5-2016

A Preliminary Investigation of Positive Imagery Training to Reduce Risk for Suicidal Behavior Among Adolescent Girls

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A Preliminary Investigation of Positive Imagery Training to Reduce Risk for Suicidal Behavior Among Adolescent Girls

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Psychology

by

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University of Arkansas
Bachelor of Arts in Psychology, 2012
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May 2016
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Abstract

Suicide is the second leading cause of death among adolescents, with risk for suicidal thoughts and suicidal behavior emerging during adolescence particularly among girls. Consistent with theory and empirical evidence, the current study examined the effects of socially-focused positive imagery training among a small sample of adolescent girls evidencing suicidal thoughts. This preliminary small *n* design also allowed for a detailed assessment of acceptability of imagery training for the adolescent sample. Risk for suicidal intent was indexed by 1) negative affect, 2) positive affect, 3) greater resting right (relative to left) prefrontal asymmetry, 4) perceived social isolation, and 5) suicidal ideation. Although the training was generally perceived as acceptable, results suggested minimal to no changes in the primary outcome variables between baseline and intervention phases. Indeed, no clear pattern regarding intervention effects was observed. Findings are discussed in terms of the strengths and challenges of this small *n* study as a first step for better understanding and offsetting adolescent risk for suicidal intent.

Acknowledgments

I want to thank my mentors, Drs. Ellen Leen-Feldner and Matthew Feldner, for their guidance and continued support. In addition, I want to thank Drs. Ana Bridges and Nate Parks for support throughout this project. I also extend my appreciation to Matt Gannon and the research assistants who assisted in this project, as well as the participants who made this project possible. Finally, I would like to give a special thank you to my brothers, Gabriel and Rodrigo, parents, Luz and Guillermo, and Liviu Bunaciu, Patricia McClurg and Marco Molina for additional mentorship and for inspiring me in their own unique way.

Dedication

I dedicate this project to my mother, Luz Rojas, the strongest and most kindhearted woman I have ever known.

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I. Introduction.

Adolescents evidence elevated risk for suicidal ideation and suicide attempts (Nock et al., 2013). In fact, suicide is the second leading cause of death among adolescents in the United States (Centers for Disease Control and Prevention, 2011), with up to 8% of youth reporting having attempted suicide at least once in the past year (Kann et al., 2014; Nock et al., 2008). This is noteworthy given the substantial literature documenting a prior suicide attempt as a robust predictor of future suicidal behavior and suicide among adolescents specifically (Bridge, Goldstein, & Brent, 2006; Miranda, De Jaegere, Restifo, & Shaffer, 2014; Prinstein et al., 2008). The transition from early to mid-adolescence is a high-risk period for adolescents in terms of endorsing suicidal behaviors (Kovacs, Goldston, & Gatsonis, 1993). In particular, girls evidence high risk for suicidal ideation (22.4%) and suicide attempts (10.6%) as compared to boys (11.6%, 5.4%, respectively; Kann et al., 2014). These rates are alarming given suicidal behavior during adolescence is associated with higher risk for negative mental health outcomes in adulthood (e.g., increased likelihood of major depressive episodes, anxiety disorders, and continued suicidal behavior; Goldman-Mellor et al., 2014; Herba, Ferdinand, Ende, & Verhulst, 2007; Reinherz, Tanner, Berger, Beardslee, & Fitzmaurice, 2006). Therefore, research aimed at advancing our understanding of how to reduce risk for suicidal behavior among female adolescents is an urgent public health priority.

A. Definitions Related to Suicide

To advance the field of suicidology and suicide prevention, standardized definitions and a clear nomenclature of suicide is fundamental, as underscored within the Prioritized Research Agenda for Suicide Prevention (National Action Alliance for Suicide Prevention, 2014) and emphasized for over a decade (Beck et al., 1972; O'Carroll et al., 1996; Silvermann et al., 2007).

More recently, the Self-Directed Violence Classification System (SDVCS), developed in collaboration with the Centers for Disease Control and Prevention (CDC) and the Veterans Integrated Service Network 19 Mental Illness, Research, Education, and Clinical Center (VISN 19 MIRECC; Crosby, Ortega, Melanson, 2011), encourages uniform definitions to improve communication efforts specific to non-suicidal and suicidal behavior. The SDVCS separates thoughts and behaviors into non-suicidal terms (non-suicidal thoughts or non-suicidal self-directed violence) and terms involving some degree of suicidal intent (suicidal thoughts or suicidal self-directed violence).

The SDVCS defines self-directed violence as behavior that deliberately results in injury or the potential for injury to oneself (Crosby et al., 2011). Accordingly, suicidal intent must involve implicit or explicit desire for death, means to act on this desire, and an understanding of the possible consequence of action. The term suicide attempt refers to non-fatal, self-initiated behavior with the potential for injury along with intent to die, whereas suicide refers to cases in which suicide attempts result in death (Van Orden et al., 2010). Risk factors for suicidal self-directed violence are factors associated with an increased likelihood of engaging in a suicide attempt (Kazdin, Kraemer, Kessler, Kupfer, & Offord, 1997; Van Orden et al., 2010). Consistent with this nomenclature, suicidal ideation 1) involving intent 2) in the absence of intent are both considered a risk factor for suicide attempts, while suicidal ideation in the absence of intent may be considered a risk factor for suicidal intent.

B. Suicide-Focused Intervention Strategies for Adolescents

In light of evidence suggesting adolescents are at high risk for suicide, national efforts prioritize reducing risk for adolescent suicide (United States Department of Health and Human Services, 2001), resulting in research on screening for suicidal ideation (Gould, Greenberg, Velting, & Shaffer, 2003) and a variety of psychotherapeutic interventions (Rathus & Miller, 2002; Spirito, Esposito-Smythers, Wolff, & Uhl, 2011). Unfortunately, few interventions thus far have demonstrated efficacy in reducing suicide (Macgowan, 2004; Van Orden et al., 2010). Screening strategies typically occur in the context of prevention programs within schools or clinical health settings and often result in psychopharmacological intervention (Ballard, Stanley, Horowitz, Cannon, & Bridge, 2013; Gould et al., 2003; Wintersteen, 2010). However, while psychopharmacological treatment for suicidal youth can decrease risk for suicide among some youth (Gibbons, Hur, Bhaumik, & Mann, 2006), it can also increase risk among others (Leon, Marzuk, Tardiff, & Teres, 2004; Mann et al., 2006).

To date, there is no gold standard psychotherapeutic intervention for adolescent suicide risk, although cognitive behavioral techniques are promising (Spirito et al., 2011; Tarrier, Taylor, & Gooding, 2008). A recent large scale open-trial suggests psychotherapy as efficacious in reducing suicide risk among recent adolescent suicide attempters compared to interventions that include pharmacotherapy, although more research is needed to increase confidence in such inferences (Grant et al., 2009). A modified version of cognitive behavioral therapy targets suicidal behavior among youth (CBT-SP-A; Stanely et al., 2009). However, to date, there is not one randomized controlled trial (RCT) for CBT-SP-A. Moreover, adapted from standard dialectical Behavior Therapy (DBT) protocol, there is dialectical behavior therapy for suicidal adolescents (DBT-A; Miller et al., 2006). DBT-A is the only treatment specific to reducing suicide risk among adolescents evaluated and supported by a RCT (Mehlum et al., 2014). Preliminary support for psychotherapy delivered within a family-based context evidences reduction in suicidal outcomes, such as attachment-based family therapy (ABFT; Diamond et al., 2010) and multisystemic therapy (MST; Huey et al., 2004). Although there is some empirical evidence that cognitive behavioral treatments reduce suicidal outcomes, there is limited evidence for cognitive behavioral treatments delivered to adolescents specifically (Brown & Jager-Hyman, 2014; Tarrier et al., 2008). These data clearly highlight the need for additional research on interventions to reduce adolescent suicide risk.

C. Five Specific Domains of Risk for Suicidal Intent among Female Adolescents

Substantial evidence suggests the presence of multiple risk factors for suicidal thoughts and behavior among adolescents (Beautrais, 2000; Esposito-Symthers, Weismoore, Zimmermann, & Spirito, 2014). Suicidal ideation, high negative affect, low positive affect, resting right (relative to left) prefrontal cortex activity, and perceived social isolation are all risk factors for suicidal intent that are particularly relevant to adolescent girls.

Suicidal Ideation

Suicidal ideation is a robust predictor for future suicidal intent among girls specifically (King, Jiang, Czyz, & Kerr, 2014; Lewinsohn, Rohde, & Seeley, Baldwin, 2000). Suicidal ideation is common among adolescent girls, although adolescent boys are more likely to die by suicide (Bridge et al., 2006). Up to 70% of adolescents report thoughts about suicide, suggesting some aspects of suicidal ideation may be relatively normative (Kimmel & Weiner, 1995; Marcenko, Fishman, & Friedman, 1999; Smith & Crawford, 1986; Stoep, McCauley, Flynn, & Stone, 2009). Suicidal ideation varies in degree of severity. Specifically, active ideation with intent is defined as desire to make a suicide attempt to end one's life (Posner, Brodsky, Yershova, Buchnan, & Mann 2014), whereas passive ideation includes a desire rather than a plan (e.g., a wish to die; Beck, Kovacs, Weissman; 1979; Posner et al., 2011). The presence of even passive suicidal thoughts indicates risk for suicide attempts (Baca-Garcia et al., 2011; Brown, Beck, Steer, & Grisham, 2000). Correspondingly, targeting the significant group of adolescents who endorse suicidal thoughts, but do not meet criteria for *active* suicidal ideation with *intent* and a *specific plan,* has potential for preventing escalation from risk for suicidal intent to suicidal directed violence.

High Negative Affect

Negative affect is a risk factor for suicidal ideation and suicide attempts (Selby, Yen, & Spirito, 2013; Stein, Apter, Ratzoni, Har-Even, & Avidan, 1998). Hostility and anger, for example, are correlated with risk for suicidal intent among adolescents (Spirto and Esposito-Smythers, 2006; Zhang et al., 2012). Mental health disorders characterized by dysregulated negative affect are also clearly established risk factors for suicidal thoughts and behavior (Van Orden et al., 2010). Adolescence is a period characterized by an increased vulnerability for depression (Birmaher et al., 1996; Emslie, Mayes, & Ruberu, 2005; Hankin et al., 1998) and a relative deficit in recovering from emotional distress, which has been linked to suicide risk (Pisani et al., 2013). For example, depression and anhedonia (a core feature of depression; Watson, 2005) have both been linked to suicidal thoughts and behavior among children and adolescents (Brent et al., 1993; Nock & Kazdin, 2002). Adolescents are thought to experience higher rates of anhedonia compared to children (Ryan et al., 1987), suggesting this may be a critical component of depression to mitigate among suicidal adolescents.

Low Positive Affect

The degree to which adolescents experience positive affect is distinct from the degree to which negative affect is experienced (Jones, Leen-Feldner, Olatunji, Readon, & Hawks, 2009). Fredrickson's (2001) broaden-and-build theory of positive emotions suggests positive emotions serve as markers of optimal well-being, while the lack of positive emotions can result in cognitive inflexibility. Broadly, positive affect increases life satisfaction and serves as a buffer against negative affect, thereby increasing resilience to stressors (Cohn et al., 2009; Fredrickson, 2001; Fredrickson & Joiner, 2002; Fredrickson, Mancuso, Branigan, & Tugade, 2000). In fact, positive affectivity is uniquely associated with risk for suicide relative to negative affect intensity among adolescents seeking treatment for mental health problems (Rojas, Leen-Feldner, Blumenthal, Lewis, & Feldner, 2015). Therefore low positive affect also emerges as a possible risk factor for suicidal intent among adolescents.

Resting Right (Relative to Left) Prefrontal Cortical Activity

The leading theoretical foundation used to explain differences in EEG prefrontal asymmetry is the approach-withdrawal motivational model (Coan & Allen, 2004; Nusslock, Walden, & Harmon-Jones, 2015). In line with this theory, relative hyperactivity of the right prefrontal cortex is thought to reflect a disposition away from approach-oriented behaviors (Berkman & Lieberman, 2010; Davidson, 1998; Kemp et al., 2010; Thibodeau, Jergensen, & Kim, 2006). Recently, relative dominance of the right prefrontal cortex region (i.e., smaller EEG prefrontal asymmetry scores) has been linked to over-active down regulation of positive affect, suggesting people characterized by relative over-activity of the right versus left prefrontal cortex at rest may have difficulty experiencing and maintaining positive affect (Light et al., 2011). Of particular importance to the current study, is a study among Hispanic adolescent suicide attempters and non-attempters (Graee et al., 1998). Specifically, non-attempters demonstrated greater resting left hemisphere activation, consistent with normative adult data (Tomarken, Davidson, Wheeler, & Doss, 1992). However, attempters did not demonstrate elevated left asymmetry, suggesting comparably greater right relative to left prefrontal activity at rest compared to non-attempters. Moreover, relatively less activation in the left hemisphere was significantly associated with increased lethality of the suicide attempt (Graee et al., 1998). These results suggest an intervention aiming to decrease resting cortical activity of right relative to left hemispheric regions has potential to reduce risk for suicidal thoughts and behavior among adolescent girls.

Perceived Social Isolation

Social isolation, resulting from a disruption or absence of interpersonal contacts (Trout, 1980), is manifested in various forms (e.g., solitary lifestyle). Perceived social isolation is defined as a shortfall in one's social resources resulting in subjective feelings of lack of social belongingness or support (Cornwell & Waite, 2009; Hawkley & Cacioppo, 2003). Importantly, perceived social isolation is a subjective perspective that assumes an emotional state of pain (Eisenberger, 2012; Laursen & Hartl, 2013; Weiss, 1973). Such an unmet need to belong, often referred to in the suicide literature as "thwarted belongingness," has long been implicated in risk for suicide (Baumeister & Leary, 1995; Leary, Terdal, Tambor, & Downs, 1995; Van Orden et al., 2012). Empirical and theoretical work has linked social isolation (or disruptions in belongingness) to increased suicide risk (Joiner, 2005; Van Orden et al., 2008). In fact, social isolation (including, for example, loneliness, having few social supports, and living in non-intact families) is one of the most robust predictors of suicidal thoughts and behavior (Van Orden et al., 2010). Research with adolescents specifically has linked social isolation to suicidal ideation and suicide attempts. For example, the absence of trusted adults living at home has been linked to past-year suicide attempts among adolescents above and beyond depressive symptoms and demographic factors (Pisani et al., 2013). Moreover, social and family-related factors increase risk for suicidal thoughts and behavior among adolescent girls, specifically (Kerr, Preuss, & King, 2006). Adolescent girls, but not boys, expressed greater levels of hopelessness, depressive symptoms, and suicidal ideation as related to perceived low parental support (Kerr et al., 2006).

These findings suggest perceived isolation may be an important factor in the development of suicidal intent among adolescent girls.

D. Socially-Focused Positive Imagery Training To Reduce Risk for Suicidal Intent

Socially-focused positive imagery intervention may be especially promising to reduce risk for suicidal intent among adolescent girls. Positively-valenced mental imagery as a way to elicit positive affect reduces negative affect among youth (Cornwall, Spence, & Schotte, 1996; Holmes, Mathews, Dalgleish, & Mackintosh, 2006; Muris, Huijding, Mayer, van As, & van Alem, 2011), and even increases positive affect among individuals experiencing dysphoria (Pictet, Coughtrey, Mathews, & Holmes, 2011). Importantly, a mental imagery intervention with adults designed to elicit positive emotions through the recall of past positive events showed positive effects for reducing hopelessness, sadness, and defeat (Panagioti, Gooding, & Tarrier, 2012). This is particularly important because feelings of hopelessness, defeat, and sadness are risk factors for suicidal behavior among adults and younger populations (Kuo, Gallo, & Eaton, 2004; Taylor, Gooding, Wood, & Tarrier, 2011; Thompson et al., 2011). Unfortunately, no research to date has examined the effects of positive imagery on suicide risk among adolescent girls.

Interventions designed to increase approach of positive affect-inducing activities (conceptually akin to a positive imagery intervention) among adults reduce activity in right prefrontal cortex regions during cognitive control tasks within experimentally induced sad contexts, highlighting that non-pharmacological interventions can reduce neurobiological abnormalities linked to suicide (Dichter, Felder, & Smoski, 2010). Behavioral interventions also can alter prefrontal asymmetry. For example, feedback provided to participants regarding electroencephalography (EEG)-measured prefrontal activity modulates frontal asymmetry

(Allen, Harmon-Jones, & Cavender, 2001). In response to cognitive behavioral group therapy, individuals with social anxiety disorder evidence reductions in right prefrontal asymmetry at post-treatment following 12 weekly sessions (Moscovitch, et al., 2011). In fact, positive imagery training conducted with neurofeedback decreases frontal asymmetry among depressed adults (Young et al., 2014). These data in combination suggest an intervention targeting increased positive imagery can reduce risk for suicidal behavior by decreasing resting right (relative to left) prefrontal cortical activity.

In addition to the effects of an intervention focused on positive images related to family and social supports discussed above, multiple converging lines of evidence suggest such an intervention can reduce risk for suicidal intent among adolescent girls by decreasing perceptions of social isolation. Broadly, social rejection images increase hostility among emerging adults, particularly those who report placing high levels of importance on social approval (Craighead, Kimball, & Rehak, 1979; Goldfried & Sobocinski, 1975). Given links between hostility and suicide attempts (Mann, Waternaux, Haas, & Malone, 1999), these findings highlight the impact socially-focused imagery may have on risk for suicidal intent. In addition, both theoretical and empirical work indicates increasing positive affect (via positive imagery, for example) will decrease perceived isolation (Lawler & Yoon, 1996). For example, increases in positive emotions strongly predict perceived cohesion with a social group (Lawler, Thye, & Yoon, 2000). Importantly, developmental changes in the prefrontal cortex during the onset of puberty allow for improvement in social cognitive processing (Blakemore, 2014), suggesting socially focused positive imagery training may be optimal to decrease risk for suicidal intent among adolescents by decreasing perceived social isolation.

E. Integrated Summary and Current Study Aims

Training in a socially-focused positive imagery intervention has potential to reduce risk for suicidal intent among adolescent girls by (1) decreasing suicidal ideation, (2) decreasing negative affect, (3) increasing positive affect, (4) reducing resting right (relative to left) prefrontal cortex activity, and (5) decreasing perceived social isolation. As such, examining a positive imagery-based intervention is timely, novel, and has significant potential to impact this area of public health priority. Accordingly, the current study aimed to examine the effects of socially-focused positive imagery training, followed by one week of structured practice in the technique, among a sample of six adolescent girls endorsing current suicidal ideation (without suicidal intent). It was hypothesized that following one week of positive imagery training, participants would evidence: a) reduced negative affect; b) increased positive affect; c) increased EEG prefrontal asymmetry scores (i.e., decreased resting right (relative to left) prefrontal cortical activity); d) decreased perceived social isolation; and e) decreased suicidal ideation. Importantly, in addition to aiming to reduce risk for suicidal intent among an adolescent sample, the current project allowed for careful monitoring of participant safety and provided preliminary data regarding intervention acceptability to inform future studies in the area. This initial step in intervention development is consistent with staged approaches to intervention development (Onken, Carroll, Shoham, Cuthbert, & Riddle, 2014).

II. Method

A. Participants

Participants were adolescent girls recruited from the local community. Participants were included in the study if they met inclusion criteria. Specifically, inclusion criteria first required all girls to be between the ages of 10 and 17 years. Of note, the prevalence of lifetime suicidal ideation among children of younger than 10 years of age is very low (< 1%; Nock et al., 2013). Additionally, this age span centers on the normative increase in depressive affect observed among adolescent girls (i.e., 13 to 15 years; Holsen, Kraft, & Vittersø, 2000). Furthermore, early adolescence is an essential developmental period for needed improvement in emotion regulation specific to social affective stimuli (Silvers et al., 2012). Second, only girls who endorsed suicidal ideation in the absence of intent to act on these thoughts and a specific plan of action for these thoughts, defined as a score of 1 to 3 on the Columbia Suicide Severity Rating Scale (C-SSRS; Posner et al., 2008) were enrolled to the study. In terms of exclusionary criteria, girls who reported (1) a lifetime suicide attempt history, (2) past month scores ≥ 4 on the C-SSRS, (3) receiving, or planning to initiate psychological or psychopharmacological treatment during the course of the study, (4) current, or histories of, psychosis, or (5) history of traumatic head injury leading to loss of consciousness were excluded from the study. Finally, adolescent girls were excluded based on inability to provide informed, written parent consent or adolescent assent.

Due to exclusion criteria presented in the phone screener, 62 girls were excluded from the study upon calling the laboratory. Moreover, 9 adolescent girls were excluded after presenting to the laboratory and completing the baseline assessment to determine eligibility. Girls were excluded due to an absence of suicidal ideation in the past month. A total of six adolescent girls between the ages of 14 and 17 years (M_{age} =15.50, *SD* = .67) were included in the study. Three participants reported a family annual income of less than $20,000. All participants reported years of education ranging from 9th to 12th grade. Two participants were enrolled in 9th grade, one in 10th grade, two in 11th grade, and one in 12th grade. The majority (*n* = 4) of the sample identified as White, while participant A identified as Hawaiian/ Native Islander, and participant B identified as American Indian/Alaska Native. All participants met criteria for a variety of lifetime mental health disorders (e.g., history of major depressive episodes, bulimia nervosa, enuresis, posttraumatic stress disorder).

B. Design Overview

Several carefully considered design decisions were made to yield an optimal balance of internal and external validity. Importantly, human subject considerations were prioritized throughout the decision-making process. A non-concurrent, multiple baseline design was used to allow for close monitoring of all study participants as well as careful evaluation of change across participants in relation to being trained in the socially-focused positive imagery intervention above and beyond effects due to the mere passage of time. The non-concurrent multiple baseline design (Watson & Workman, 1981) allowed for successive participants to be randomly assigned to predetermined baseline lengths as adolescent girls become available and enrolled into the study. Specifically, girls who reported suicidal ideation (without a specific suicidal plan or suicidal intent) were randomly assigned to a predetermined baseline assessment phase ranging from three to five assessment points (at one assessment per day).

C. Measures

<u>Baseline Assessment: History of Suicidal Thoughts and Behaviors</u>

The Columbia-Suicide Severity Rating Scale (C-SSRS; Posner et al., 2008) was administered to index recent suicidal ideation and histories of suicidal ideation and behavior. Intensity of ideation was measured in regards to frequency, duration, controllability, deterrents, and reasons for suicidal ideation. Scores related to ideation ranged from 0 to 5: 1 = *desire to be dead;* 2 = *non-specific thoughts*; 3 = *thoughts include method without specific plans*; 4 = *thoughts with intent*; and 5 = *thoughts with plan and intent*. Previous work demonstrated the C-SSRS significantly predicted suicide attempts among adolescents (Gipson, Agarwala, Opperman, Horwitz, & King, 2014; Posner et al., 2011), suggesting adequate predictive validity. The C-SSRS also has demonstrated concurrent validity as evidenced by significant associations with other measures of adult and adolescent suicidal ideation, suggesting convergent validity (Posner et al., 2011). Divergent validity has also been determined adequate as illustrated by relatively small correlations with items from the Beck Depression Inventory (Beck, Steer, & Carbin, 1988) and the Montogomery-Asberg Depression Rating Scale (Davidson, Turnbull, Strickland, Miller, & Graves, 1986), which were developed to measure somatic symptoms and depression (Posner et al., 2011). Inter-rater reliability among clinically trained interviewers also is adequate (Brent et al., 2009; Kerr, Gibson, Leve, & DeGarmo, 2014). The C-SSRS Since Last Visit was also administered for day two and day three.

Baseline Assessment: Psychopathology

The Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version (K-SADS-PL) is a semi-structured diagnostic interview evidencing concurrent validity with other measures measuring child psychopathology, excellent inter-rater reliability, and test-retest reliability (Kaufman et al., 1997). The K-SADS was designed to index current and past episodes of psychopathology in children according to DSM-III-R and DSM-IV criteria (which was deemed optimal given no comparably validated measure for DSM-5). The K-SADS-PL was administered to identify current and past psychopathology among adolescents. Also, additional probes and objective criteria were provided to rate individual exclusionary diagnostics such as presence of current or a history of psychosis via the psychosis diagnostic screen.

Baseline Assessment: Demographics

Age, sex, race, ethnicity, years of education, and family income were indexed via a demographics questionnaire administered to adolescents.

<u>Baseline Assessment: Imagery Ability</u>

The 16-item Vividness of Visual Imagery Questionnaire (VVIQ-2; Marks, 1995) revised for use with adolescents (Mischel & Leen-Feldner, 2013) was used to measure differences in baseline ability to generate mental imagery (e.g., *think of a friend or family member that you see often. Do not think about the person who came to the lab with you today. Carefully think about the picture that comes to mind: 1) the exact shape of their face, head, shoulders, and body*). The VVIQ-2 measures individuals' ability to imagine images using a 5 (*No image at all, you only "know" that you are thinking of the object*) to 1 (*perfectly clear image, as vivid as normal vision*) scale, yielding a possible range of scores of 16 to 80.

<u>Intervention Safety and Acceptability</u>

Intervention acceptability was gauged via feasibility, fidelity, safety, and satisfaction consistent with recommendations (Onken et al., 2014) and intervention development work (e.g., Feldner, Smith, Monson, & Zvolensky, 2013; Feldner, Zvolensky, Babson, Leen-Feldner, & Schmidt, 2008). Feasibility was indexed via retention, defined as completing the entirety of the socially-focused positive imagery project (i.e., presence at all three laboratory sessions). Intervention fidelity was indexed via inter-rater reliability of the socially-focused positive images generated by the participant and primary researcher. All images were coded by an additional researcher to index the degree of agreement that images were socially-focused, positive, and included reference to senses, response, and meaning. To monitor fidelity across the intervention phase, participant completion of daily positive imagery practice was indexed by time-stamped audiotaped recordings of the practice and time-stamped voicemails participants left on a secure, password protected voicemail system upon completing the imagery practice and assigned questionnaires each day. Safety of the intervention was indexed with a series of questions focused on any potential iatrogenic effects of the imagery procedure (e.g., "Did you notice any negative effects of the imagery procedure?"). The Client Satisfaction Questionnaire-8 (CSQ; Larsen et al., 1979) was used to measure adolescents' satisfaction with the positive imagery training and parent satisfaction with their adolescents' intervention practice. The CSQ included 8 questions (e.g., How satisfied are you with the amount of help you have received?). Participants respond to each question using a 4-point rating scale [1 (*Quite dissatisfied*) to 4 (*Very satisfied*)]. This measure demonstrates adequate psychometric properties, including reliability (coefficient alphas between .78 and .94), construct validity (e.g., correlation with program completion), and internal reliability (Attkisson & Greenfield, 1999; Attkisson & Zwick, 1982; Copeland, Koeske, & Greeno, 2004; Freed et al., 1998).

Rating of Positively Valenced Images

Valence of images was defined as receiving a rating of ≥ 8 on the valence scale of pleasure of the Self-Assessment Manikin (SAM; Lang, 1980). The SAM is a non-verbal pictorial assessment that has been validated and employed with children and adolescents (Greenbaum, Turner, Cook, & Melamed, 1990; Leen-Feldner, Zvolensky, & Feldner, 2004; McCormick, Leen-Feldner, & Zvolensky, 2003). Factor analytic research suggests that the SAM measures two fundamental dimensions of affective responding – hedonic valence and arousal (Lang, 1984). Specifically, SAM ratings are made over or between five figures depicting varying degrees of valence and arousal from negative to positive and no arousal to highly arousing, respectively, yielding a range of 0 to 9 (Lang, Bradley, & Cuthbert, 1990). Participants completed SAM pleasure ratings for each image developed for the imagery procedure.

Repeated Measures: Dependent Variables

A developmentally-appropriate, multi-modal assessment for measuring risk for suicidal behavior with well-established psychometrics was administered at the pre-intervention baseline phase, intervention phase, and post-intervention phase.

Suicidal Ideation

The 21-item Beck Scale for Suicide Ideation (BSS; Beck, Steer, & Ranieri, 1988) was used to measure suicidal ideation, rather than the C-SSRS, given it is a continuous measure of current suicidal thoughts (Beck & Steer, 1991) and is sensitive to change (Rathus & Miller, 2002). The BSS includes 21 items rated on a three-point scale (0 to 2), with higher scores yielding greater suicidal intensity. The BSS evidences good psychometric properties for use with adolescents, as evidenced by adequate construct validity (e.g., BSS significantly correlates with depression and hopelessness measures; Kumar & Steer, 1995; Rathus & Miller, 2002; Steer, Kumar, & Beck, 1993).

State Positive and Negative Affect

The state version of the Positive and Negative Affect Schedule for Children (PANAS-C; Laurent et al., 1999) was used to measure state positive and negative affect. The positive and negative affect scales include 27 descriptors of participant ratings on a 5-point scale (1 = *very slightly* to 5 = *extremely*) the degree to which a descriptor represents how they currently feel (positive affect = 12 items with a possible subtotal score range from 12-60; negative affect = 15 items with a possible subtotal score range from 15-75). The PANAS-C demonstrates good internal consistency as well as discriminant and convergent validity, as evidenced by significant correlations with depression and anxiety measures (Hughes & Kendall, 2009; Laurent et al., 1999).

Perceived Social Isolation

The Belongingness subscale of the Interpersonal Needs Questionnaire (INQ-BS; Van Orden et al., 2012) is comprised of nine items and was used to measure perceived social isolation on a 7-point scale. Specifically, higher scores suggest greater levels of thwarted belongingness (e.g., "These days, I rarely interact with people who care about me" (reversed score); "These days I am close to other people"). The INQ has established psychometrics, including convergent validity for the INQ-BS (e.g., correlations with the UCLA Loneliness Scale) and good internal consistency (Chronbach's α = .85; Van Orden et al., 2012). Moreover, the INQ has been used with adolescents (Hurtado Alvarado, 2013).

Resting Prefrontal Electrophysiological Recordings

Resting right prefrontal asymmetry was measured consistent with previously established procedures (e.g., Coan & Allen, 2003; Stewart, Bismark, Towers, Coan, & Allen, 2010). Participants were outfitted with passive recording Ag/AgCl electrodes for electroencephalogram (EEG) recordings for an assessment of neural activity at rest with eyes opened and closed (Allen, Coan, & Nazarian, 2004). Electrodes were positioned across the scalp using a Lycra stretch cap with tin electrodes pre-positioned in the international 10/20 montage customized for use with adolescents according to standard 10-20 positions (Jasper, 1958). Figure 1 depicts the international 10/20 system used to position electrodes to measure cortical activity in frontal regions.

D. Procedure

All study procedures were approved by the University of Arkansas Institutional Review Board. Participants were initially screened via phone to ensure potential eligibility and to determine interest in completing a more comprehensive eligibility assessment at the University of Arkansas. Participants came to the laboratory for three visits. During the first visit, participants completed a laboratory-based multi-modal assessment of risk for suicidal intent at baseline, which included the C-SSRS and the K-SADS-PL. Upon presenting to the laboratory, girls first provided written informed assent and parental written informed consent was also obtained at this time. Baseline assessment determined eligibility and ineligible girls were compensated $10 and debriefed. At the next visit, all girls were trained in socially-focused positive imagery and provided with an individualized imagery rehearsal plan for the following seven days. Finally, all participants returned to the laboratory to complete a laboratory-based post-intervention assessment.

Resting Frontal Electrophysiology Acquisition and Processing

Participants completed two EEG recording sessions in a dimly lit room to avoid distractions. The first recording was completed during the second visit as the pre-intervention recording. The follow-up recording was completed a week following daily socially-focused positive imagery training. Participants were randomly assigned to one of two counterbalanced ordered (C-O-O-C-O-C-C-O, O-C-C-O-C-O-O-C) eyes-open (O) and eyes-closed (C) 1-minute blocks of resting cortical activity. All recordings were made while participants were in a relaxed state for 8 minutes. This method was chosen given support suggesting excellent internal consistency reliability for 8 minute recording periods of raw EEG data (Allen et al. 2004; Meyer et al., 2015) and is consistent with previous work on resting prefrontal asymmetry (e.g., Coan & Allen, 2003; Nusslock et al., 2011; Stewart et al., 2010; Stewart, Coan, Towers, & Allen, 2014).

EEG recordings were from mid-frontal (F3/F4), lateral frontal (F7/F8), central (C3/C4), posterior temporal (T7/T8), parietal (P3/P4), occipital (O1/O2) scalp regions, and linked mastoids references (A1 + A2). Regional EEG recordings were performed using a BIOPAC

MP150 Data Acquisition System (BIOPAC Systems, Inc.) and EEG100C amplifiers with a gain of 500. AcqKnowledge 4 software was used for data acquisition. All impedance values were maintained below 5 kΩ for each recording site. Electrooculogram (EOG) data were concurrently collected (using standard superior and inferior orbit of the left eye and outer canthi electrode placements) for data noise reduction (e.g., Stewart et al., 2010). EOG recordings involved the placement of electrodes on the subject's skin around the eye. Specifically, electrodes were placed 1 cm above and below the left eye to measure vertical eye movements and 1 cm on the outer edge of each eye to measure horizontal eye movements. These electrodes record passively and are for the sole purpose of recording the subject's bioelectric activity.

All electrode sites were gently abraded and filled with electrolyte gel for signal transduction. Following the placement of EEG/EOG electrodes, participants were instructed to listen for a computerized voice that instructing "open" or "close" to inform participants to close or open their eyes at the beginning of the different trials (i.e., 4 eyes open and 4 eyes closed blocks). Participants were instructed to fixate on a dot presented on a computer monitor during the eyes open blocks. For the closed eyes blocks participants were asked to rest quietly with their eyes closed. Participants were also asked to minimize eye blinks and movements.

Recordings were sampled at 500 Hz onto a computer where data were re-referenced offline to an average scalp reference. A band-pass filter (0.1 to 35 HZ) was then applied. Processing of raw EEG data was completed using Brain Vision Analyzer 2.0 software (Brain Products). Before data processing, ocular correction was manually applied and artifacts removed. Each ocular artifact-free 1-min EEG block was divided into 2-s epochs with 1.5-s overlap and transformed to raw power scores via Fast Fourier Transformation (FFT) using a Hamming window over the distal of 10% of each 1-min block. Power natural log scores were computed in the alpha frequency band between 7.81 and 13.18 Hz averaged across .488-Hz bins. To provide an average spectrum for pre-intervention and post-intervention sessions, the power spectra obtained from all artifact free epochs across all 8 minutes for each trial were averaged. After segmentation, an artifact correction module was used to remove epochs with movement and muscle artifacts, yielding removal of an additional 18% of epochs at pre-intervention and 13% of epochs at post-intervention. Total artifact-free epochs at pre-intervention (*M* = 490.60 *SD* = 85.35) and post-intervention (*M* = 505.75 *SD* = 132.42) were available for computation of prefrontal EEG asymmetry scores. To interpret mean power for each electrode site at pre and post intervention, power was scaled appropriately (μV^2).

<u>Image Generation, Development, and Imagery Training</u>

Following baseline assessment, 7 socially-focused images rated as positively valenced were developed for participants' daily practice. Images included more than one person engaged in a positive mutual exchange, while the participants' self was salient (Crisp & Turner, 2009). The researcher worked with participants to develop the images to maximize the degree to which each positive image elicited positive affect. Each image included 1) stimulus propositions: information about external context (e.g., time of day, description of social partners involved, and the senses engaged), 2) response propositions: information about cognitive, physiological, and behavioral responses elicited by the context (e.g., feeling happy, laughing), and 3) meaning propositions: relations derived from the stimulus and response elements (e.g., It's nice to have close friends, I feel welcomed when with my family). Research has demonstrated that emphasizing response propositions increases the effects of imagery procedures (e.g., Bakker, Boschker, & Chung, 1996) and training participants to focus on their active responses in the imagery scene (e.g., behavioral responses such as smiling) increases synchrony between self-report and physiological reactions to ideographic images (e.g., Lang et al., 1980). Accordingly, participants were instructed to elaborate on these propositions for written descriptions of the event and were provided with a checklist to mark which propositions were met during practice of socially focused positive imagery training for each daily recording.

To maximize practice, participants completed a semi-standardized 30-min imagery training protocol. Participants were taught to first prepare for the imagery practice session by creating a relaxing environment in which to practice (e.g., limit interruptions). Second, participants were instructed to imagine the practice image as vividly as possible, including integration of all of the sensory and response details identified in the image development procedures. Third, participants were instructed to focus on the affect experienced during the situation being imagined. Finally, participants were instructed to focus on the aspects of the situation that elicited positive affect (e.g., enjoying an outing with mother led to me feeling happy and supported).

Following the 30-min imagery training protocol, participants were instructed in methods for adhering to a daily practice schedule (Haynes et al., 2008). Specifically, participants were provided with information of effective communication of adherence importance (e.g., informed consent, necessity of adherence for intervention effects) and all exercises were labeled "practice sessions" as opposed to "homework" (Bowsworth, 2010; Cameron, 1996; Robiner, 2005; Vermeire, Hearnshaw, Van Royen, & Denekens, 2001). Moreover, participants were provided with step-by-step, clear, unambiguous instructions for practicing the imagery procedure for 7 days, which included scheduling a time to practice the procedure. Step-by-step, written instructions were also provided in the socially-focused positive imagery binder that participants took home. Participants were provided with an audio voice recorder and instructed to record each imagery practice session. Participants also were instructed to call the laboratory phone and leave a message on a password-protected secure voicemail system confirming (with a time stamp) the daily imagery practice and the assigned measures were completed. Additionally, participants and parents were asked to sign a daily monitoring log to document training was completed.

Pre-intervention Baseline Phase

After assessment and training procedures were completed, all participants were randomly assigned to a predetermined pre-intervention baseline length (i.e., 3, 4, or 5 days). During the pre-intervention baseline phase, participants were asked to complete the BSS, PANAS-C, and INQ-BS each day. Participants were instructed to complete these measures at a similar time every day for the duration of the pre-intervention phase. Following completion of the baseline phase, participants were instructed to begin the intervention phase.

Intervention Phase

As described above, all participants were provided with written instructions to adhere to the imagery practice schedule for seven days (after completion of the predetermined baseline phase). The intervention phase consisted of daily practice in socially-focused positive imagery and completion of the BSS, PANAS-C, and INQ-BS for a seven day period.

Post-Intervention Phase

After one week of daily practice using socially-focused imagery, participants returned to the laboratory for a full post-intervention assessment, which included completion of the socially-focused positive imagery training, C-SSRS, EEG assessment, assessment of the primary dependent variables (i.e., suicidal ideation, negative affect, positive affect, and perceived social isolation), CSQ, and open ended questions regarding safety.

Participant Remuneration and Debriefing

A weighted compensation schedule was employed as follows: $20 for completing the baseline assessment in day 1, $25 for imagery training, $5 for each day a call was made to confirm completion of the assigned measures during the baseline phase (i.e., three, four, or five days; total ranging from $15-$25) and $5 for each day a call was made to confirm completion of the imagery practice and assigned measures during the intervention phase (totaling up to $35), and $30 for the final assessment. Collectively, participants could receive up to $110 for completing the study protocol.

Participants and parents were fully debriefed and given the opportunity to have any questions pertaining to the research project addressed. Also, all participants (regardless of diagnosis or laboratory response) were provided with a hard copy packet of information aimed at facilitating understanding of both depression and suicidal behaviors, as well as a list of local referral sources.

E. Data Analytic Plan

A series of descriptive analyses related to the baseline, pre- and post-, and intervention acceptability data were conducted first, followed by a series of primary hypothesis tests. Descriptive data included demographic (e.g., SES, age) and other baseline characteristics (e.g., diagnoses indexed via the KSADS, imagery ability as indexed by the VVIQ-2). Descriptive statistics regarding feasibility (retention), fidelity (practice completion) and acceptability (CSQ scores) were also calculated. Any safety concerns identified via open-ended question were described.

Tau-U analyses (assuming an alpha level of $p < .05$) were conducted to examine change in suicidal ideation (measured by BSS), state positive and negative affect (measured by the

PANAS-C), and perceived social isolation (measured by INQ-BS) across baseline, intervention, and post-intervention phases. Tau-U analyses are advantageous in this context given a combined index of nonoverlapping data between phases (level) is possible with this approach. Also, this approach allows for examination of trend in data within and across phases and it is sensitive to length of a baseline period, which allows for management of assumptions regarding reliability and continuation of trends observed during baseline (Parker Vannest, Davis, & Sauber, 2011).

Finally, EEG resting prefrontal asymmetry was described at both the baseline assessment and the post-intervention assessment. EEG resting prefrontal asymmetry was measured at three right and left paired scalp regions (F2-F1; F4-F3; F8-F7). These regions are commonly used in the EEG prefrontal asymmetry literature (e.g., Cantisani et al., 2015). Activity in these scalp regions have been linked to depression, stress, and affect (Gollan et al., 2014; Meyer et al., 2015; Coan & Allen, 2004). EEG prefrontal asymmetry scores reflect a difference between natural log-transformed scores for right hemisphere and corresponding left hemisphere electrodes (i.e., F2-F1, F4-F3, F6-F5, and F8-F7). Higher prefrontal asymmetry scores represent less right asymmetry (i.e., less right cortical activity), while smaller scores represent greater right asymmetry. Considering the approach and avoidance hypothesis specific to EEG prefrontal asymmetry (Coan & Allen, 2003), greater scores represent greater activity specific to the approach motivation system (less right activity relative to left), while lower scores represent greater activity specific to the avoidance system (greater right activity relative to left).

III. Results

A. Descriptive Data

Current suicidal ideation scores ranged between 1 and 2 on the C-SSRS. Specifically, a score of 1 for current suicidal ideation, indicating a wish to be dead, was endorsed by four participants. Most severe lifetime suicidal ideation ranged between scores of 2 and 5 on the C-SSRS (*M* = 3; *SD* = 1.26). No participants reported a history of suicide attempts. Suicidal ideation since last visit was also assessed at the beginning of day two and day three; one participant reported a score of 1 on day two and a different participant reported a score of 1 on day three. Scores on the VVIQ-2, which was used to assess baseline ability to generate mental imagery, ranged between 22 and 42 (*M* = 28.83; *SD* = 7.73), indicating average imagery ability.

B. Intervention Acceptability

All participants were present for the entirety of the protocol, suggesting study feasibility was promising. Intervention fidelity was excellent as evidenced by 100% inter-rater agreement on the image's social focus, positive valance, and the inclusion of senses, meaning and response for each image generated by the participant and primary researcher. There were, however, limitations with respect to fidelity across the intervention phase specific to participants' practice of the imagery training. In addition to time-stamped voicemails signifying completion of study practice during the baseline and intervention phases, participants were required to provide time-stamped, audiotaped recordings of their practice during the intervention phase. Participant A was missing a time- stamped voicemail for baseline day three and an audiotape recording of practice for training days three and five. Participant D was missing a time-stamped voicemail and audiotaped recording of practice for training day three. Participant E was missing a time-stamped voicemail for baseline day two and training day three. Moreover, participant E was missing all audiotaped recordings. She also reported that she did not have time to complete the imagery training. Participant F was missing all audiotaped recordings; however, she reported completing imagery practice for all intervention days and provided time-stamped voicemails for each day. Adolescent client satisfaction (CSQ scores) was excellent ranging between 28 and 32 (*M* =

29.83; *SD* = 1.83). Only two parents (i.e., of A & F) filled out the CSQ and both scored a 30. Adolescent and parent satisfaction indicated high overall levels of intervention satisfaction. No safety concerns were reported during the debriefing of the study. Overall, participants reported positive experiences with the imagery procedure (e.g., “It can help someone turn from a gloomy mood to a joyful mood”; “It feels good to remember positive things about those around you”).

C. **Primary Variables Indexed by TAU-U**

Figure 2 provides a graphical representation of daily total scores on all repeated measures indexing risk for suicidal intent (i.e., BSS, PANAS-PA, PANAS-NA, and INQ-TB). Data for participant F were not subjected to TAU-U analyses due to failure to complete measures during the intervention phase. Assessment points for baseline phase varied by participants as a function of randomly assigned baseline phases. Participant A was assigned to a five day baseline phase, participant B, C and D were assigned to a three day baseline phase, and participant E was assigned to a four day baseline phase. Moreover, assessment points varied between participants due to missing data. Specifically, participant A failed to complete the INQ-TB for baseline day five. Participant B did not complete any measure at intervention day seven. Finally, participant D did not complete the BSS, PANAS-PA, PANAS-NA, and INQ-TB for intervention day three.

Table 1 first details BSS findings. Higher scores represent greater severity of suicidal ideation. Mean scores for participants at final assessment in the laboratory (*M* = 0.25) (*M* = 2.20) were lower than scores reported during baseline assessment in the laboratory (*M* = 2.20). Overall, there were minimal differences between baseline (*M* = 1.43; *SD* = 2.91; Range = 0 -11) and intervention phases (*M* = 0.93; *SD* = 2.65; Range = 0 -14). Participants A-E did not evidence significant improvements within or across baseline and intervention phases.

Positive affect, as indexed via the PANAS-PA, was comparable at final assessment point

(*M* = 40.50) as compared to baseline assessment in the laboratory (*M* = 39.60). Higher scores reflect greater levels of positive affect. PANAS-PA scores reported during the baseline phase (*M* = 37.17; *SD* = 12.04; range = 13-58) were slightly lower as compared to scores reported during the intervention phase (*M* = 39.06; *SD* = 10.50; range = 13-55). Participants A-E did not evidence significant improvements within or across baseline and intervention phases.

Negative affect scores, as indexed via the PANAS-NA, were higher at baseline (*M* = 26.60) as compared to the final assessment in the laboratory (*M* = 16.75). Higher scores represent greater levels of negative affect. Scores reported during the baseline phase (*M* = 21.08; *SD* = 6.42; range = 15-39) were higher as compared to scores reported during the intervention phase (*M* = 18.31; *SD* = 4.37; range = 15-37). Participants A, C, and D did not evidence significant improvements within or across baseline and intervention phases. Participant B, however, did evidence a significant trend demonstrating an increase in PANAS-NA scores, suggesting worsening during the intervention phase. Participant B, however, did not evidence significant worsening or improvements across the baseline and intervention phases after controlling for trends observed during the baseline phase. Participant E did not evidence any significant improvements within baseline and intervention phases. However, participant E did evidence significant improvements across the baseline and intervention phases after controlling for trends observed in the baseline phase.

Scores on the INQ-TB were used to measure perceived social isolation. Higher scores reflect higher levels of perceived social isolation. Mean scores reported during the laboratory baseline assessment (*M* = 25.00) were higher as compared to the scores collected during the laboratory final assessment (*M* = 21.00). Similarly, scores reported during the baseline phase (*M* = 22.64; *SD* = 11.13; range = 10-48) were higher as compared to scores reported during the intervention phase (*M* = 20.18; *SD* = 9.54; range = 9-48). Participants A, C, D did not evidence significant improvements within or across baseline and intervention phases. Participant B did not evidence significant improvements within the baseline phase. Participant B did however evidence significant improvement during the intervention phase. Further examination suggested there were significant improvement across the intervention phase as compared to the baseline phase after controlling for baseline trends. Participant E evidenced significant worsening during the intervention phase; however, after controlling for baseline trends, there were no significant worsening or improvements across the intervention phase as compared to the baseline phase.

D. EEG Resting Prefrontal Asymmetry

Table 2 outlines the means and standard deviations of alpha power at F1, F2, F3, F4, F7, and F8 at both pre-intervention and post-intervention assessment points. Participant A was removed from the EEG resting prefrontal asymmetry analysis due to a flatline observed for EOG channels, which did not allow for removal of ocular artifacts. Figure 3 provides a graphical depiction of EEG resting prefrontal asymmetry scores (i.e., F2-F1, F4-F3 & F8-F7) at pre-intervention and post-intervention for participants B-E. The small sample size limited our ability to run statistical analyses to evaluate any significant changes in EEG prefrontal asymmetry scores from pre-intervention to post-intervention.

Data collected at pre and post intervention did, however, make it possible to observe trends between assessment points across participants (Figure 3). In general, negative asymmetry scores indicate greater relative right cortical activity at resting state. Specifically, higher values for EEG resting prefrontal asymmetry scores reflect less relative right versus left prefrontal cortical activity at resting state. Participant B evidenced reduced resting right asymmetry for all regions (i.e., F2-F1, F4-F3, & F8-F7) at post-intervention as compared to pre-intervention, as indexed by larger EEG resting prefrontal asymmetry scores. Participant C evidenced reduced resting right asymmetry scores for region F4-F3, while also evidencing greater resting right resting asymmetry at regions measured via F2-F1 and F8-F7 at post-intervention as compared to pre-intervention. Participant D evidenced reduced resting right asymmetry scores for regions F2-F1 and F8-F7 and greater resting right asymmetry scores for F4-F3 at post-intervention as compared to pre-intervention. Participant E evidenced reduced resting right asymmetry scores at F2-F1 and greater resting right asymmetry scores for F4-F3 and F8-F7 at post-intervention as compared to pre intervention. Participant F evidenced reduced resting right asymmetry at F4-F3 and greater resting right asymmetry at regions measured via F2-F1 and F8-F7 at post-intervention as compared to pre intervention.

IV. Discussion

Suicide has been on the rise throughout the last decade in the United States (American Foundation for Suicide Prevention, 2013). In addition to potentially fatal outcomes, the impact of suicide attempts is remarkably large. Notwithstanding the emotional costs for the attempter, friends, and family, the economic burden alone is nearly $7 billion per year in lost wages, lost productivity, and direct medical care for those who have made suicide attempts (American Foundation for Suicide Prevention, 2013). In light of evidence highlighting the early risk for suicidal intent during adolescence (e.g., suicidal ideation; Kann et al., 2014; Stoep et al., 2009), the current study aimed to reduce risk for suicidal intent among a small sample of adolescent girls via a socially-focused positive imagery intervention. To understand the potential risks and benefits associated with this intervention, a non-concurrent multiple baseline design was employed. Taking into account multiple converging lines of evidence suggesting socially-focused positive imagery may reduce suicide risk (Holmes et al., 2006; Panagioti et al., 2012;

Young et al., 2014), it was hypothesized that data would provide preliminary evidence of intervention acceptability and, following one week of positive imagery training, girls would evidence reduced risk for suicidal intent across self-report and EEG prefrontal asymmetry measures.

A benefit of the current study's small *n* design is it allows for careful monitoring and evaluation of the acceptability of the intervention (e.g., feasibility, safety). Onken and colleagues (2014) recommend stage modeling for state-of-the-art development and evaluation of behavioral interventions. Consistent with these guidelines, small *n* studies allow for pilot testing to assess the intervention in terms of acceptability and refinement of intervention procedures (Onken et al., 2014). All enrolled participants were present for the entire protocol, which consisted of three laboratory visits within a time period ranging between 15 to 22 days, suggesting feasibility was promising. Fidelity across the intervention phase, however, varied and was questionable for participants E and F. Specifically, voice recordings were not provided by participants E and F and it is unclear if the imagery procedures were in fact completed. Participant E verbally reported she did not complete the imagery practice, while participant F reported completing all practice during the intervention phase. Safety was not a concern as suggested by participants' responses to open-ended questions regarding safety. In fact, the study was described as enjoyable, which was consistent with CSQ results. Moreover, the C-SSRS was used to measure suicide risk at each laboratory visit and there were no increases in suicidal ideation. In fact, only reductions in suicidal ideation, as measured by the C-SSRS, were observed in the last laboratory visit as compared to the first laboratory visit. Taken together, these findings provide preliminary evidence for acceptability. However, given the small sample size and indications that there may have been a negative impact of the intervention (as discussed in greater detail below) specific to negative affect (albeit limited in frequency and scope), additional research is needed and the current preliminary results should be interpreted cautiously. Future work utilizing a more comprehensive assessment of acceptability and safety (e.g., Bowen et al., 2009) may be necessary to evaluate the potential for successful and safe implementation of a socially-focused positive imagery training for adolescents at risk for suicidal intent.

A key variable used to measure risk for suicidal intent in the current study was level of suicidal ideation. Results suggested there were no significant changes in suicidal ideation. Suicidal ideation was nearly absent throughout the baseline and intervention phases. Thus, a floor effect may have precluded observing an intervention-related reduction in suicidal ideation. Such patterns, which are likely due to the low intensity of suicidal ideation reported, are consistent with previous research (King, Hill, Wynne, & Cunningham, 2012). Specifically, King and colleagues (2012) found no differences in self-report of suicidal ideation among at-risk adolescents who were notified they would receive an in-person follow up after their visit to the pediatric emergency department as compared to a adolescents informed they would receive a no-in person follow-up. As reported, this was likely due to the sample's preponderance of low/zero scores on the measure of suicidal ideation (King et al., 2012). Future work testing the effects of the intervention examined here would benefit from enrolling samples with higher levels of suicidal ideation. For example, the current study enrolled adolescent girls experiencing suicidal ideation ranging from a score of 1 to 3 on the C-SSRS. Future work may focus on a sample reporting active suicidal thoughts specific to killing oneself (scores of 2 to 4 on the C-SSRS) as opposed to thoughts only related to a wish to be dead or not waking up (score of 1 on the C-SSRS). However, any intervention work with adolescents experiencing severe suicidal ideation needs to carefully consider issues related to the protection of human subjects. Specifically, a rigorous addressing of ethical issues to ensure safety for the participants and researchers is warranted (King & Kramer, 2008; Lakeman & FitzGerald, 2009; Mishra & Weisstub, 2005). For example, investigators are responsible for informing participants about alternative available treatments and the limitations of treatment effectiveness (King & Kramer, 2008).

Negative affect was also measured as a risk factor for suicidal intent given its association with suicidal ideation (e.g., Selby et al., 2013). TAU-U results for participant B indicated worsening within the intervention phase. It is worth noting, however, that worsening during the intervention phase was not significant after controlling for the baseline phase. Any worsening is critical to consider for determining safety at this early stage of intervention development. Although worsening was observed during the intervention phase, participant B's PANAS-NA scores never surpassed the PANAS-NA scores reported during the first laboratory visit. Thus, there was no *overall* worsening for participant B. In contrast, participant E evidenced significant reductions in negative affect across the intervention phase after controlling for trends observed in the baseline phase. Participant E did, however, report that she was unable to complete the positive imagery training throughout the intervention phase. Therefore, her improvement is likely not the result of the socially-focused positive imagery intervention. Taken together, there was no evidence to suggest socially-focused positive imagery training reduced state levels of negative affect. An experimental design including a control group, random assignment, and a large enough sample to identify small effects would help to further understand the potential effects, or lack thereof, of socially-focused positive imagery training on decreasing negative affect.

Contrary to predictions, socially-focused positive imagery training did not appear to have significant effects on positive affect among this small *n* sample. Results suggested there were no significant changes in positive affect within or across baseline and intervention phases. Future work may benefit from enrolling more participants in a study to obtain a larger sample size that allows for observing relatively small effects. Future directions may also include laboratory studies aimed at understanding the effects of socially-focused positive imagery. Repeated measurement of affect in response to socially-focused positive imagery, in the controlled environment of the laboratory, would allow for greater control to measure changes in state positive affect.

Social interactions are particularly important during adolescence (Blakemore & Choudhury, 2006; Laursen & Collins, 2009) and the lack of positive social resources is underscored as a risk factor for suicidal intent (Mann et al., 1999; Miller et al., 2015; Van Orden et al., 2010). Participant E did evidence significant worsening during the intervention phase; however, worsening was not significant after baseline trend was controlled. Moreover, given participant E did not complete the imagery training, worsening is unlikely a result of the socially focused positive imagery training. Unfortunately, there were no significant reductions in perceived social isolation following positive imagery training for participants A, C, and D. There were, however, significant improvements observed for participant B. These trends observed within the intervention phase and across intervention and baseline for participant B suggest socially-focused positive imagery training may have had a positive effect on perceived social isolation for participant B. Importantly, participant B reported starting a romantic relationship during the intervention phase. As a result, it is possible the observed change in perceived isolation was due to this non-intervention-related change in the participant’s life. Taken together, this pattern of results suggests that there was not a reliable effect of the imagery intervention on perceived social isolation. Future work may be able to capitalize on these findings by highlighting the meaning of the social resources available to the participant via enhancing aspects of the socially-focused positive imagery. Alternatively, future work in this area may consider a socially-focused intervention aimed at having a greater impact in the adolescent's social network. An intervention including actual involvement in socially-focused positive events, as opposed to engaging in imagery, may evidence reduced perceived social isolation and greater reductions of overall risk for suicidal intent.

To measure changes at a neurocognitive level, EEG prefrontal asymmetry was measured at the first and last laboratory visits following a week of socially-focused positive imagery training. Research suggests greater right versus left cortical activity (i.e., greater right resting asymmetry scores) is linked to avoidance motivation, while greater left cortical activity reflects approach motivation (Coan & Allen, 2004). Consistent with Fredrickson's (2001) broaden and build theory, decreases in right resting cortical activity (i.e., greater EEG prefrontal asymmetry scores) were expected to result following one week of socially-focused positive imagery training. In the current study, decreases in right cortical activity from pre- to post-intervention were observed for some scalp regions. However, patterns were not consistent within or between subjects. In previous work, activity in the F4-F3 regions is commonly employed for measuring EEG prefrontal asymmetry (Coan & Allen, 2004; Thibodeau et al., 2006). In the current study only participants B, C, and F evidenced trends suggesting reductions in resting right asymmetry scores measured by F4-F3, while greater resting right asymmetry F4-F3 scores were observed at post-intervention for participants D and E. Noteable, previous work has also suggested F8-F7 to be a more stable marker of trait affect (Jacobs & Snyder, 1996). Participants B and D evidenced reductions in resting right asymmetry scores measured by F8-F7 and participants C, E, and F evidenced greater resting right asymmetry for F8-F7 at post-intervention. Taken together, patterns observed in the current study were not reliable and no robust effect of the intervention on prefrontal asymmetry was observed. Future work would benefit from a larger sample size to allow for inferential statistics to compare pre- and post-levels of prefrontal asymmetry or three or more assessment points during baseline and intervention phases to allow for a TAU-U analysis.

In addition to the limitations noted above (e.g., small sample size, no control group), it is important to highlight the limited generalizability of this small *n* study. Specifically, the sample consisted exclusively of adolescent girls. Thus, it remains unclear whether male adolescents at risk for suicidal intent would respond to socially-focused positive imagery training. Moreover, participants reported low intensity of suicidal ideation, limiting generalizability to adolescents experiencing more intense suicidal ideation. Importantly, suicidal ideation is considered a particularly unstable variable (Selby & Yen, 2014; Witte, Fitzpatrick, Joiner, & Schmidt, 2005). Given low stability in suicidal ideation, it may be challenging to observe significant reductions in a small *n* evaluation. The lack of significant observable trends in positive affect, negative affect, perceived social isolation, and suicidal ideation may be a function of the lack of stability during the baseline phase. Indeed, establishing a stable baseline prior to the presentation of an independent variable, in this case socially-focused positive imagery training, is necessary for identifying the effects of an independent variable in a small *n* design (Kazdin, 2003).

These limitations notwithstanding, the current study adds to knowledge regarding the potential effectiveness of socially-focused positive imagery training to reduce risk for suicidal intent. Safety and pragmatic issues that may arise in research with adolescents at risk for suicidal intent are also highlighted. The study targeted five separate indicators of risk for suicidal intent via self-report and at a neurocognitive level through EEG prefrontal resting asymmetry. Given little is known about how to reduce risk for suicidal intent among adolescents, future work may consider measuring risk for suicidal intent via the variables used in the current study. Results suggest socially-focused positive imagery did not evidence promising effects on the outcomes variables measured here. Future work aiming to explore socially-focused positive imagery training may need to enhance intervention effects via more days of practice or greater emphasis on the meaning of the social resources found in each image. Additional research is needed to understand if socially-focused positive imagery is promising or ineffective in reducing risk for suicidal intent among adolescents. As noted above, other future interventions may aim to create a more intense positive social experience via involvement in actual (cf., imaginal) social activities. Moreover, it may be worth considering such an intervention for individuals endorsing higher levels of perceived isolation as compared to suicidal thoughts. Our limited knowledge specific to empirically supported treatment for adolescents reporting suicidal ideation hinders the application of appropriate and efficacious interventions. Future work employing similar small *n* methods from the current study may aid in understanding the appropriateness of existing and future interventions targeting adolescent risk for suicidal intent.

V. References

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Table 1.
Tau-U Analysis of Primary Dependent Variables per Day Within and Across Baseline (BL) and Intervention (IN)

	Improvement/ Worsening	*S*	Tau	SD_s	Var_s	*Z*
Outcome Measure: BSS						
Participant A						
Trend during BL	4/1	3.00	0.20	3.42	11.66	0.88
Trend during IN	4/2	2.00	0.10	4.00	16.00	0.50
BL vs. IN + IN – trend BL	11/12	-2.00	-0.03	10.18	103.63	-0.20
Participant B						
Trend during BL	0/0	NA	NA	NA	NA	NA
Trend during IN	0/0	NA	NA	NA	NA	NA
BL vs. IN + IN – trend BL	0/0	NA	NA	NA	NA	NA
Participant C						
Trend during BL	0/3	-3.00	-1.00	2.24	5.00	-1.34
Trend during IN	0/0	0.00	0.00	0.00	0.00	NA
BL vs. IN + IN – trend BL	10/0	10.00	0.22	6.32	39.94	1.58
Participant D						
Trend during BL	2/1	1.00	0.17	2.24	5.00	0.45
Trend during IN	7/2	5.00	0.33	4.43	19.62	1.13
BL vs. IN + IN – trend BL	14/10	4.00	0.09	8.98	80.64	0.45
Participant E						
Trend during BL	5/2	3.00	0.30	3.61	13.00	0.83
Trend during IN	0/0	0.00	0.00	0.00	0.00	NA
BL vs. IN + IN – trend BL	30/5	25.00	0.38	11.98	143.52	2.09
Outcome Measure: PANAS-PA						
Participant A						
Trend during BL	10/4	6.00	0.40	5.23	27.33	1.15
Trend during IN	16/4	12.00	0.57	6.58	43.33	1.82
BL vs. IN + IN – trend BL	36/38	-2.00	-0.03	16.27	264.65	-0.12
Participant B						
Trend during BL	2/3	-1.00	-0.17	2.77	7.66	-0.36
Trend during IN	10/4	6.00	0.40	5.23	27.33	1.15
BL vs. IN + IN – trend BL	28/15	11.00	0.24	11.09	122.99	0.99

Table 1. (Cont.)

	Improvement/ Worsening	*S*	Tau	SD_s	Var_s	*Z*
Participant C						
Trend during BL	1/5	-4.00	-0.67	2.94	8.64	-1.36
Trend during IN	13/7	6.00	0.29	6.58	43.30	0.91
BL vs. IN + IN – trend BL	36/17	19.00	0.31	12.77	163.00	1.49
Participant D						
Trend during BL	3/3	0.00	0.00	2.94	8.64	0.00
Trend during IN	9/6	3.00	0.20	5.23	27.33	0.57
BL vs. IN + IN – trend BL	27/17	10.00	0.22	11.13	123.88	0.90
Participant E						
Trend during BL	2/8	-6.00	-0.60	4.08	16.66	-1.47
Trend during IN	7/11	-4.00	-0.19	6.31	39.80	-0.63
BL vs. IN + IN – trend BL	21/41	-20.00	-0.30	14.42	207.99	-1.39
Outcome Measure: PANAS-NA						
Participant A						
Trend during BL	10/5	5.00	0.33	5.32	28.30	0.94
Trend during IN	15/3	12.00	0.57	6.38	40.67	1.88
BL vs. IN + IN – trend BL	45/25	20.00	0.26	16.06	257.92	1.25
Participant B						
Trend during BL	5/0	5.00	0.83	2.76	7.62	1.81
Trend during IN	1/12	-11.00	-0.73	5.23	27.33	-2.10*
BL vs. IN + IN – trend BL	17/21	-4.00	-0.09	10.97	120.33	-0.36
Participant C						
Trend during BL	2/4	-2.00	-0.33	2.94	8.64	-0.68
Trend during IN	10/9	1.00	0.05	6.51	42.33	0.15
BL vs. IN + IN – trend BL	31/19	12.00	0.22	12.62	159.26	0.95
Participant D						
Trend during BL	1/4	-3.00	-0.50	2.94	8.64	-1.02
Trend during IN	8/6	2.00	0.13	5.23	27.33	0.38
BL vs. IN + IN – trend BL	16/22	-6.00	-0.13	10.92	119.25	-0.55
Participant E						
Trend during BL	6/4	2.00	0.20	4.08	16.66	0.49
Trend during IN	10/1	9.00	0.43	5.21	27.13	1.73
BL vs. IN + IN – trend BL	45/9	36.00	0.55	13.93	193.99	2.58*

Table 1. (Cont.)

	Improvement/ Worsening	*S*	Tau	SD_s	Var_s	*Z*
Outcome Measure:						
INQ-TB						
Participant A						
Trend during BL	7/2	5.00	0.50	3.95	15.60	1.27
Trend during IN	12/9	3.00	0.14	6.66	44.33	0.45
BL vs. IN + IN – trend BL	38/26	12.00	0.16	14.51	210.66	0.83
Participant B						
Trend during BL	4/2	2.00	0.33	2.94	8.64	0.68
Trend during IN	11/3	8.00	0.53	5.23	27.33	1.53*
BL vs. IN + IN – trend BL	34/8	26.00	0.58	11.02	121.33	2.36**
Participant C						
Trend during BL	4/2	2.00	0.33	2.94	8.64	0.68
Trend during IN	8/13	-5.00	-0.24	6.66	44.33	-0.75
BL vs. IN + IN – trend BL	26/29	-3.00	-0.05	12.85	164.99	-0.23
Participant D						
Trend during BL	6/0	6.00	1.00	2.94	8.64	2.04
Trend during IN	10/5	5.00	0.33	5.32	28.32	0.94
BL vs. IN + IN – trend BL	21/21	0.00	0.00	11.05	121.99	0.00
Participant E						
Trend during BL	1/8	-7.00	-0.70	3.96	15.67	-1.77
Trend during IN	9/12	-3.00	-0.14	6.58	44.30	-0.46*
BL vs. IN + IN – trend BL	26/35	-9.00	-0.14	14.38	206.78	-0.63

Note. Worsening = count of decreases in score form one measurement to the next; Improvement = count of increases in score from one measurement to the next; BSS = Beck Scale for Suicidal Ideation; PANAS-PA = Positive and Negative Affect Schedule- Positive Affect; PANAS-NA = Positive and Negative Affect Schedule- Negative Affect; INQ-TB = Interpersonal Needs Questionnaire- Thwarted Belongingness. * = *p* (two-sided exact) < .05; ** = *p* (two-sided exact) < .01. Participant F is not included in analysis due to failure to provide scores throughout the intervention phase.

Table 2.
EEG Alpha Power Scores Averaged across 8 min as a Function of Region and Assessment Session

	Region	Pre-Intervention *M* (*SD*)	Post-Intervention *M* (*SD*)
Participant B			
	F1	0.75 (1.68)	0.36 (0.46)
	F2	0.08 (0.15)	0.08 (0.08)
	F3	0.08 (0.09)	0.03 (0.04)
	F4	0.07 (0.12)	0.06 (0.06)
	F7	0.31 (0.55)	0.21 (0.22)
	F8	0.06 (0.08)	0.06 (0.07)
Participant C			
	F1	0.20 (0.25)	1.06 (1.59)
	F2	0.09 (0.19)	0.05 (0.08)
	F3	0.10 (0.12)	0.08 (0.14)
	F4	0.04 (0.04)	0.09 (0.11)
	F7	0.19 (0.25)	0.51 (0.80)
	F8	0.10 (0.21)	0.05 (0.08)
Participant D			
	F1	1.73 (3.39)	1.12 (1.67)
	F2	0.10 (0.18)	0.01 (0.18)
	F3	0.07 (0.12)	0.09 (0.14)
	F4	0.21 (0.36)	0.13 (0.17)
	F7	0.79 (2.02)	0.65 (0.73)
	F8	0.13 (0.19)	0.17 (0.31)
Participant E			
	F1	0.89 (0.21)	0.19 (0.31)
	F2	0.22 (0.33)	0.51 (1.27)
	F3	0.09 (0.16)	0.25 (0.37)
	F4	0.24 (0.47)	0.13 (0.18)
	F7	0.82 (2.09)	2.23 (5.17)
	F8	0.40 (0.77)	0.50 (1.18)
Participant F			
	F1	.80 (1.81)	2.69 (5.30)
	F2	.13 (0.27)	0.44 (0.74)
	F3	.11 (0.13)	0.41 (0.87)
	F4	.08 (0.16)	0.94 (2.34)
	F7	.89 (1.61)	5.46 (14.97)
	F8	.17 (0.42)	0.48 (0.76)

Note. Natural log of the alpha power of electrodes connected to regions in the left hemisphere (F1, F3, and F7) and right hemisphere (F2, F4, and F8). Participant A was removed from the analysis due to inability to remove ocular artifacts.

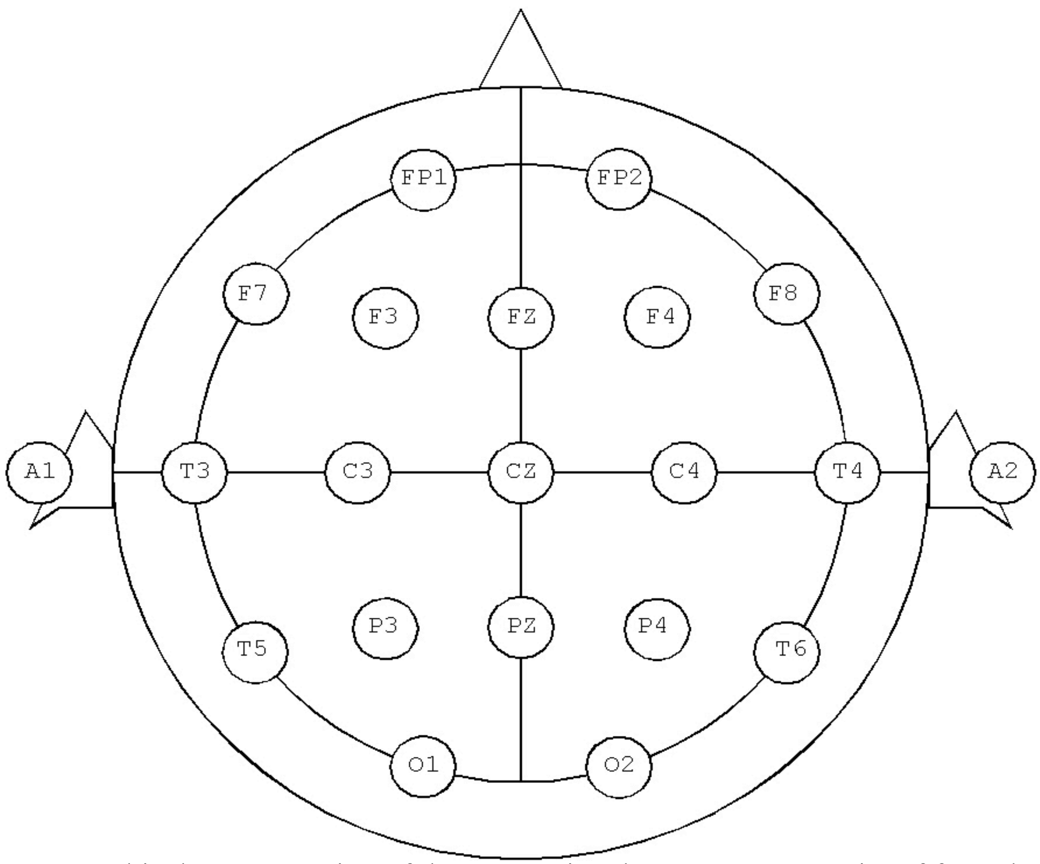
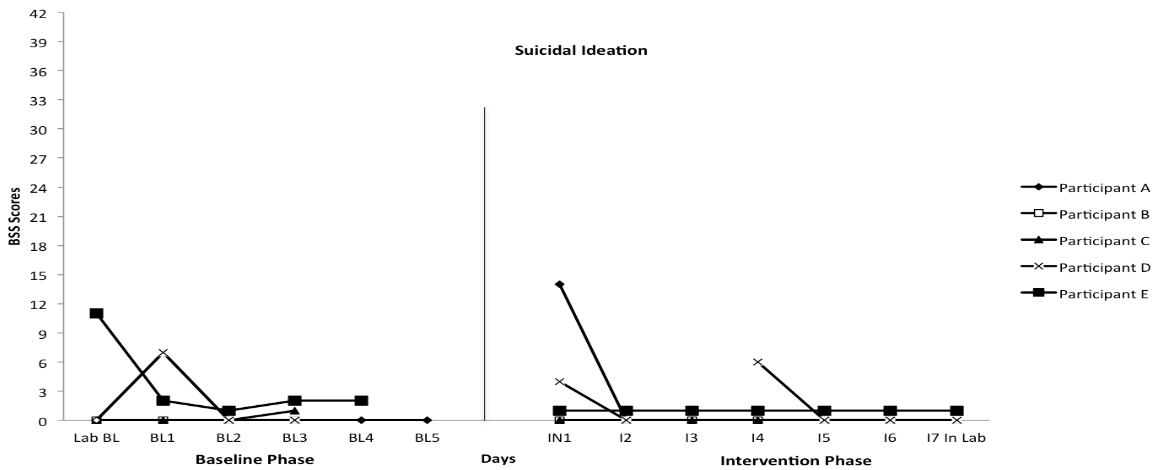
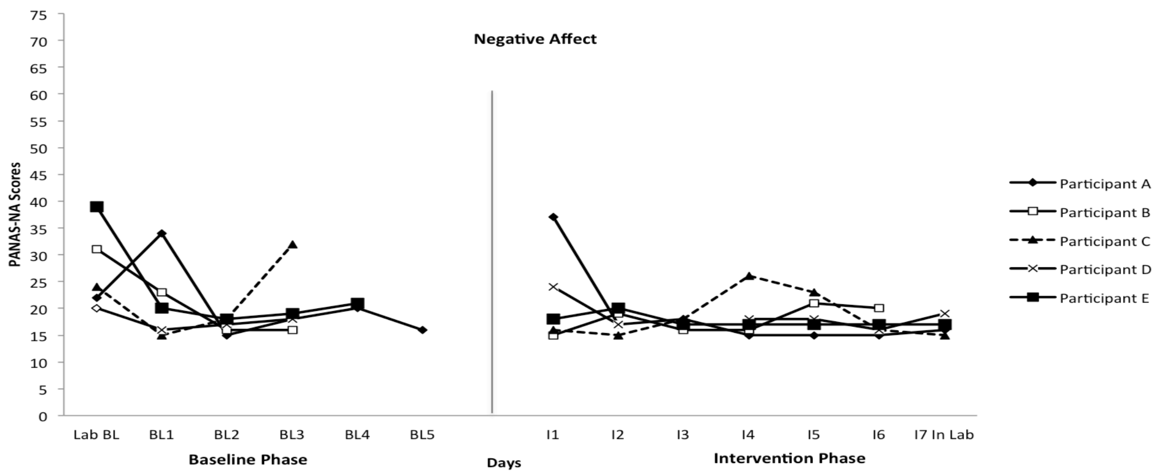
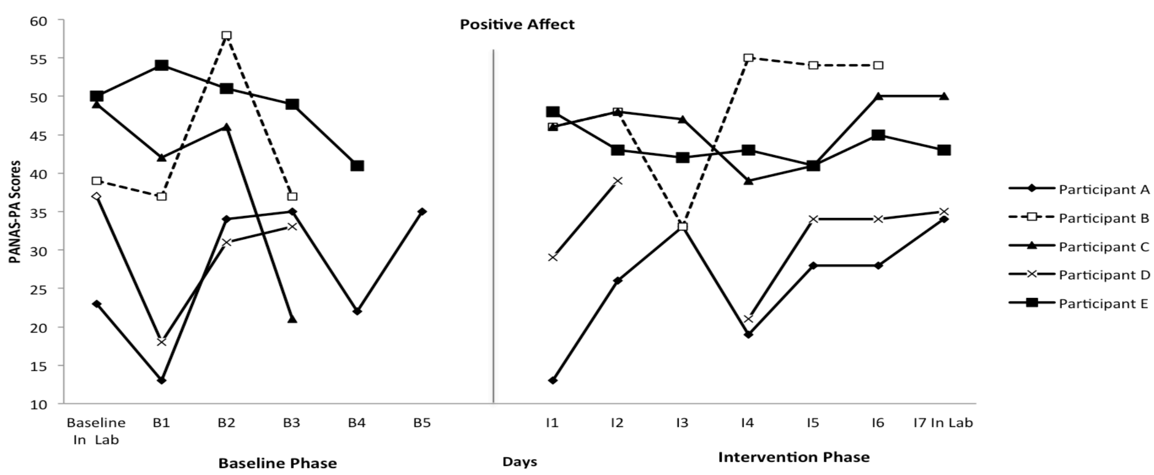


Figure 1. Graphical representation of the International 10-20 system. Pairs of frontal EEG channels used to understand Prefrontal EEG Asymmetry for the present study included: F1 (left) and F2 (right), F3 (left) and F4 (right), and F7 (left) and F8 (right).


Suicidal Ideation
BSS Scores
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
Lab BL
BL1
BL2
BL3
BL4
BL5
IN1
I2
I3
I4
I5
I6
I7 In Lab
Baseline Phase
Days
Intervention Phase
Participant A
Participant B
Participant C
Participant D
Participant E


Negative Affect
PANAS-NA Scores
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Lab BL
BL1
BL2
BL3
BL4
BL5
I1
I2
I3
I4
I5
I6
I7 In Lab
Baseline Phase
Days
Intervention Phase
Participant A
Participant B
Participant C
Participant D
Participant E


Positive Affect
PANAS-PA Scores
60
55
50
45
40
35
30
25
20
15
10
Baseline In Lab
B1
B2
B3
B4
B5
I1
I2
I3
I4
I5
I6
I7 In Lab
Baseline Phase
Days
Intervention Phase
Participant A
Participant B
Participant C
Participant D
Participant E

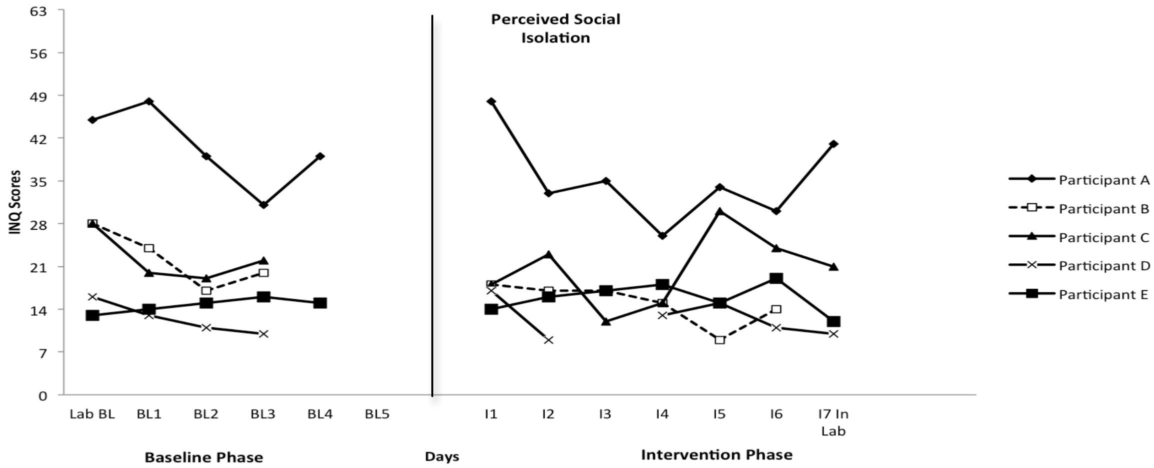
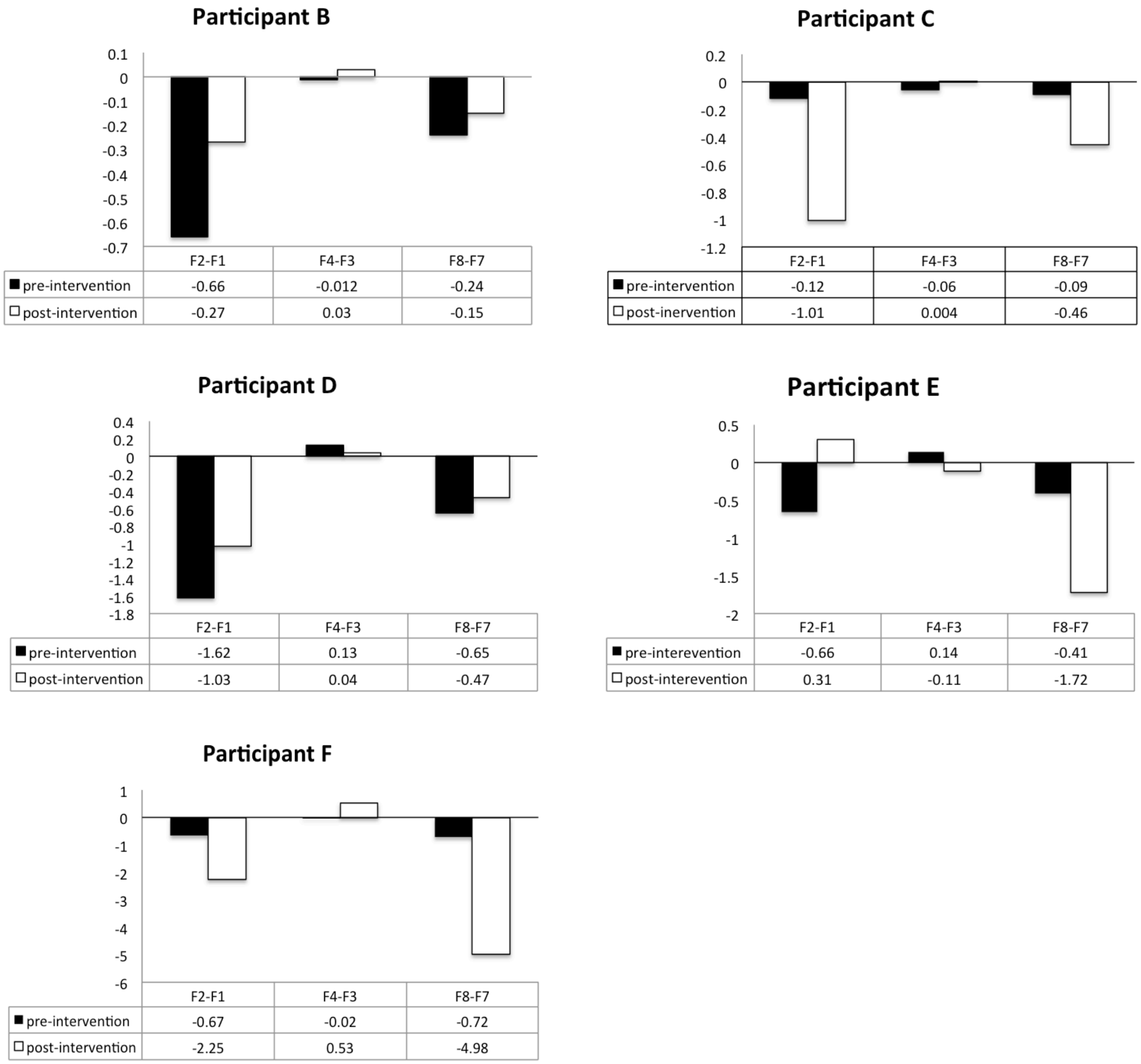


Figure 2. Total scores of primary dependent variables across baseline and intervention phases. Participant A is missing an INQ score for baseline day 5. Participant B is missing scores for intervention day 7. Participant D is missing BSS, PANAS- PA, PANAS-NA, and INQ-TB scores for intervention day 3. Participant F was excluded from the analysis given failure to report scores for the intervention phase. BSS = Beck Scale for Suicidal Ideation; PANAS-PA = Positive and Negative Affect Schedule-Positive Affect; PANAS-NA = Positive and Negative Affect Schedule- Negative Affect; INQ-TB = Interpersonal Needs Questionnaire- Thwarted Belongingness.



Participant B

	F2-F1	F4-F3	F8-F7
■ pre-intervention	-0.66	-0.012	-0.24
□ post-intervention	-0.27	0.03	-0.15

Participant C

	F2-F1	F4-F3	F8-F7
■ pre-intervention	-0.12	-0.06	-0.09
□ post-inervention	-1.01	0.004	-0.46

Participant D

	F2-F1	F4-F3	F8-F7
■ pre-intervention	-1.62	0.13	-0.65
□ post-intervention	-1.03	0.04	-0.47

Participant E

	F2-F1	F4-F3	F8-F7
■ pre-interevention	-0.66	0.14	-0.41
□ post-interevention	0.31	-0.11	-1.72

Participant F

	F2-F1	F4-F3	F8-F7
■ pre-intervention	-0.67	-0.02	-0.72
□ post-intervention	-2.25	0.53	-4.98

Figure 3. EEG Prefrontal Asymmetry Scores calculated Asymmetry scores calculated by ln(Right) - ln(Left) at all frontal positions. Larger numbers reflect less relative right versus left prefrontal cortical activity at resting state. Participant A is not included due to inability to remove ocular artifacts.

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

October 27, 2014

MEMORANDUM

TO:	Sasha Rojas Lauren Rogers Ellen Leen-Feldner Matthew Feldner
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	14-10-152
Protocol Title:	*Positive Imagery Training for Adolescent Girls*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 10/26/2014 Expiration Date: 10/25/2015

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 30 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.

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