differences in the social needs of young adults. Specifically, social network density appears to be a stronger (inverse) predictor of loneliness for young men than for young women (Stokes & Levin, 1986). Researchers believe that young men may prefer the camaraderie of large, interconnected social groups, whereas young women may prefer the emotional closeness of friendship dyads (Stokes & Levin, 1986). Thus female participants may have experienced greater reductions in loneliness during the present study because dyads are quicker and easier to establish than large groups. Another possibility is that male participants in the present study had a harder time overcoming the social stigma that accompanies loneliness. Borys and Perlman (1985) found that both men and women judge lonely males more harshly than lonely females. Thus male participants in the present study

may have encountered more social rejection, which impeded their ability to establish social connections.

Participant race was also a significant predictor of loneliness improvement during the present study. Specifically, White participants and those identifying with other racial groups reported significant improvement in loneliness, while Asian participants did not. This finding was disappointing, as Asian individuals constituted approximately half of the present sample. It is unclear why the present study appealed particularly to Asian individuals, but this finding could be explained by higher levels of collectivism in Asian cultures. Collectivism refers to the cultural belief that group harmony and mutual obligation are paramount, and is often contrasted with individualism, or the belief that personal rights and autonomy are most important (Oyserman, Coon, & Kemmelmeier, 2002). People from Asian countries (e.g., Hong Kong, India, China, Taiwan) report greater collectivism and lower individualism than people from the United States (US), and Asian Americans report greater collectivism and lower individualism than White Americans (Oyserman et al., 2002). Thus a study on ‘building social connections’ may have been particularly interesting to Asian individuals if they ascribed to collectivist beliefs. In addition, research indicates that Asian individuals are especially distressed by the experience of loneliness (Goodwin, Cook, & Yung, 2001), and this distress may have motivated them to enroll in the study. Unfortunately, I did not measure participants’ collectivist and individualist beliefs and therefore cannot test these hypotheses directly. However, the impact of cultural beliefs on the phenomenological experience of loneliness is an important future research direction.

Asian individuals were highly motivated to enroll in the present study; however, they appear to have derived limited benefit from participation. One possibility is that the intervention strategies had low cultural relevance for individuals identifying as Asian. However, prior studies

evaluating the efficacy of single-session CBT and positive psychology interventions have included large proportions of Asian participants (e.g., Alden & Trew, 2013; Bentley et al., 2017). Thus this explanation appears unlikely. Alternatively, the finding could be explained by differences in the social determinants of loneliness in collectivist vs. individualist cultures. For example, Lykes and Kimmelmeier (2013) examined the social correlates of loneliness across European countries and found that interactions with family members negatively predicted loneliness in collectivist countries but not individualist countries, while interactions with friends negatively predicted loneliness in individualist countries but not collectivist countries (Lykes & Kimmelmeier, 2013). It is possible that the present study primarily targeted social connections with friends and therefore failed to address the social needs of Asian participants. Another possibility is that Asian participants faced unique barriers to social connection that were not relevant for other study participants. Anecdotal reports from Asian participants in the present study indicated that many were international students who had recently immigrated to the US. These individuals may have experienced unique challenges including homesickness, culture shock, and discrimination, which influenced their perceived social isolation. In fact, Liu, Wong, and Tsai (2016) found that discrimination based on gender, race, and nationality, were all associated with loneliness among female, Asian, international students living in the US. Thus Asian participants in the present study may have needed different strategies to cope with these specific loneliness causes.

Limitations and strengths

The results of the present study should be interpreted in light of several methodological limitations. First, the primary limitation of the study was the absence of a non-intervention control condition, without which it was impossible to determine whether change was attributable

to study participation or extra-therapeutic factors. Though the inclusion of an active control condition enabled control of nonspecific therapeutic factors, an additional non-intervention control condition would have been instructive. A related limitation was the use of an active control condition that prescribed activities with a reasonable likelihood of effecting loneliness change. In the future, researchers should select control interventions with minimal chance of influencing social behavior (e.g., daily practice of word puzzles or brain teasers). Third, the present sample included a subset of participants with relatively low baseline loneliness levels. Inclusion criteria required that all participants endorse current loneliness *or* a desire to increase their social connections, which likely enabled some non-lonely individuals with a desire to expand their social networks to qualify. Interestingly, moderation analyses indicated that those with low baseline loneliness did not demonstrate improvement in loneliness during the study period. Researchers conducting future loneliness treatment studies should therefore consider limiting participation to a selected sample of lonely individuals. Fourth, I relied on self-report assessments of primary and secondary outcome variables. However, numerous factors are known to bias self-report assessments including recency effects, demand characteristics, and lack of insight. To address this limitation in future studies, researchers may wish to include clinical assessments completed by independent evaluators. A final limitation of the study was the brief one-month follow-up period. Loneliness improved linearly during this one-month period at a rate of approximately 0.5 points per week on the ULS-3. However, it is unknown whether this trajectory would have continued over succeeding months, or whether improvement would have plateaued or reversed. Given that the development of social relationships takes time, future studies should include an extended follow-up period.

Notwithstanding these limitations, the present study also had several methodological strengths. First, the relatively large sample and low rate of attrition afforded adequate power for the detection of medium size treatment effects. Second, the use of intent-to-treat analyses guarded against biases that often arise from excluding partial completers. Third, the use of an active control intervention increased the rigor of the study design. Fourth, the use of detailed intervention protocols helped to ensure clear operationalization of the intervention conditions. And finally, the EMA component of the study helped to address important questions about the association between participants' intervention compliance and loneliness outcome. These characteristics strengthen the inferences that can be drawn from the present results.

Future directions

The results of the present study indicate that brief behavioral interventions for loneliness are both satisfactory and acceptable to young adults. This conclusion is supported by the excellent treatment adherence and low attrition observed across study conditions. However, the present results also indicate a need for more effective loneliness interventions for this age group. Future studies should therefore continue to explore the causes of chronic loneliness as well as the potential strategies to mitigate these causal factors.

Several correlates of loneliness appear particularly important to consider in future research on causal mechanisms. First, loneliness is associated with reduced reward-related activation in the ventral striatum in response to positive social stimuli (J. T. Cacioppo et al., 2009), which could cause loneliness via reduced social motivation. Future studies should therefore explore reduced reactivity to social rewards a risk factor for loneliness. Second, cardiac vagal tone, which is an indicator of physiological flexibility, is associated with both social connectedness (Kok & Fredrickson, 2010) and social support-seeking (Geisler, Kubiak, Siewert,

& Weber, 2013). Thus low vagal tone, indicating physiological rigidity, should be explored as another risk factor for loneliness. Third, loneliness is associated with the use of maladaptive ER strategies (Vanhalst et al., 2018), while ER abilities predict the development of social skills and friendship quality over time (Blair et al., 2015). Studies are now needed to determine whether manipulating ER abilities effects prospective change in loneliness. Fourth, certain cognitive styles, including an insecure attachment style (Bernardon, Babb, Hakim-Larson, & Gragg, 2011) and a depressive attributional style (Vanhalst et al., 2015) are both associated with loneliness and should be explored as potential risk factors. Finally, lonely individuals demonstrate social avoidance behavior (Vanhalst et al., 2018) as well as a tendency to prefer indirect means of social contact (e.g., contact via social media; see Nowland, Necka, & Cacioppo, 2018). This passive behavioral style may be another risk factor for loneliness. Once modifiable risk factors are identified, these factors can become targets in future treatment development research.

Future studies should also explore the optimal format for loneliness interventions. The present results suggest that a single intervention session is insufficient to effect clinically significant change in chronic loneliness. Furthermore, several participants in the present study commented on their desire for more treatment sessions, more strategies, and a longer practice period, in the qualitative feedback section. Future studies should therefore explore whether longer interventions that teach numerous skills and allow time for iterative practice and feedback are more effective for reducing loneliness. However, researchers must also be mindful of the relationship between treatment length and barriers to care, especially logistical and financial barriers. Studies investigating the treatment preferences of lonely individuals may be useful for identifying the intervention structure that maximizes efficacy and minimizes barriers. Given the high prevalence of loneliness in modern societies, it will also be important for researchers to

consider scalable modes of treatment delivery. Internet-delivered cognitive-behavioral therapy (iCBT) has been shown to be a scalable, efficacious treatment for MDD, particularly when patients are guided by a therapist (Webb, Rosso, & Rauch, 2017). An eight-session, guided, iCBT intervention for loneliness has shown promising effects in an initial study (Käll et al., Under Review), and should be investigated further. Finally, it is likely that numerous factors contribute to the development and maintenance of loneliness, and that these factors vary across individuals. Future studies should therefore explore methods for matching patients to loneliness intervention based on the presence of specific risk factors.

Conclusion

In conclusion, loneliness describes the negative affective response to perceived social isolation. It is prevalent in modern societies and increases risk for both physical and mental illness. Brief, scalable, interventions are needed in order to alleviate this painful emotional experience and to prevent loneliness sequelae. However, the results of the present study indicate that a single-session CBT intervention and a single-session positive psychology intervention are not more effective than a self-monitoring intervention for reducing loneliness among young adults. These findings suggest that much work remains to be done in order to understand the causes of chronic loneliness as well as the best strategies to mitigate these causal factors.

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Appendices

Appendix A: Intervention protocols

Building Social Connections NAT Protocol

□ Discuss motivation

E.g. *In this study we're investigating the effectiveness of different daily activities to increase social connections. You've been randomly assigned to receive training in one set of activities. Before we begin the training, can you tell me a little bit about why you would like to increase your social connections?* [Provide reflective listening and validation].

□ Prime incremental theory of social connections

E.g. *Thanks for sharing that. Some people think that a person's level of social connection is fixed and can't be changed. However research suggests that effort combined with the right strategies can have a big impact on a person's social connections. I'm going to teach you some activities we think will increase your social connections. I think these activities could help you reach your social goals. Should we get started?*

□ Explain intervention rationale

E.g. *First, I'll explain why we think social disconnection develops. We think people become socially disconnected because they get stuck in a pattern of thoughts and behaviors that lead to negative emotions in social situations. Let me explain with an example. Imagine that someone moves to a new city for a job. The person tries to make new friends at work, but none of the person's coworkers seem interested in socializing. The person might start to think that people in this new city are generally unfriendly, which could cause negative emotions such as anxiety, anger, or sadness. The person might start to avoid social situations to prevent these negative emotions. However, avoidance maintains the person's belief that he or she cannot make friends and leads to even more negative emotions. Let me show you a picture of this process. [Document model example on worksheet]. Have you ever experienced anything like this cycle? [Document participant example on worksheet]. In order to increase your social connections, our goal is to reduce negative emotions in social situations. To do this, I am going to teach you activities that target the thoughts and behaviors in this cycle.*

□ Teach REAPPRAISAL

E.g. *The first activity I am going to teach you targets the thoughts portion of the cycle. This activity is called REAPPRAISAL. We all go through life generating interpretations and predictions about the world around us. These interpretations and predictions are called appraisals. Our appraisals have a big impact on our emotions. For example, imagine a situation in which a person has a fight with his or her roommate. How might that person interpret the situation? [Elicit different appraisals and different emotions that follow from those appraisals]. So, our appraisals have a big impact on how we feel. This is important because, if we only pay attention to negative appraisals of social situations, we will experience a lot of negative emotions in those situations. REAPPRAISAL is an activity that*

helps us to think more flexibly and notice different interpretations of social situations. The goal of the activity is to identify your initial negative appraisals of social situations and then to think of another, more positive way of looking at those situations. Let's try it. First, can you think of a recent social situation in which you experienced a negative emotion? [Write situation on worksheet]. What was going through your mind in that situation? Were you making any predictions about what might happen? Or were you making any judgments about yourself? [Write initial negative appraisal on worksheet]. Now, come up with another, more positive interpretation of the situation. [Write reappraisal on worksheet]. Great! Let's try one more to make sure you've got it. [Have participant practice REAPPRAISAL on worksheet]. So for the next two weeks, try to practice this exercise once per day. Do you have any questions about this activity?

□ Teach AVOIDANCE REDUCTION

E.g. The second activity I am going to teach you targets the behaviors portion of the cycle. Specifically this activity focuses on reducing avoidance of social situations. Avoidance is a natural response to situations in which we expect a negative outcome. However sometimes we over-predict the likelihood of a negative outcome and/or under-predict our ability to cope. For example, you might avoid meeting someone new because you are afraid this person won't like you. In this situation, avoidance is unnecessary and counterproductive. It prevents you from learning that the situation is not upsetting and it maintains your anxiety about meeting new people. Sometimes avoidance is observable behavior, like avoiding starting a conversation. Sometimes avoidance is cognitive, like mentally preparing a comment in your head before you say it. And sometimes avoidance occurs through the use of safety signals, which are objects or tools that a person uses to reduce the likelihood of a negative outcome. Can you think of any social avoidance behaviors you might be using? [Have participant brainstorm ideas and record on the worksheet].

The second activity involves acting opposite to some of these avoidance behaviors. What are some ways that you could act opposite to these avoidance behaviors in your daily life? [List two AVOIDANCE REDUCTION behaviors on the worksheet]. So for the next two weeks, try to practice one of these AVOIDANCE REDUCTION behaviors each day. To get the most out of the activity, try to practice AVOIDANCE REDUCTION face-to-face (vs. over the phone or social media). Also, try to pay attention to the outcome of the situation. Did your feared outcome occur? If it did, how did you cope with it? Do you have any questions about this activity?

□ Review rationale and activities

E.g. We've gone over a lot today. Let's review everything to make sure I explained it clearly. [Ask participant to explain the treatment model. Ask participant to explain the purpose of REAPPRAISAL and how he or she will practice it. Ask participant to explain the purpose of AVOIDANCE REDUCTION and how he or she will practice it. Clarify any points of confusion].

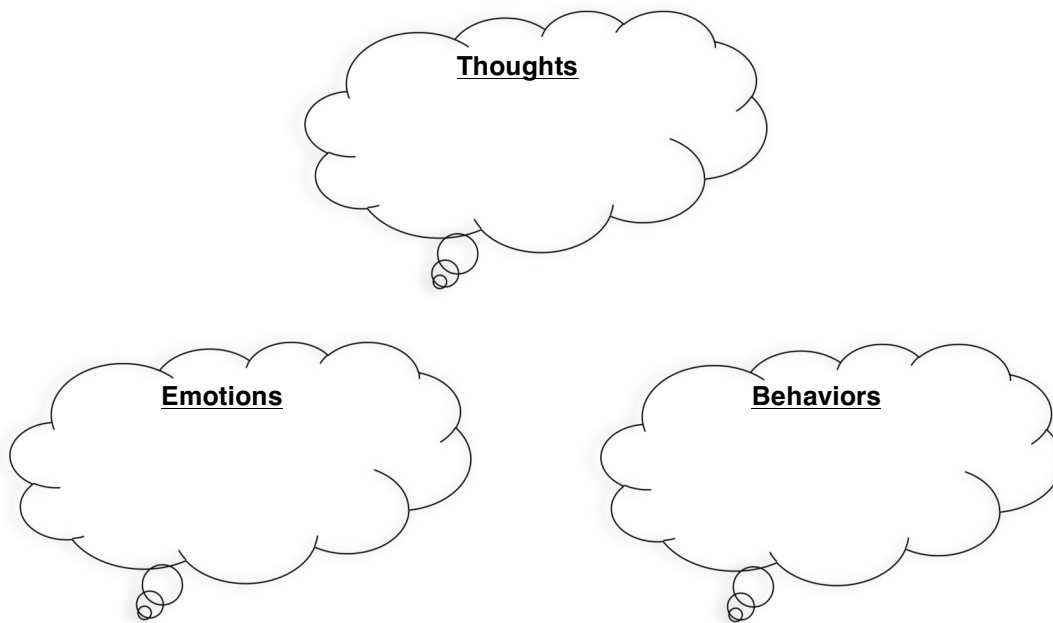
□ Discuss implementation intentions

E.g. Great, so for the next two weeks you'll be trying to practice REAPPRAISAL and AVOIDANCE REDUCTION once each day. It can be hard to integrate new activities into your daily schedule, and one strategy that can help with this is to make a daily practice plan. A daily practice plan is an if-then plan of when you will engage in these activities. For example, you might decide that if you notice yourself becoming anxious in a social situation, then you will practice REAPPRAISAL. Or if you are in class, then you will practice avoidance reduction by chatting with classmates. What might be a good daily practice plan for you for REAPPRAISAL? What about for AVOIDANCE REDUCTION?

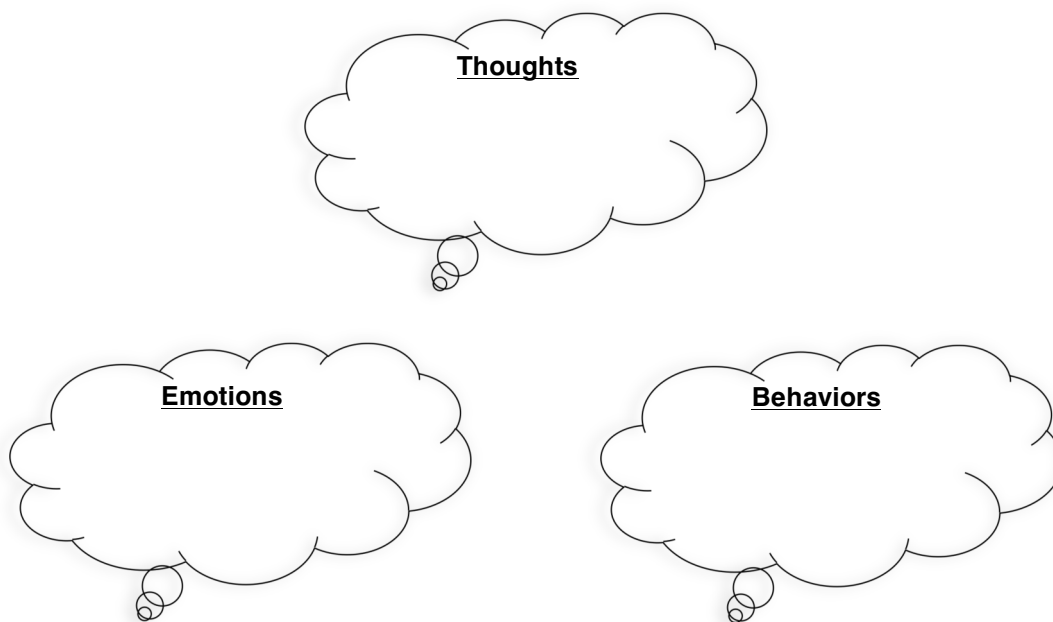
□ Provide instruction for daily practice

E.g., I have some materials for you to help with your daily practice. [Review daily practice instructions with participants – either instructions for RealLife Exp or instructions for paper forms]. You'll also be making daily ratings of whether you practiced the activities and about your mood [Review adherence and mood rating instructions – either instructions for RealLife Exp or instructions for paper forms]. Do you have any questions?

MODEL: EXAMPLE



MODEL: YOUR EXPERIENCE



Changing Thoughts: REAPPRAISAL

Social Situation	Automatic Negative Appraisal	Reappraisal

Daily practice plan: *If ...* _____

then ... _____

Changing Behaviors: AVOIDANCE REDUCTION

Avoidance Behavior	Avoidance Reduction Behavior
→	
→	

Daily practice plan: *If ...* _____

then ... _____

Building Social Connections PAT Protocol

□ Introductions and discussion of motivation for training

E.g. *In this study we're investigating the effectiveness of different daily activities to increase social connections. You've been randomly assigned to receive training in one set of activities. Before we begin the training, can you tell me a little bit about why you would like to increase your social connections?* [Provide reflective listening and validation].

□ Prime incremental theory of social connections

E.g. *Thanks for sharing that. Some people think that a person's level of social connection is fixed and can't be changed. However research suggests that effort combined with the right strategies can have a big impact on a person's social connections. I'm going to teach you some activities we think will increase your social connections. I think like these activities could help you reach your social goals. Should we get started?*

□ Explain model

E.g. *First, I'll explain why we think social disconnection develops. We think people become socially disconnected because they get stuck in a cycle of thoughts and behaviors that lead to fewer positive emotions in social situations. Let me explain with an example. Imagine that someone moves to a new city for a job. The person tries to socialize with coworkers, but finds that it isn't very fun. The person might feel bored or disinterested with his or her social life, and might expect future social activities to be similarly dull. Over time, he or she might lose motivation to seek out social connections and become increasingly socially withdrawn. Unfortunately, this behavior maintains the cycle because the person continues to experience a lack of social pleasure and social motivation. Let me show you a picture of this process. [Document model example on worksheet]. Have you ever experienced anything like this cycle? [Document participant example on worksheet]. In order to increase your social connections, our goal is to increase positive emotions in social situations. To do this, I am going to teach you activities that target the thoughts and behaviors in this cycle.*

□ Teach THREE GOOD THINGS

E.g. *The first activity I am going to teach you targets the thoughts portion of the model. This activity is called THREE GOOD THINGS. Sometimes, when a person's social environment becomes less rewarding, that person begins to overlook positive social experiences that do happen. If a person is not expecting positive social experiences, it makes sense that he or she may not recognize them when they occur. To address this problem, I am going to teach you to think about, and savor positive social experiences in your daily life. To practice this activity, you will take some time each day to identify three positive social things that happened. These can be big things (e.g., made a new friend) or small things (e.g., smiled at a stranger). So if we were to practice this right now, what three good social experiences would you write down? [Write participants' THREE GOOD THINGS on the worksheet. If participant has trouble coming up with THREE GOOD THINGS, elicit with Socratic questioning. If participant cannot come up with three things, have them come up with as many as they are able to]. Now, the second thing you will do is to think about the role you played in bringing about each of these good social experiences. For example, if one of your good social experiences was chatting with a classmate before lecture, you might write down*

that you asked him or her a question that started the conversation. So what did you do to bring about each of the three good social things on the worksheet? [Write participants' causes on the worksheet]. By practicing this exercise, you will be thinking about the positive social experiences that happen each day and recognizing the connection between your own effort and these positive experiences. So for the next two weeks you'll practice this activity once per day. Do you have any questions about this activity?

□ Teach KIND ACTS

E.g. The second activity I am going to teach you targets the behaviors portion of the model. This activity is called KIND ACTS. Remember that if a person's social environment feels unrewarding, he or she may lose motivation to initiate social activities. The second activity I will teach you counteracts this process. This activity has been shown to generate positive emotions in social situations. Over time, these positive emotions help us to feel more socially connected and socially motivated. The activity is to perform KIND ACTS for others. We'll define KIND ACTS as acts that benefit others or make others happy, typically at some cost to oneself. These can be big – like signing up to volunteer, or small – like holding a door for someone. Some other ideas for KIND ACTS include ... [read list of KIND ACTS from worksheet]. Can you think of KIND ACTS that you could perform in your daily life over the next two weeks? [Record participants' brainstorming ideas on the worksheet.] So for the next two weeks, try to engage in one KIND ACT for another person each day. You can use ideas from the list, or new ideas that you come up with. To get the most out of the activity, try to perform KIND ACTS face-to-face (vs. via the phone or social media). Also, try to vary the type of act that you perform each day. Do you have any questions about this activity?

□ Treatment review

E.g. We've gone over a lot today. Let's review everything to make sure I explained it clearly. [Ask participant to explain the treatment model. Ask participant to explain the purpose of THREE GOOD THINGS and how he or she will practice it. Ask participant to explain the purpose of KIND ACTS and how he or she will practice it. Clarify any points of confusion].

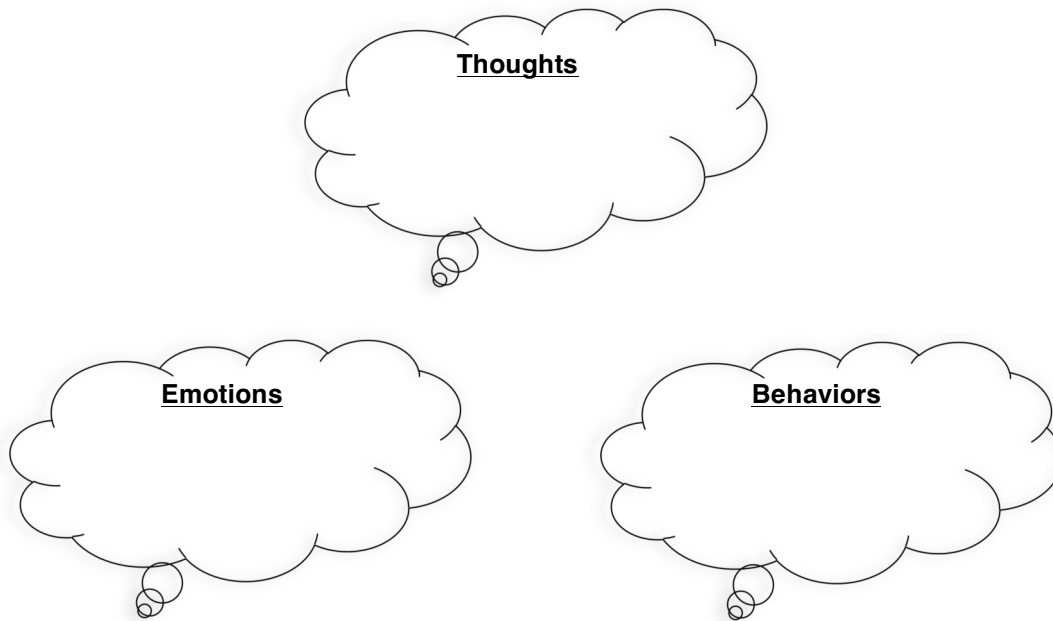
□ Discuss implementation intentions

E.g. Great, so for the next two weeks you'll be trying to practice THREE GOOD THINGS and KIND ACTS once each day. It can be hard to integrate new activities into your daily schedule, and one strategy that can help with this is to make a daily practice plan. A daily practice plan is an if-then plan of when you will engage in these activities. For example, you might decide that if you are walking by yourself during the day, then you will practice THREE GOOD THINGS. Or if you have not done a KIND ACT by dinnertime, then you will give a friend a compliment. What might be a good daily practice plan for you for THREE GOOD THINGS? What about for KIND ACTS?

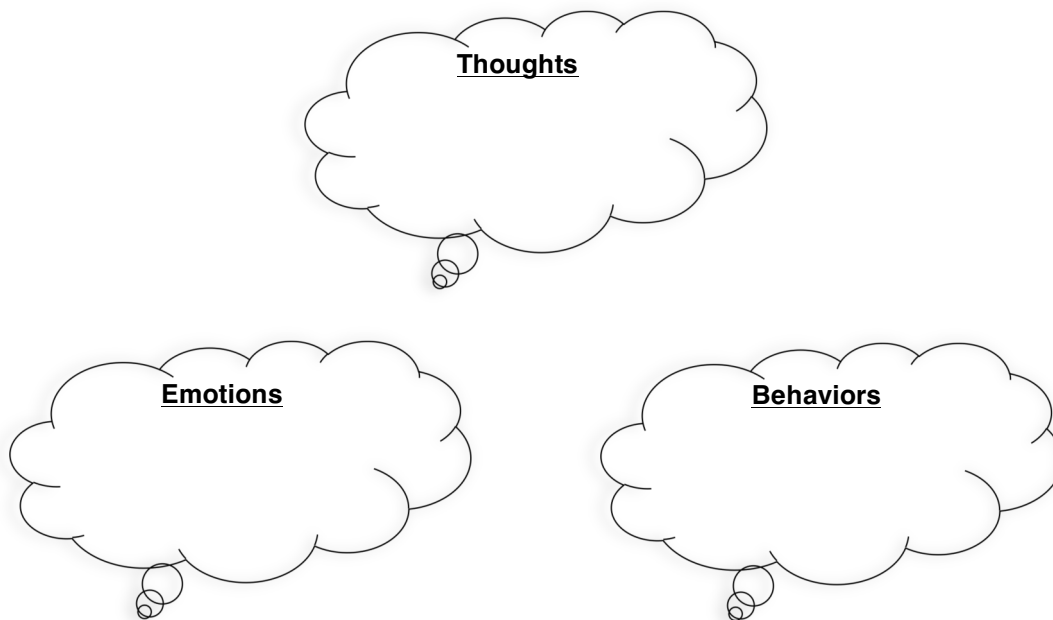
□ Instructions for daily practice

E.g., I have some materials for you to help with your daily practice. [Review daily practice instructions with participants – either instructions for RealLife Exp or instructions for paper forms]. You'll also be making daily ratings of whether you practiced the activities and about your mood [Review adherence and mood rating instructions – either instructions for RealLife Exp or instructions for paper forms]. Do you have any questions?

MODEL: EXAMPLE



MODEL: YOUR EXPERIENCE



Changing Thoughts: THREE GOOD THINGS

List three good social experiences today	Describe your role in causing these good experiences
1. →	
2. →	
3. →	

Daily practice plan: *If ...* _____

then ... _____

Changing Behaviors: KINDS ACTS

Ideas for Kind Acts:

- Taking on extra work to help a coworker
- Helping an elderly person you don't know
- Thanking someone
- Bringing someone flowers
- Asking someone how they are doing
- Doing a last minute favor for a friend
- Giving up your place in line for someone
- Lending money to a friend in need
- Volunteering to help others
- Holding a door open for someone
- Caring for someone who is sick
- Giving a surprise gift to someone
- Giving emotional support to a friend
- Giving up your seat to someone

Brainstorm Kind Acts you could do in the next two weeks	
1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

Daily practice plan: *If ...* _____

then ... _____

Building Social Connections: Control Protocol

□ Introductions and discussion of motivation for training

E.g. *In this study we're investigating the effectiveness of different activities to increase social connections. You've been randomly assigned to receive training in one type of activity. Before we begin the training, can you tell me a little bit about why you would like to increase your social connections?* [Provide reflective listening and validation].

□ Prime incremental theory of social connections

E.g. *Thanks for sharing that. Some people think that a person's level of social connection is fixed and can't be changed. However research suggests that effort combined with the right strategies can have a big impact on a person's social connections. I'm going to teach you some activities we think will increase your social connections. I think these activities could help you reach your social goals. Should we get started?*

□ Explain model

E.g. *First, I'll explain why we think social disconnection develops. We think people become socially disconnected because the fast pace of modern life interferes with social activities. A person might become so busy that social activities are not prioritized in his or her daily life. Let me explain with an example. Imagine that someone moves to a new city for a job. The person tries to make new friends at work, but none of the person's coworkers seem interested in socializing. The person becomes increasingly busy at work, and doesn't have time to pursue social activities outside of the office. Over time, the person begins to feel socially disconnected. Have you experienced anything like this process? I'm going to teach you two activities that will help you increase your social connections by being more mindful of your schedule and activity level.*

□ Teach A Daily Check-In

E.g. *The first activity I am going to teach you is called A DAILY CHECK-IN. The purpose of this activity is to take a moment each day to think about how busy and/or overwhelmed you are feeling. By checking in with yourself in this way, you may be more mindful of your activity level and less likely to over-fill your schedule in a way that prevents social connections. To practice this activity, set aside a moment each day to rate your how busy and overwhelmed you feel. Rate yourself on a 10 point-scale, with 0 being 'not at all busy or overwhelmed' and 10 being 'extremely busy or overwhelmed'. [Show participant scale on worksheet]. So if you were to practice this right now, how would you rate yourself? Great, so for the next two weeks, you'll practice this activity once per day. Do you have any questions about this activity?*

□ Teach Recording Life Details

E.g. *The second activity I am going to teach you is called RECORDING LIFE DETAILS. The purpose of the activity is to pay more attention to your daily activities. You might typically move through your day without thinking very much about what you're doing. But by paying attention to your life details, you may be able to recognize obstacles to social connection. To practice this activity, you will take some time each day to write a short summary of your activities in the following time-blocks: night (midnight – 6AM), morning (6AM – noon),*

afternoon (noon – 6PM), and evening (6PM – midnight). Try to use non-judgmental language when recording your activities. Just stick to the facts. For example, if you spent the afternoon watching TV, you could write “watched three episodes of XXX show.” Don’t write, “... spent a lazy afternoon watching TV,” or “... spent a relaxing afternoon watching TV,” because both of these statements include judgment words. So if you were to practice this write now, what would you write on the worksheet? [Participant records his or her daily activities on the worksheet]. So for the next two weeks you’ll practice this activity once per day. Do you have any questions about this activity?

□ Treatment review

E.g. We’ve gone over a lot today. Let’s review everything to make sure I explained it clearly. [Ask participant to explain the treatment model. Ask participant to explain the purpose of A DAILY CHECK-IN and how he or she will practice it. Ask participant to explain the purpose of RECORDING LIFE DETAILS and how he or she will practice it].

□ Discuss implementation intentions

E.g. Great, so for the next two weeks you’ll be trying to practice A DAILY CHECK-IN and RECORDING LIFE DETAILS once each day. It can be hard to integrate new activities into your daily schedule, and one strategy that can help with this is to make a daily practice plan. A daily practice plan is an if-then plan of when you will engage in these activities. For example, you might decide that if you notice yourself becoming stressed during the day, then you will practice A DAILY CHECK-IN. Or if you sit down to do relax in the evening, then you will practice RECORDING LIFE DETAILS. What might be a good daily practice plan for you for A DAILY CHECK-IN? What about for RECORDING LIFE DETAILS?

□ Instructions for daily practice

E.g., I have some materials for you to help with your daily practice. [Review daily practice instructions with participants – either instructions for RealLife Exp or instructions for paper forms]. You’ll also be making daily ratings of whether you practiced the activities and about your mood [Review adherence and mood rating instructions – either instructions for RealLife Exp or instructions for paper forms]. Do you have any questions?

A DAILY CHECK-IN

Take a moment to rate how busy and/or overwhelmed you felt today on the following scale:

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9 --- 10

Not at all busy
or overwhelmed

Extremely busy
or overwhelmed

Daily practice plan: *If ...* _____

then ... _____

RECORDING LIFE DETAILS

Night: Midnight - 6AM	Morning: 6AM - Noon	Afternoon: Noon - 6 PM	Evening: 6PM - Midnight
Describe activities: 	Describe activities: 	Describe activities: 	Describe activities:

Daily practice plan: *If ...* _____

then ... _____

Appendix B: Inclusion/Exclusion Checklist

Building Social Connections

INCLUSION AND EXCLUSION CHECKLIST

1. Subject is age 18-30 years. ☐

2. Subject is willing and able to complete the study protocol ☐

- Initial 2-hours laboratory visit. ☐
- 13 days of activity practice and daily adherence and mood ratings. ☐
- 2 follow-up assessments via online survey. ☐

3. Subject meets one of the two loneliness criteria:

3a. Affirmative answer to, "Do you want to increase your social connections?" ☐

~ OR ~

3b. Score of ≥ 5 on the Three Item Loneliness Scale. ☐

	Hardly ever	Some of the time	Often
How often do you feel that you lack companionship?	1	2	3
How often do you feel left out?	1	2	3
How often do you feel isolated from others?	1	2	3
Total Score:			

4. Subjects **does not** meet criteria for current major depressive episode, past month suicidal thoughts or behaviors (operationally defined as an affirmative answer to any of questions B1a-B17 on the MINI), current manic or hypomanic episode, or current psychosis. ☐

If screen fail, note why:

Appendix C: RealLife Exp Instructions

Control Condition

Thank you for participating in Building Social Connections! You have just learned some activities that we think will help you feel more connected. Your job is to practice these activities for the next 13 days [from _____ to _____]. The **RealLife Exp** app will help you practice.

Follow these steps to download the app.

1. Download the “**RealLife Exp**” app on your smartphone. Make sure that you allow the app to send you push notifications!
2. Click “Sign Up ” and follow the instructions to create a free account.
3. Once logged in, go to “Download LifePak” and choose “**Connect! (A)**” from the list of LifePaks you can download (do not use the search bar). Enter the password, which will be provided by the researcher.
4. Enter your LifePak ID, which will be provided by the researcher.

You will now receive daily reminders every day at noon to practice the study activities. Open the daily reminder by clicking on the bell icon to see brief steps for how to practice the activities. For more detailed instructions for how to practice the activities, click on the person icon and open instructions for **A DAILY CHECK-IN** or **RECORDING LIFE DETAILS**.

You will also receive daily questions every day at 6 PM. Open the daily questions by clicking on the bell icon, and then record your daily activity practice and mood. You will have until midnight each day to respond to the questions. If you complete at least 12 of the 13 daily questions, you will receive \$10 for this part of the study.

We hope that you will practice **A DAILY CHECK-IN** and **RECORDING LIFE DETAILS** every day. But even if you don’t, you can still receive the \$10. The most important thing is that you complete at least 12 of the 13 daily questions honestly. If you miss a day of activity practice, see if you can try to practice the next day!

If you have questions or concerns during the study, you can do one of the following:

1. You can access the activity instructions from within the app at any time. Click on the person icon and open instructions for **A DAILY CHECK-IN** or **RECORDING LIFE DETAILS**.
2. If you have trouble using the app or need to reach the study team for any reason, email nleblanc@fas.harvard.edu.
3. If you become upset or feel any distress during this study or any other time, you can always call a mental health professional
 - a. For emergencies, call 911 or go to an emergency room
 - b. Harvard students can call 617-495-2042 to reach HUHS
 - c. Other participants can call 617-665-1372 to reach the Cambridge Hospital Emergency Psychiatric Service
 - d. You can access these phone numbers from within the app by clicking on the person icon and opening **If you’re distressed**

Thank you for participating in Building Social Connections! You have just learned some activities that we think will help you feel more connected. Your job is to practice these activities for the next 13 days [from _____ to _____]. The **RealLife Exp** app will help you practice.

NAT

Follow these steps to download the app.

1. Download the “**RealLife Exp**” app on your smartphone. Make sure that you allow the app to send you push notifications!
2. Click “Sign Up ” and follow the instructions to create a free account.
3. Once logged in, go to “Download LifePak” and choose “**Connect! (B)**” from the list of LifePaks you can download (do not use the search bar). Enter the password, which will be provided by the researcher.
4. Enter your LifePak ID, which will be provided by the researcher.

You will now receive daily reminders every day at noon to practice the study activities. Open the daily reminder by clicking on the bell icon to see brief steps for how to practice the activities. For more detailed instructions for how to practice the activities, click on the person icon and open instructions for **REAPPRAISAL** or **AVOIDANCE REDUCTION**.

You will also receive daily questions every day at 6 PM. Open the daily questions by clicking on the bell icon, and then record your daily activity practice and mood. You will have until midnight each day to respond to the questions. If you complete at least 12 of the 13 daily questions, you will receive \$10 for this part of the study.

We hope that you will practice **REAPPRAISAL** and **AVOIDANCE REDUCTION** every day. But even if you don’t, you can still receive the \$10. The most important thing is that you complete at least 12 of the 13 daily questions honestly. If you miss a day of activity practice, see if you can try to practice the next day!

If you have questions or concerns during the study, you can do one of the following:

1. You can access the activity instructions from within the app at any time. Click on the person icon and open instructions for **REAPPRAISAL** or **AVOIDANCE REDUCTION**.
2. If you have trouble using the app or need to reach the study team for any reason, email nleblanc@fas.harvard.edu.
3. If you become upset or feel any distress during this study or any other time, you can always call a mental health professional.
 - a. For emergencies, call 911 or go to an emergency room
 - b. Harvard students can call 617-495-2042 to reach HUHS
 - c. Other participants can call 617-665-1372 to reach the Cambridge Hospital Emergency Psychiatric Service
 - d. You can access these phone numbers from within the app by clicking on the person icon and opening **If you’re distressed**

PAT

Thank you for participating in Building Social Connections! You have just learned some activities that we think will help you feel more connected. Your job is to practice these activities for the next 13 days [from _____ to _____]. The **RealLife Exp** app will help you practice.

Follow these steps to download the app.

1. Download the “**RealLife Exp**” app on your smartphone. Make sure that you allow the app to send you push notifications!
2. Click “Sign Up ” and follow the instructions to create a free account.
3. Once logged in, go to “Download LifePak” and choose “**Connect! (C)**” from the list of LifePaks you can download (do not use the search bar). Enter the password, which will be provided by the researcher.
4. Enter your LifePak ID, which will be provided by the researcher.

You will now receive daily reminders every day at noon to practice the study activities. Open the daily reminder by clicking on the bell icon to see brief steps for how to practice the activities. For more detailed instructions for how to practice the activities, click on the person icon and open instructions for **THREE GOOD THINGS** or **KIND ACTS**.

You will also receive daily questions every day at 6 PM. Open the daily questions by clicking on the bell icon, and then record your daily activity practice and mood. You will have until midnight each day to respond to the questions. If you complete at least 12 of the 13 daily questions, you will receive \$10 for this part of the study.

We hope that you will practice **THREE GOOD THINGS** and **KIND ACTS** every day. But even if you don’t, you can still receive the \$10. The most important thing is that you complete at least 12 of the 13 daily questions honestly. If you miss a day of activity practice, see if you can try to practice the next day!

If you have questions or concerns during the study, you can do one of the following:

1. You can access the activity instructions from within the app at any time. Click on the person icon and open instructions for **THREE GOOD THINGS** or **KIND ACTS**.
2. If you have trouble using the app or need to reach the study team for any reason, email nleblanc@fas.harvard.edu.
3. If you become upset or feel any distress during this study or any other time, you can always call a mental health professional.
 - a. For emergencies, call 911 or go to an emergency room
 - b. Harvard students can call 617-495-2042 to reach HUHS
 - c. Other participants can call 617-665-1372 to reach the Cambridge Hospital Emergency Psychiatric Service
 - d. You can access these phone numbers from within the app by clicking on the person icon and opening **If you’re distressed**

Appendix D: Practice Instructions

Control

Thank you for participating in Building Social Connections! You have just learned some activities that we think will help you feel more connected. Your job is to practice these activities for the next 13 days [from _____ to _____]. Follow these instructions to guide your practice.

Create a daily reminder for practicing the study activities (e.g., set an alarm on your phone). You can use the daily reminder text on the next page to remind you of the brief steps for how to practice the activities. For more detailed instructions for how to practice the activities, see the activity instructions for **A DAILY CHECK-IN** and **RECORDING LIFE DETAILS** at the end of this packet.

Complete the daily questions every day between 6 PM and midnight (record the time you fill out the questions). These daily questions will ask about your daily activity practice and mood. If you complete at least 12 of the 13 daily questions, you will receive \$10 for this part of the study.

We hope that you will practice **A DAILY CHECK-IN** and **RECORDING LIFE DETAILS** every day. But even if you don't, you can still receive the \$10. The most important thing is that you complete at least 12 of the 13 daily questions honestly. If you miss a day of activity practice, see if you can try to practice the next day!

If you have questions or concerns during the study, you can do one of the following:

4. You can find detailed activity instructions for **A DAILY CHECK-IN** and **RECORDING LIFE DETAILS** at the end of this packet
5. If you have trouble filling out the daily questions or need to reach the study team for any reason, email nleblanc@fas.harvard.edu.
6. If you become upset or feel any distress during this study or any other time, you can always call a mental health professional
 - a. For emergencies, call 911 or go to an emergency room
 - b. Harvard students can call 617-495-2042 to reach HUHS
 - c. Other participants can call 617-665-1372 to reach the Cambridge Hospital Emergency Psychiatric Service

NAT

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Create a daily reminder for practicing the study activities (e.g., set an alarm on your phone). You can use the daily reminder text on the next page to remind you of the brief steps for how to practice the activities. For more detailed instructions for how to practice the activities, see the activity instructions for **REAPPRAISAL** and **AVOIDANCE REDUCTION** at the end of this packet.

Complete the daily questions every day between 6 PM and midnight (record the time you fill out the questions). These daily questions will ask about your daily activity practice and mood. If you complete at least 12 of the 13 daily questions, you will receive \$10 for this part of the study.

We hope that you will practice **REAPPRAISAL** and **AVOIDANCE REDUCTION** every day. But even if you don't, you can still receive the \$10. The most important thing is that you complete at least 12 of the 13 daily questions honestly. If you miss a day of activity practice, see if you can try to practice the next day!

If you have questions or concerns during the study, you can do one of the following:

1. You can find detailed activity instructions for **REAPPRAISAL** and **AVOIDANCE REDUCTION** at the end of this packet
2. If you have trouble filling out the daily questions or need to reach the study team for any reason, email nleblanc@fas.harvard.edu.
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PAT

Thank you for participating in Building Social Connections! You have just learned some activities that we think will help you feel more connected. Your job is to practice these activities for the next 13 days [from _____ to _____]. Follow these instructions to guide your practice.

Create a daily reminder for practicing the study activities (e.g., set an alarm on your phone). You can use the daily reminder text on the next page to remind you of the brief steps for how to practice the activities. For more detailed instructions for how to practice the activities, see the activity instructions for **THREE GOOD THINGS** and **KIND ACTS** at the end of this packet.

Complete the daily questions every day between 6 PM and midnight (record the time you fill out the questions). These daily questions will ask about your daily activity practice and mood. If you complete at least 12 of the 13 daily questions, you will receive \$10 for this part of the study.

We hope that you will practice **THREE GOOD THINGS** and **KIND ACTS** every day. But even if you don't, you can still receive the \$10. The most important thing is that you complete at least 12 of the 13 daily questions honestly. If you miss a day of activity practice, see if you can try to practice the next day!

If you have questions or concerns during the study, you can do one of the following:

1. You can find detailed activity instructions for **THREE GOOD THINGS** and **KIND ACTS** at the end of this packet
2. If you have trouble filling out the daily questions or need to reach the study team for any reason, email nleblanc@fas.harvard.edu.
3. If you become upset or feel any distress during this study or any other time, you can always call a mental health professional
 - a. For emergencies, call 911 or go to an emergency room
 - b. Harvard students can call 617-495-2042 to reach HUHS
 - c. Other participants can call 617-665-1372 to reach the Cambridge Hospital Emergency Psychiatric Service

Appendix E: Daily Reminder Text

Reminder:

Practice A DAILY CHECK-IN today using the following steps: 1) Reflect on your day, and 2) Rate how busy and/or overwhelmed you felt today on a scale from 0-10.

Practice RECORDING LIFE DETAILS today using the following steps: 1) Write a description of your daily activities this morning, afternoon, evening, and night, and 2) Remember to use non-judgmental language.

Reminder:

Practice REAPPRAISAL today using the following steps: 1)Identify a recent social situation in which you experienced negative emotions, 2)Identify your initial negative appraisal, and 3)Generate a reappraisal.

Practice AVOIDANCE REDUCTION today using the following steps:
1)Choose an avoidance reduction behavior,
2)Practice this avoidance reduction behavior, and
3)Reflect on what you learned.

Reminder:

Practice THREE GOOD THINGS today using the following steps: 1)Notice three good social experience that happened today, and 2)Notice your role in causing these good experiences.

Practice KIND ACTS today using the following steps:
1)Choose a kind act, and
2)Practice this kind act.

Appendix F: Daily Questions

Control

Study ID: _____ Date: _____ Time: _____ (please answer between 6PM – Midnight)

Instructions: Please answer the following questions by circling your answer.

Did you practice A
DAILY CHECK-IN
today?

YES NO

If yes → Great work! Now take a moment to think about when you can practice A DAILY CHECK-IN tomorrow.

If no → Thanks for your response. Can you try to practice A DAILY CHECK-IN tomorrow? Take a moment to think about when you can practice.

Did you practice
RECORDING LIFE
DETAILS today?

YES NO

If yes → Great work! Now take a moment to think about when you can practice RECORDING LIFE DETAILS tomorrow.

If no → Thanks for your response. Can you try to practice RECORDING LIFE DETAILS tomorrow? Take a moment to think about when you can practice.

Please continue to the reverse side.

Instructions: Please answer the following questions by circling your answer.

How enthusiastic did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How happy did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How calm did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sleepy did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sad did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How nervous did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How excited did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How satisfied did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How relaxed did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sluggish did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How disappointed did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How afraid did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How socially connected did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Thank you for recording your responses today!

NAT

Study ID: _____ Date: _____ Time: _____ (please answer between 6PM – Midnight)

Instructions: Please answer the following questions by circling your answer.Did you practice
REAPPRAISAL
today?

YES

NO

*If yes → Great work! Now take a moment to think about when you can practice REAPPRAISAL tomorrow.**If no → Thanks for your response. Can you try to practice REAPPRAISAL tomorrow? Take a moment to think about when you can practice.*

Did you practice
AVOIDANCE
REDUCTION
today?

YES

NO

*If yes → Great work! Now take a moment to think about when you can practice AVOIDANCE REDUCTION tomorrow.**If no → Thanks for your response. Can you try to practice AVOIDANCE REDUCTION tomorrow? Take a moment to think about when you can practice.*

If you practiced
AVOIDANCE
REDUCTION
today, which of
the following best
describes your
avoidance
reduction
behavior?

Face-to-face

(i.e. you interacted
directly with another
person)

Spoken

communication

(i.e. you interacted
with another person
via phone, video chat,
etc.)

Written

communication

(i.e. you interacted
with another person
via letter, text
message, email,
social media, etc.)

Remote

(i.e. you did not
interact with another
person)

Please continue to the reverse side.

Instructions: Please answer the following questions by circling your answer.

How enthusiastic did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How happy did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How calm did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sleepy did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sad did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How nervous did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How excited did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How satisfied did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How relaxed did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sluggish did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How disappointed did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How afraid did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How socially connected did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Thank you for recording your responses today!

PAT

Study ID: _____ Date: _____ Time: _____ (please answer between 6PM – Midnight)

Instructions: Please answer the following three questions by circling your answer.

Did you practice
THREE GOOD
THINGS today?

YES NO

*If yes → Great work! Now take a moment to think about when you can practice
THREE GOOD THINGS tomorrow.*

*If no → Thanks for your response. Can you try to practice THREE GOOD
THINGS tomorrow? Take a moment to think about when you can practice.*

Did you practice
KIND ACTS today?

YES NO

*If yes → Great work! Now take a moment to think about when you can practice
KIND ACTS tomorrow.*

*If no → Thanks for your response. Can you try to practice KIND ACTS tomorrow?
Take a moment to think about when you can practice.*

If you practiced KIND ACTS today, which of the following best describes your kind act?	Face-to-face (i.e. you interacted with the recipient in person)	Spoken communication (i.e. you interacted with the recipient via phone, video chat, etc.)	Written communication (i.e. you interacted with the recipient via letter, text message, email, social media, etc.)	Remote (i.e. you did not interact with the recipient)
---	--	--	--	--

Please continue on the reverse side.

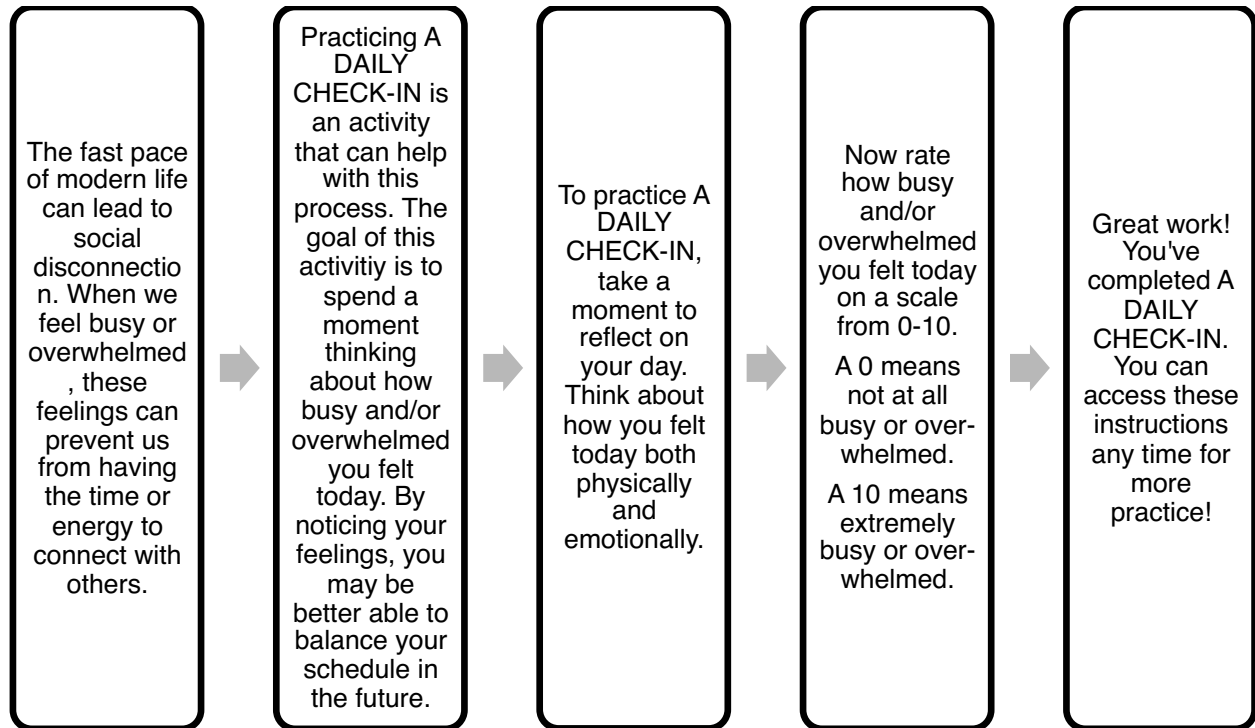
Instructions: Please answer the following questions by circling your answer.

How enthusiastic did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How happy did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How calm did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sleepy did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sad did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How nervous did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How excited did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How satisfied did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How relaxed did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How sluggish did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How disappointed did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How afraid did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
How socially connected did you feel today?	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

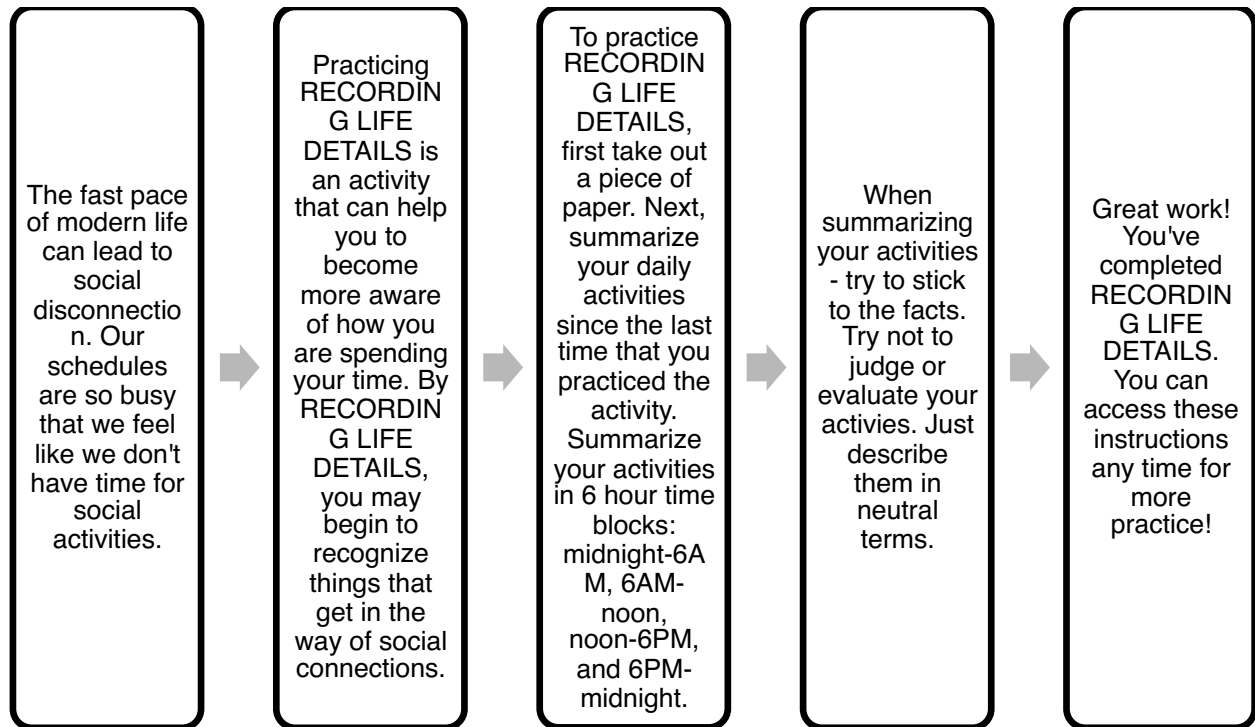
Thank you for recording your responses today!

Appendix G: Intervention Instructions

A Daily Check-In



Recording Life Details



REAPPRAISAL

We all make interpretations and predictions about the world around us. These interpretations and predictions are called appraisals.

Our appraisals have a big impact on how we feel about different situations. If we only notice negative appraisals of social situations, we will feel a lot of negative emotions in social situations.



REAPPRAISAL is an activity that you can use to think more flexibly in social situations. The goal is to identify your initial negative appraisal of a social situation and then to think of another way of looking at the situation (i.e. to think of a **REAPPRAISAL**). This activity can help to reduce negative emotions in social situations.



To practice **REAPPRAISAL**, take out a piece of paper. Write down a brief description of a recent social situation in which you felt negative emotions. Next, ask yourself ...
1) What did I expect would happen?
2) What judgements was I making about myself? Write down your initial negative appraisal on the piece of paper

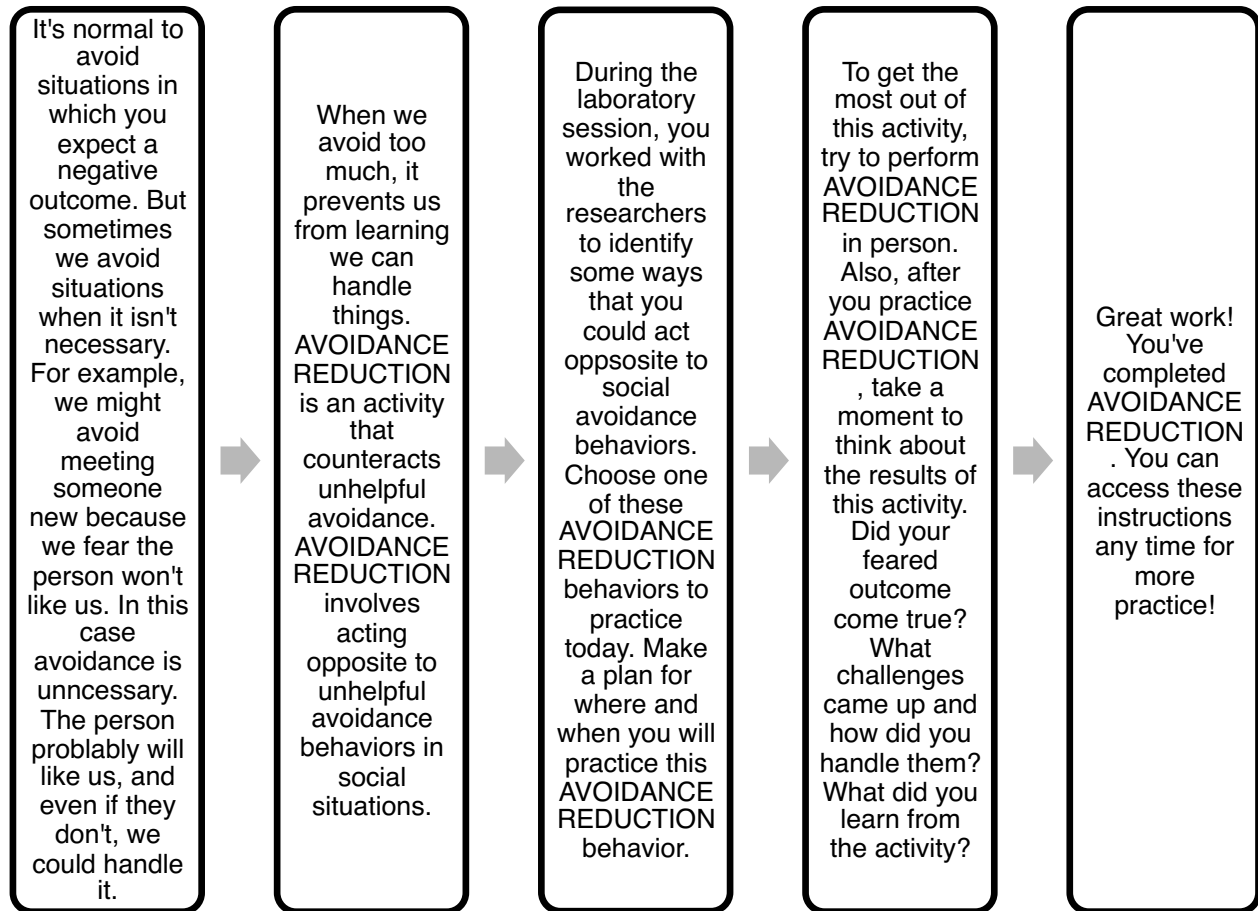


Now practice coming up with a more positive **REAPPRAISAL** of the situation. The following questions might help you think of a **REAPPRAISAL**.
1) Is there another way of looking at the situation?
2) What are the real odds of a negative outcome?
3) How could I handle a negative outcome?
Write down your **REAPPRAISAL** on the piece of paper.



Great work!
You've completed **REAPPRAISAL**. You can access these instructions any time for more practice!

AVOIDANCE REDUCTION



THREE GOOD THINGS

If we aren't getting a lot of enjoyment out of our social activities, we might stop expecting good social things to happen. We might even overlook good social things when they do happen. This process prevents us from experiencing positive emotions in social situations.



THREE GOOD THINGS is an activity that you can use to savor positive social experiences in your life. The goal of this activity is to think about the positive social experiences that happen each day, and to notice your role in causing these experiences. This activity can help to increase positive emotions and social motivation.



To practice **THREE GOOD THINGS**, first take out a piece of paper. Next, write down three good social things that happened today. These could be big things (e.g., made a new friend) or small things (e.g., waved at a neighbor). If you're having troubling thinking of three things, write down as many as you can think of.

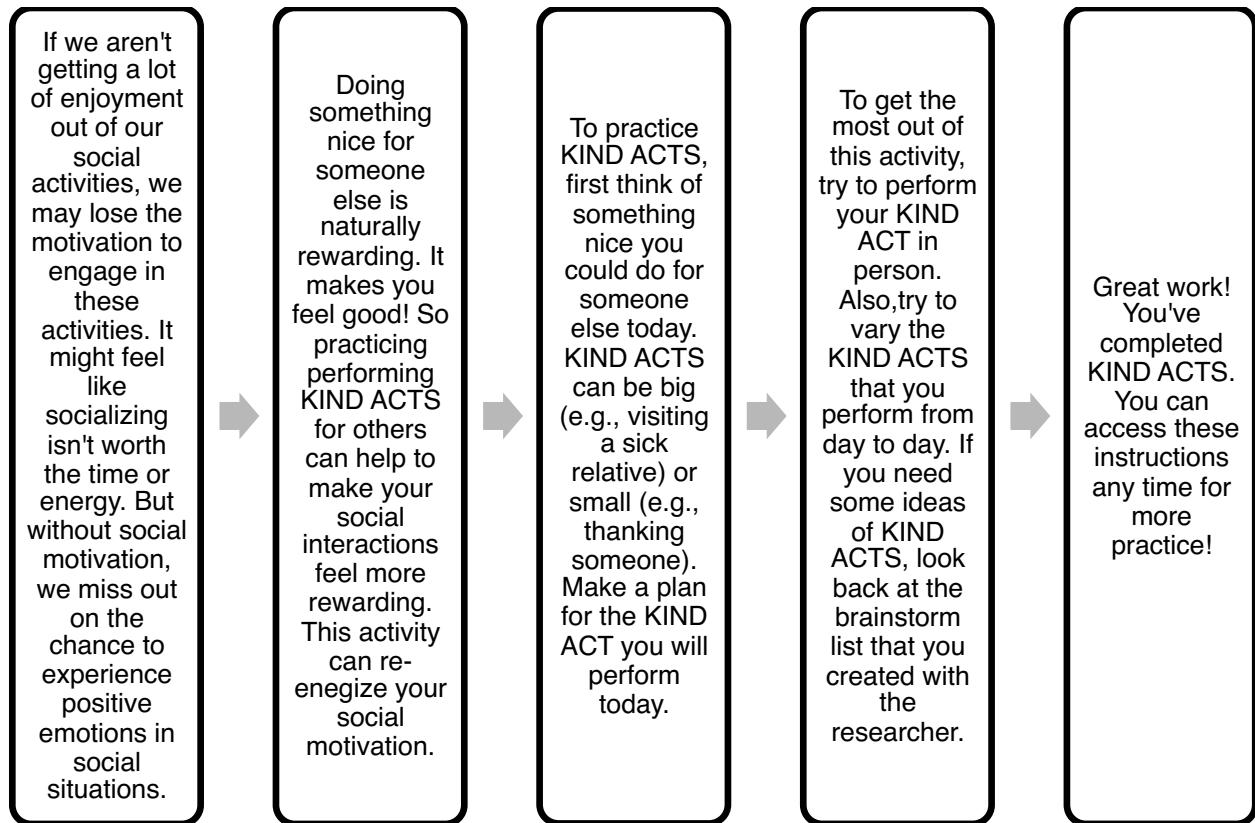


Now, think about the role you played in causing each of these **THREE GOOD THINGS**. For example, if one of your good things was that you talked to a classmate, you might write down that you asked your classmate a question that started the conversation. Write down your role in causing each of your **THREE GOOD THINGS** on the paper.



Great work!
You've completed **THREE GOOD THINGS**. You can access these instructions any time for more practice!

KINDS ACTS



Appendix H: Endpoint Instructions

Thank you for completing the questionnaires! You have now completed two weeks of daily activity practice.

If you used the RealLife Exp app:

- You will no longer receive daily reminder messages.
- You will no longer be prompted to record your daily activity practice and mood.
- You can continue practicing the activities as much or as little as you want.

If you used the paper forms:

- You no longer need to record your daily activity practice and mood on the paper forms. Please email the researcher (nleblanc@fas.harvard.edu) to schedule a time to return your paper forms.
- You can continue practicing the activities as much or as little as you want.

You will receive an email with a link to a final follow-up survey in two weeks. Thank you for your participation!

Appendix I: Questionnaires developed for the present study

Demographics Questionnaire

1. Your age: _____
2. Your gender:
 - Male
 - Female
 - Other (please specify) _____
3. Your race:
 - Caucasian/White
 - Hispanic/Latino
 - American Indian/Alaskan Native
 - Multiracial
 - African American/Black
 - Asian
 - Native Hawaiian/Pacific Islander
 - Other (please specify) _____
4. Which of the following describes you highest level of education?
 - Elementary school (grades 1-8)
 - Some college
 - 4-year degree (e.g. B.A., B.S.)
 - 2-year graduate (e.g. M.A., M.B.A.)
 - Secondary school (grades 9-12)
 - 2-year degree (e.g. Associates)
 - Some graduate
 - Doctorate (e.g. M.D., Ph.D., J.D.)
5. Which of the following best describes your current employment status?
 - Full-time
 - Unemployed
 - Student
 - Part-time
 - Homemaker
 - On disability
6. Which of the following best describes your religious beliefs?
 - Atheist or Agnostic
 - Buddhist
 - Hindu
 - Muslim
 - Other (please specify) _____
 - Catholic
 - Jewish
 - Protestant
7. How did you hear about this study?
 - Harvard Psychology Study Pool
 - Word of mouth
 - Advertisement that asked, "Do you feel lonely?"
 - Advertisement that asked, "Feeling disconnected?"

- Can't remember
- Other (please specify) _____

8. Are you currently receiving treatment from a mental health professional (e.g., psychologist, psychiatrist, social worker, mental health counselor, etc.)?

- Yes
- No

Treatment continuation, satisfaction, acceptability, and feedback

1. Over the past two weeks, did you continue to perform activities that you learned in the training?

NO YES – ONCE OR TWICE YES – REGULARLY

Instruction: Please answer the following questions regarding you impressions of the activity training that you received in this study.

2. How satisfied are you with the training?

1-----2-----3-----4-----5-----6-----7-----8-----9-----10
Not at all satisfied Very satisfied

3. How acceptable was the training as an intervention to increase your social connections?

1-----2-----3-----4-----5-----6-----7-----8-----9-----10
Not at all acceptable Very acceptable

4. What aspects of the training did you find most helpful? _____

5. What aspects of the training did you find least helpful? _____

6. What, if anything, about the training was confusing? _____

7. How could we improve the training? _____

Appendix J: Supplementary Tables

Supplementary Table 1. Zero-order correlations between age and DVs.

Variable	Correlation	<i>p</i>-value
ULS-3	$r = .06$	.400
MSPSS Total	$r = -.13$	.082
RS Total	$r = -.04$	.637
SIIS-SP	$r = -.08$	.265
SIIS-SN	$r = -.09$	.252
SIIS-OP	$r = -.02$	.798
SIIS-ON	$r = -.11$	.127
PHQ-8	$r = .03$	.683
Q-LES-Q	$r = -.03$	.664
SDS	$r = -.02$	.839
PANAS Positive	$r = .12$	.097
PANAS Negative	$r = .07$	.349

Note. ULS-3 = UCLA Loneliness Scale Version 3; MSPSS = Multidimensional Scale of Perceived Social Support; RS = Relationship Satisfaction; SIIS-SP = Social Interaction Initiation Scale – Self-initiate Positive Subscale; SIIS-SN = Social Interaction Initiation Scale – Self-initiated Negative Subscale; SIIS-OP = Social Interaction Initiation Scale – Other-initiated Positive Subscale; SIIS-ON = Social Interaction Initiation Scale – Other-initiated Negative Subscale; PHQ-8 = Patient Health Questionnaire – 8; QLESQ-SF = Quality of Life Enjoyment and Satisfaction Scale – Short Form; SDS = Sleep Disturbance Scale; PANAS = Positive and Negative Affect Scale.

Supplementary Table 2. Group differences in DVs by gender.

Variable	Male M(SD)	Female M(SD)	Non-binary M(SD)	Test for group difference
ULS-3	40.45(9.47) ^a	44.60(10.52) ^b	47.00(1.41) ^{ab}	$F(2,177) = 3.98$, $p = .020$
MSPSS Total	5.65(0.93) ^a	5.44(0.90) ^a	5.67(0.71) ^a	$F(2,177) = 1.23$, $p = .295$
RS Total	20.92(3.77) ^a	18.39(4.22) ^b	21.50(2.12) ^{ab}	$F(2,177) = 9.02$, $p < .001$
SIIS-SP	26.57(11.06) ^a	21.61(9.42) ^b	26.50(14.85) ^{ab}	$F(2,177) = 5.24$, $p = .006$
SIIS-SN	9.04(8.94) ^a	8.98(6.07) ^a	15.00(9.90) ^a	$F(2,177) = 0.62$, $p = .538$
SIIS-OP	13.13(7.41) ^a	11.39(5.20) ^a	13.00(8.48) ^a	$F(2,177) = 1.69$, $p = .188$
SIIS-ON	4.82(4.93) ^a	5.49(4.56) ^a	7.50(2.12) ^a	$F(2,177) = 0.69$, $p = .502$
PHQ-8	2.17(2.62)	2.00(2.38)	5.00(2.83)	$F(2,177) = 1.46$, $p = .236$
Q-LES-Q	0.70(0.13) ^a	0.69(0.12) ^a	0.50(0.05) ^a	$F(2,174) = 2.37$, $p = .096$
SDS	15.57(5.39) ^a	17.17(6.03) ^{ab}	26.00(0.00) ^b	$F(2,177) = 4.50$, $p = .012$
PANAS Positive	35.42(7.72) ^a	32.33(7.24) ^b	25.00(11.32) ^{ab}	$F(2,177) = 5.13$, $p = .007$
PANAS Negative	15.66(5.31) ^a	16.15(4.82) ^a	17.00(8.49) ^a	$F(2,177) = 0.25$, $p = .780$

Note. Groups that do not share a superscript are significantly different at $p < .05$, per Hochberg's GT2 post-hoc test; ULS-3 = UCLA Loneliness Scale Version 3; MSPSS = Multidimensional Scale of Perceived Social Support; RS = Relationship Satisfaction; SIIS-SP = Social Interaction Initiation Scale – Self-initiate Positive Subscale; SIIS-SN = Social Interaction Initiation Scale – Self-initiated Negative Subscale; SIIS-OP = Social Interaction Initiation Scale – Other-initiated Positive Subscale; SIIS-ON = Social Interaction Initiation Scale – Other-initiated Negative Subscale; PHQ-8 = Patient Health Questionnaire – 8; QLESQ-SF = Quality of Life Enjoyment and Satisfaction Scale – Short Form; SDS = Sleep Disturbance Scale; PANAS = Positive and Negative Affect Scale.

Supplementary Table 3. Group differences in DVs by race.

Variable	White M(SD)	Black M(SD)	Latino M(SD)	Asian M(SD)	Multi- racial M(SD)	Test for group difference
ULS-3	44.55 ^a (8.91)	45.56 ^a (15.02)	39.80 ^a (9.84)	40.76 ^a (9.92)	51.57 ^a (11.89)	$F(4,175) = 3.21$, $p = .014$
MSPSS Total	5.33 ^{ab} (0.85)	4.81 ^a (1.40)	6.09 ^b (0.79)	5.71 ^b (0.85)	5.27 ^{ab} (0.86)	$F(4,175) = 4.47$, $p = .002$
RS Total	18.36 ^a (3.93)	19.00 ^{ab} (5.93)	19.40 ^{ab} (5.10)	20.77 ^b (3.80)	16.71 ^{ab} (3.55)	$F(4,175) = 4.34$, $p = .002$
SIIS-SP	23.11 ^a (9.32)	18.44 ^a (7.86)	24.30 ^a (10.31)	25.57 ^a (11.10)	17.43 ^a (10.49)	$F(4,175) = 1.98$, $p = .100$
SIIS-SN	9.31 (5.91)	7.00 (5.48)	8.50 (4.09)	8.84 (8.93)	13.29 (7.25)	$F(4,175) = 0.76$, $p = .551$
SIIS-OP	12.05 (5.31)	10.11 (4.46)	12.10 (5.55)	12.71 (7.34)	10.14 (5.18)	$F(4,175) = 0.57$, $p = .682$
SIIS-ON	5.94 ^a (4.44)	4.00 ^a (6.20)	4.30 ^a (4.03)	4.67 ^a (4.71)	8.29 ^a (5.02)	$F(4,175) = 1.69$, $p = .154$
PHQ-8	2.42 ^a (2.24)	2.00 ^a (2.18)	1.20 ^a (2.15)	1.97 ^a (2.74)	2.57 ^a (2.57)	$F(4,175) = 0.71$, $p = .585$
Q-LES-Q	0.67 ^a (0.12)	0.67 ^a (0.13)	0.75 ^a (0.10)	0.71 ^a (0.13)	0.61 ^a (0.10)	$F(4,175) = 2.12$, $p = .081$
SDS	17.75 ^a (5.94)	15.11 ^a (7.91)	14.90 ^a (6.10)	15.71 ^a (5.39)	20.00 ^a (5.22)	$F(4,175) = 2.14$, $p = .077$
PANAS Positive	32.19 ^a (7.06)	36.22 ^a (8.07)	33.30 ^a (3.62)	34.71 ^a (8.20)	31.14 ^a (8.40)	$F(4,175) = 1.47$, $p = .213$
PANAS Negative	16.31 ^a (4.46)	16.00 ^a (5.02)	15.30 ^a (4.24)	15.49 ^a (5.33)	18.86 ^a (6.91)	$F(4,175) = 0.88$, $p = .477$

Note. Groups that do not share a superscript are significantly different at $p < .05$, per Hochberg's GT2 post-hoc test; ULS-3 = UCLA Loneliness Scale Version 3; MSPSS = Multidimensional Scale of Perceived Social Support; RS = Relationship Satisfaction; SIIS-SP = Social Interaction Initiation Scale – Self-initiate Positive Subscale; SIIS-SN = Social Interaction Initiation Scale – Self-initiated Negative Subscale; SIIS-OP = Social Interaction Initiation Scale – Other-initiated Positive Subscale; SIIS-ON = Social Interaction Initiation Scale – Other-initiated Negative Subscale; PHQ-8 = Patient Health Questionnaire – 8; QLESQ-SF = Quality of Life Enjoyment and Satisfaction Scale – Short Form; SDS = Sleep Disturbance Scale; PANAS = Positive and Negative Affect Scale.

Supplementary Table 4. Zero-order correlations between baseline variables.

	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
1.	-.65 **	-.73 **	-.53 **	.25 **	-.37 **	.44 **	.29 **	-.53 **	.26 **	.46 **	.34 **	-.53 **	-.32 **	-.26 **	.53 **	-.14 **	.40 **	-.23 **	-.17 *	-.08
2.	--	.57 **	.44 **	.14	.33 **	.24 **	.24 **	.46 **	.33 **	.44 **	.22 **	.34 **	.24 **	.20 **	.40 **	.14	.29 **	.27 **	.24 **	.25 **
3.	--	--	.57 **	.19 *	.46 **	.39 **	.16 *	.52 **	.20 **	.49 **	.22 **	.37 **	.29 **	.26 **	.48 **	.20 **	.31 **	.28 **	.22 **	.21 **
4.	--	--	--	.17 *	.80 **	.03	.13	.45 **	.22 **	.52 **	.10	.51 **	.21 **	.15 *	.33 **	.26 **	.24 **	.26 **	.25 **	.24 **
5.	--	--	--	--	.29 **	.68 **	.28 **	.20 **	.10	.05	.36 **	.05	-.32 **	.21 **	.20 **	.06	.08	.06	.01	.05
6.	--	--	--	--	--	.07	.04	.32 **	.16 *	.37 **	.01	.33 **	.13	.09	.22 **	.25 **	.10	.18 *	.15 *	.16 *
7.	--	--	--	--	--	--	.22 *	-.25 **	.14	.13	.36 **	.09	-.33 **	.16 *	.29 **	.02	.19 *	.01	.04	.04
8.	--	--	--	--	--	--	--	.36 **	.43 **	.37 **	.45 **	.14	.30 **	.29 **	.32 **	.08	.22 **	.10	.02	.06
9.	--	--	--	--	--	--	--	--	.40 **	.60 **	.34 **	.26 **	.33 **	.42 **	.41 **	.17 *	.26 **	.24 **	.17 *	.24 **
10.	--	--	--	--	--	--	--	--	--	.35 **	.35 **	.13	-.20 **	.12	.24 **	.05	.23 **	.19 *	.08	.09
11.	--	--	--	--	--	--	--	--	--	--	.23 **	.37 **	.36 **	.47 **	.48 **	.32 **	.36 **	.38 **	.26 **	.36 **
12.	--	--	--	--	--	--	--	--	--	--	--	.16 *	.34 **	.27 **	.46 **	.06	.34 **	.08	.05	.12
13.	--	--	--	--	--	--	--	--	--	--	--	--	.16 *	.15 *	.40 **	.29 **	.29 **	.32 **	.35 **	.18 **
14.	--	--	--	--	--	--	--	--	--	--	--	--	--	.25 **	.45 **	.15 *	.21 **	.01	.18 *	.20 **
15.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.37 **	.09	.15 *	.24 **	.10	.15 *
16.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.22 **	.68 **	.22 **	.25 **	.05
17.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.12	.23 **	.35 **	.13
18.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.21 **	.26 **	.17 *
19.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.38 **	.40 **
20.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.23 **
21.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Supplementary Table 4 Continued. Zero-order correlations between baseline variables.

Note. * $p < .05$, ** $p < .01$. 1. UCLA Loneliness Scale – Version 3. 2. Multidimensional Scale of Perceived Social Support. 3. Relationship Satisfaction. 4. SIIS Self Positive. 5. SIIS Self Negative. 6. SIIS Other Positive. 7. SIIS Other Negative. 8. Patient Health Questionnaire-8. 9. Quality of Life and Enjoyment Satisfaction Questionnaire. 10. Sleep Disturbance Scale. 11. PANAS Positive Affect. 12. PANAS Negative Affect. 13. BFI Extraversion. 14. BFI Agreeableness. 15. BFI Conscientiousness. 16. BFI Neuroticism. 17. BFI Openness. 18. BIS. 19. BAS Drive. 20. BAS Fun-Seeking. 21. BAS Reward Responsiveness.

Supplementary Table 5. Marginal means for outcome variables across study time-points

Variable	Full Sample M(SD)	Control M(SD)	NAT M(SD)	PAT M(SD)
ULS-3: Day 0	42.71 (10.18)	44.07 (9.44)	41.22 (9.86)	42.85 (11.14)
ULS-3: Day 14	41.83 (9.09)	44.05 (7.96)	40.24 (8.04)	41.13 (10.74)
ULS-3: Day 28	40.73 (9.72)	42.25 (8.72)	39.52 (8.83)	40.40 (11.42)
MSPSS: Day 0	5.54 (0.92)	5.55 (0.98)	5.56 (0.81)	5.50 (0.96)
MSPSS: Day 14	5.58 (0.95)	5.43 (1.03)	5.68 (0.82)	5.65 (0.97)
MSPSS: Day 28	5.57 (1.08)	5.55 (1.10)	5.73 (0.87)	5.44 (1.25)
RS: Day 0	19.59 (4.19)	19.53 (4.03)	19.95 (3.76)	19.28 (4.75)
RS: Day 14	20.04 (4.03)	19.19 (3.62)	20.64 (3.59)	20.31 (4.71)
RS: Day 28	20.54 (4.28)	20.15 (4.01)	21.11 (3.75)	20.38 (5.02)
SIIS-SP: Day 0	23.95 (10.49)	23.27 (11.54)	24.75 (9.46)	23.83 (10.48)
SIIS-SP: Day 14	28.50 (9.43)	26.77 (9.73)	28.80 (9.16)	30.02 (9.25)
SIIS-SP: Day 28	27.25 (9.77)	25.81 (10.93)	28.39 (9.63)	27.55 (8.58)
SIIS-SN: Day 0	9.07 (7.54)	9.10 (7.26)	8.58 (7.01)	9.53 (8.38)
SIIS-SN: Day 14	10.76 (11.25)	10.68 (11.06)	11.25 (13.41)	10.33 (9.01)
SIIS-SN: Day 28	10.12 (13.08)	8.32 (11.05)	10.74 (13.20)	11.32 (14.80)
SIIS-OP: Day 0	12.21 (6.37)	12.02 (7.27)	12.23 (5.27)	12.38 (6.50)
SIIS-OP: Day 14	13.48 (6.16)	12.54 (6.82)	14.07 (6.07)	13.85 (5.48)
SIIS-OP: Day 28	13.82 (6.78)	13.35 (7.33)	13.94 (6.58)	14.17 (6.48)
SIIS-ON: Day 0	5.21 (4.72)	4.68 (4.29)	5.22 (4.49)	5.72 (5.32)
SIIS-ON: Day 14	6.13 (7.04)	5.91 (6.31)	6.80 (8.67)	5.69 (5.91)
SIIS-ON: Day 28	5.68 (7.99)	5.61 (7.64)	5.54 (7.61)	5.89 (8.82)
PHQ-8: Day 0	2.11 (2.50)	2.15 (2.51)	1.82 (2.02)	2.37 (2.91)
PHQ-8: Day 14	2.62 (3.18)	2.70 (2.70)	2.73 (3.60)	2.43 (3.25)
PHQ-8: Day 28	2.98 (3.75)	3.07 (3.76)	2.74 (3.62)	3.11 (3.93)
QLESQ-SF: Day 0	0.69 (0.13)	0.67 (0.12)	0.70 (0.14)	0.71 (0.13)
QLESQ-SF: Day 14	0.70 (0.14)	0.67 (0.12)	0.71 (0.13)	0.73 (0.15)
QLESQ-SF: Day 28	0.71 (0.15)	0.68 (0.13)	0.72 (0.14)	0.72 (0.16)
SDS: Day 0	16.53 (5.84)	17.35 (6.50)	15.62 (4.58)	16.62 (6.21)
SDS: Day 14	16.58 (5.83)	17.46 (5.63)	15.45 (5.15)	16.80 (6.57)
SDS: Day 28	16.92 (6.01)	17.94 (6.16)	15.72 (5.77)	17.09 (5.98)

Note. ULS-3 = UCLA Loneliness Scale Version 3; MSPSS = Multidimensional Scale of Perceived Social Support; RS = Relationship Satisfaction; SIIS-SP = Social Interaction Initiation Scale – Self-initiate Positive Subscale; SIIS-SN = Social Interaction Initiation Scale – Self-initiated Negative Subscale; SIIS-OP = Social Interaction Initiation Scale – Other-initiated Positive Subscale; SIIS-ON = Social Interaction Initiation Scale – Other-initiated Negative Subscale; PHQ-8 = Patient Health Questionnaire – 8; QLESQ-SF = Quality of Life Enjoyment and Satisfaction Scale – Short Form; SDS = Sleep Disturbance Scale.

Appendix K: Qualitative Feedback Summaries

Control

Q1. What aspects of the training did you find most helpful?

Analyst 1: Logging helped the majority of participants to reflect upon and become more aware of how much time they spent socializing and doing other activities. Through logging activities, several people also became more reflective of their mood/feelings and their perception of their social interactions. Additionally, logging and reflection was helpful for some participants' time management. Another helpful aspect of this study for a few was the app, which provided effective reminders and helped instill habits. A couple of participants found the check-ins most helpful, and another couple expressed general satisfaction with the study. Several participants emphasized the improvement they could make through this training.

Analyst 2: Many participants appreciated the requirement of recording daily activities, stating that it made them more aware of how they spent their time and how their time management could be improved. Similarly, the reflection time built into the intervention allowed participants to be more mindful of the way they spent their time and how they might adjust their daily activities. Many participants also found reflection for the sake of reflection helpful. Some participants specifically mentioned that they became more aware of their social interactions and opportunities to increase those interactions as a result of the intervention. Others became more self-aware, gaining insight into their perceptions of social interactions and changing moods. Finally, some participants found the app and its built-in reminders useful.

Q2. What aspects of the training did you find least helpful?

Analyst 1: A large number of people found nothing unhelpful in the study. However, others did take issue with the tasks, structure, and outcome of the study. Several people felt the task of recording their activities was unhelpful. A few others found the daily busyness check-in ratings unhelpful, with a couple of these people specifying that it was repetitive with already having to record their activities. A few people felt least helped by the mood check-in ratings, and a couple others expressed a dissatisfaction with the daily check-ins altogether.

Regarding the structure of the study, a couple people suggested a reframing of the questions in the tasks. A few people also critiqued the study design in its daily repetitiveness and its timing of tasks. Several people criticized the lack of accountability in the study, which could have been achieved through better instructions and reminders for social activity. Regarding the outcome of the study, the insufficient instructions on how to improve social connections contributed to participants' lack of encouragement for/increase in their social connections.

Analyst 2: Some participants did not find the daily check-in helpful, either because it was too repetitive or did not feel beneficial. Similarly, some participant did not find the daily activities listing helpful, sometimes because writing out activities was not feasible or because the structure was too general. Several participants discussed a lack of clear strategies or instructions for improving their social interactions throughout the intervention. A number of participants also did not find the busy check-in helpful, often because it was redundant with other parts of the

intervention. A few participants mentioned that the mood check-in or the scale used for mood was not helpful. Two participants recommended more ways to access past data. Finally, a few participants were satisfied with all components of the intervention.

Q3. What, if anything, about the training was confusing?

Analyst 1: The vast majority of participants found nothing confusing in the study. There were a few people who did not understand how the experiment was meant to improve social connection. A couple of participants had problems with the app, and another couple had problems with the timing of the training activities.

Analyst 2: Most participants found that the intervention was very clear. A few had difficulties with the app, including in how to use it, the timing of its reminders, and a technical malfunction. A few participants found the feedback survey's questions confusing. Finally, a few participants were confused about absence of strategies for increasing social connections, suspecting that they were in the control group.

Q4. How could we improve the training?

Analyst 1: A substantial number of participants felt there was no need for improvement. Several people did suggest improving the reminder notifications by making them more clear, frequent, and customizable. An equal number of participants addressed that the app itself could be improved by creating a more organized place in the app to record activities and by fixing glitches. A few people suggested the study help participants focus more on identifying how much of their time is spent meaningfully or wastefully. A couple of participants felt the study should encourage more goal-setting, and a few more people made other suggestions of additions to make the study experience more meaningful. Only a couple of people responded to this question by referencing the study's lack of overall effectiveness.

Analyst 2: Many participants had suggestions for the mechanical aspects of the intervention. Several users thought the intervention could be improved by making data more accessible for reflection and adding data entry to the app. Other users thought the app as a whole could be improved. Finally, several participants suggested customizing or increasing the number of reminders to complete the activities. In terms of intervention content, several participants suggested adding reflection on daily activities in order to improve time management. Others did not think that the strategies given were effective for improving social connections, and thought that adding more strategies or motivation would be helpful. Finally, many participants thought that the intervention did not need to be improved.

NAT

Q1. What aspects of the training did you find most helpful?

Analyst 1: Quite a few participants felt the lab training was effective with clear explanations and examples. Regarding techniques in this condition, the majority of participants felt that reappraisal was the most helpful, several people found avoidance reduction most helpful, and a few people found both techniques effective. It was also helpful for several participants to have reminders and structure in the study, which encouraged some people to build habit. Many people also felt encouraged in this study to be social and push past their comfort zones. Another aspect that benefitted some people was the ability to reflect. A couple of people expressed general satisfaction with the study.

Analyst 2: Participants in this condition found all three cognitive strategies – reflection, reappraisal, and avoidance reduction – very helpful. Reappraisal was mentioned especially often as a strategy for maintaining a positive mindset. Participants also appreciated the structure of the intervention, often discussing the clarity of the initial training, the attentiveness of the trainer, and the helpfulness of daily reminders in building habits. Participants indicated improvements in their social interactions and a motivation to leave their comfort zone as a result of the intervention. Finally, a few participants mentioned mindfulness.

Q2. What aspects of the training did you find least helpful?

Analyst 1: A large portion felt that nothing was unhelpful. A few people, however, did point out that the techniques were hard to apply every day and to every social situation (such as close friendships or group settings). Specifically, quite a few people expressed that reappraisal was unhelpful, often because there were not always sufficient opportunities or necessity to reappraise. A few people instead felt that avoidance reduction was difficult or not particularly helpful, sometimes because it was hard to identify where in the day to apply this technique. A couple of people commented on the training being too simple or repetitive. Lastly, just a few participants in the study felt their social interactions were still difficult to improve.

Analyst 2: Many participants were satisfied with all components of the intervention. Some participants did not find reappraisal helpful or applicable, while others felt similarly about avoidance reduction. A few participants found practicing the activities each day difficult or infeasible. A few participants did not find the training helpful, and others found that building strong relationships was difficult with the given strategies.

Q3. What, if anything, about the training was confusing?

Analyst 1: The vast majority of participants found nothing confusing. A few people experienced confusion with the study's wording or structure, particularly when it clashed with participants' personal circumstances.

Analyst 2: The vast majority of the participants did not find anything about the intervention confusing. Two participants were unsure about the way the activities worked and whether they

were doing them frequently enough, one participant had difficulties with the app, and one participant found avoidance reduction confusing.

Q4. How could we improve the training?

Analyst 1: A large portion of participants felt nothing needed improvement. People did make suggestions for improvement upon the content and structure of the study. Regarding content, several participants wanted the study to teach additional techniques to improve social connections. A few others requested more examples in the training. Regarding structure, a couple people desired the option to write on paper, while a few other wanted the study to be more digitalized. A couple people requested more app reminders, and another couple people suggested more frequent training/practice of the techniques in the study. Lastly, a couple of participants recommended extending the study to longer than two weeks.

Analyst 2: Participants in this condition had several common suggestions for improving the intervention. Several participants asked for a wider variety of strategies for improving social interactions. Others asked for a greater number of examples and more opportunities for training and practice. Participants were split on the structure of data entry, with some asking for paper entry and others asking for a fully digital intervention. Some participants said that having more reminders that they could customize would be helpful. Finally, a few participants thought that extending the intervention or solidifying the techniques so that they could practice them after the intervention had ended would be helpful. Many participants thought that the intervention was very helpful and should not be changed.

PAT

Q1. What aspects of the training did you find most helpful?

Analyst 1: A large number of participants found the 3 positive interactions reflection most helpful, especially in its contribution to self-awareness in social interactions and to sociability. An equally large portion felt that the kind acts were most helpful and satisfying. A couple of people felt that both these activities were helpful. Several people were encouraged by having accountability and goals to be social and kind. The structure of the study itself, including the app and reminders, was applicable and encouraged social interaction for a substantial number of participants. Lastly, a couple of people expressed general satisfaction with the study, while another couple expressed that they had not improved from the study.

Analyst 2: Participants in this condition frequently mentioned the “Three Good Things” and the kind acts components of the interventions as helpful in boosting mood and reappraising social situations. Initiating social interactions was mentioned as well, but much less frequently. Participants also appreciated the opportunities for reflection, which helped increase self-awareness. Finally, many participants mentioned that different aspects of the intervention structure – the daily reminders, the ease of use of the app, the low time commitment, and recording and practicing the activities – were helpful.

Q2. What aspects of the training did you find least helpful?

Analyst 1: A relatively large number of participants found nothing unhelpful. Quite a few, however, did complain about having to physically write items down. A small number of people didn’t like the act of activity-recording in general. Regarding the tasks in this condition, a few people found the 3 positive interactions activity unhelpful. A few others, had difficulty with the kind acts task for multiple reasons. There was a theme of lack of improvement through the study, expressed by several people who felt the tasks were no different from their behavior prior to the study, could not get into a routine, or did not feel the experiment helped their mood or social connections long-term. Finally, a few people felt the survey was not helpful.

Analyst 2: Many participants found each component of the intervention helpful. Some participants did not find the kind acts helpful in improving social connections or felt self-congratulatory when recording them, while others found that recording three good things did not change mood or behavior for long. Many participants did not find writing their activities each day helpful, and some suggested incorporating this recording into the app. A few participants were negative about the survey, and others felt that the intervention generally did not do much to change their behavior or social connections.

Q3. What, if anything, about the training was confusing?

Analyst 1: The vast majority of participants found nothing confusing. A few people experienced confusion with the study’s wording or structure, particularly when it clashed with participants’ personal circumstances.

Analyst 2: The vast majority of participants did not find the intervention confusing. A few participants had trouble distinguishing between different components of the intervention. A few participants also had individual circumstances that made the strategies more difficult to carry out or some of the questions difficult to answer.

Q4. How could we improve the training?

Analyst 1: A large portion of participants felt nothing needed improvement in the study. A few people suggested giving more clear descriptions and purposes of the assignments. Several others had difficulty filling out the daily question; a helpful change would be to allow later/different deadlines for answering the daily questions, to give time to include everything in the day. A substantial number of participants also implied a need for more accountability, which could be achieved in multiple ways: a few people suggested more monitoring of participants' logging by the experimenter, a few requested more specific goal-setting, and a couple others recommended more frequent/clear app reminders to improve accountability. Finally, a couple of people suggested improvements in the app's design.

Analyst 2: Participants in this condition had a wide variety of suggestions for the intervention. A few participants mentioned improvements to the content of the activities, like giving more examples of kind acts and reflecting on three good things. In terms of the structure of the intervention, several participants mentioned adding more listing and logging of activities, that having more reminders would be helpful, and that the app could be improved. Others felt that the survey could be improved by being less vague and more streamlined. Finally, several participants suggested extending the deadline for the daily report, because having the app close at 11 pm made it difficult for them to get their responses in on time.