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TACTING OF FUNCTION IN COLLEGE STUDENT MENTAL HEALTH:  
AN ONLINE AND APP-BASED APPROACH  
TO PSYCHOLOGICAL FLEXIBILITY

by

Benjamin Pierce

A dissertation submitted in partial fulfillment  
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Psychology

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Logan, Utah

2019

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## ABSTRACT

Tacting of Function in College Student Mental Health:  
An Online and App-Based Approach  
to Psychological Flexibility

by

Ben Pierce, Master of Science

Utah State University, 2019

Major Professor: Michael Levin, Ph.D.  
Department: Psychology

College students' mental and emotional health concerns are both prevalent and diverse, with depression and anxiety as the most common presentations. College counseling centers face an increasing demand to address these concerns but are limited by resources and the need to triage high-risk problems. Transdiagnostic interventions have the potential to ameliorate this situation through increasing flexibility to address a wide range of presenting concerns based on a set of common underlying processes. Psychological inflexibility is a transdiagnostic process with demonstrated connections to the most common college student concerns involving depressive and anxious symptoms. This process involves excesses in efforts to avoid, suppress, or control unwanted

experiences coupled with deficits in patterns of behavior that approach a person's values. Interventions for psychological inflexibility emphasize taking a functional perspective on one's experiences, helping people reduce behavior with an avoidant function and increase behavior that approaches personal values. However, the capacity for clients in such interventions to notice and label the functions of their behavior, such as whether an action "avoids" or "approaches" some contingency, has never been assessed.

Given the need to develop increasingly broad-reaching and effective interventions among college students, this study examined whether explicitly training the capacity to notice and label the functions of one's behavior (i.e., tacting of function) through a brief online and app-based intervention can produce changes in symptoms of depression and anxiety among college students. The aims of this study are twofold: First, the study assessed the effectiveness of training the ability to notice and label the functions of behavior on common college student concerns. Second, the study examined the role of noticing and labeling the functions of behavior as a mechanism of change paralleling psychological inflexibility and supporting changes in this process over time. Participants in the study included 106 students with symptoms of depression and anxiety who were recruited from a medium-sized university in the Mountain West of the United States for an eight-week study period. During this period, participants were assigned to either receive three weekly online sessions and use an app focused on noticing and labeling the functions of behavior or to wait until the end of the eight-week study before receiving the online sessions and app. Participants were surveyed biweekly on five occasions to examine the immediate and longer-term impacts of the intervention.

The results of the study indicated that the intervention produced changes in

symptoms of depression and anxiety but failed to produce changes in indicators of valued behavior and life satisfaction/quality. The intervention also produced changes in psychological inflexibility and related processes (e.g., mindfulness), as well as the ability to notice and label one's internal experiences. However, there was no support for changes in the ability to notice and label the functions of one's actions due to the intervention. Similarly, changes in symptoms, behavioral activity, and life satisfaction were explained through changes in psychological inflexibility yet were not explained through changes in noticing and labeling of function. Altogether, the results suggest that changes in psychological inflexibility among students may occur in the absence of changes in noticing and labeling the functions of behavior, and this change may contribute to subsequent changes in distress, activity, and life satisfaction. Inconclusive findings on the skill of noticing and labeling the functions of behavior raise questions about the capacity to measure this skill via self-report and the need to identify and examine mechanisms through which students may learn to respond based on the functions of their experience. The results are discussed in terms of interventions for psychological inflexibility and the role of such interventions in college student mental healthcare.

(132 pages)

## PUBLIC ABSTRACT

### Tacting of Function in College Student Mental Health: An Online and App-Based Approach to Psychological Flexibility

Ben Pierce

Mental and emotional health concerns among college students are prevalent and diverse in their symptom presentations. With increasing demands on counseling centers to provide efficient care and to address students with higher acuity or risk for harm, there has been an increased focus on identifying therapeutic targets that underlie a wide breadth of concerns to broaden the scope and impact of mental health services. Psychological inflexibility is one such target and refers to a combination of excessive avoidance of internal experiences coupled with a lack of actions that align with a person's values. Interventions for psychological inflexibility aim to support people in reducing actions that are mostly about avoiding unwanted thoughts and feelings and actions that involve moving towards chosen values. Such interventions may produce changes in people's actions in part through helping people notice and label the different roles their actions play in relation to thoughts, feelings, and personal values. However, the skill of noticing and labeling the purposes of one's actions has not been studied in interventions

for psychological inflexibility despite being discussed in theoretical writings. Training this skill may serve as a direct means of reducing psychological inflexibility and as a foundation for other interventions, thus it may be a relevant target in interventions for psychological inflexibility among college students. Given this, the present study developed and tested an intervention focused on noticing and labeling one's actions as an intervention for psychological inflexibility in a college student sample, as delivered through web and app-based media. The study recruited 106 students with symptoms of depression and anxiety from a medium sized university in the Mountain West of the United States, and then randomly assigned them to either wait for eight weeks or receive a three-week online and app-based training for noticing and labeling avoidant and values-consistent actions. The results of the study indicated short-term effects on symptoms of depression and anxiety for participants who received the online and app-based training as compared with participants who were asked to wait, although both groups showed reductions in symptoms by the end of the study period. Participants did not report changes in the target skill of noticing and labeling their actions although the study did find larger reductions in psychological inflexibility among participants who received the training as compared with those asked to wait. Further, changes in psychological flexibility were related to changes in behavioral activity and life satisfaction, but not life quality. The results raise questions about the necessity of training the ability to notice and label one's actions as a direct intervention mechanism for psychological inflexibility. The findings also suggest that changing inflexible patterns of behavior may be more important than the capacity to notice such changes. These results are further interpreted in relation to interventions for college student mental and emotional health.



## DEDICATION

I want to dedicate this project to my brother, Jake, who has taught me so much and has shown me how to dream, take risks, and take life less seriously. Your friendship, humor, and support have impacted my life and walk in the world more than you know.

*Ben Pierce*

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## CHAPTER I: INTRODUCTION

Mental health concerns among college students are ubiquitous and diverse, with demands for services often exceeding what counseling centers can provide. For example, over one-third of students in a nationally representative sample from 2010 reported significant impairment and distress due to mood and anxiety-related symptoms (American College Health Association, 2014). Further, symptoms among college students are often severe, with high rates of suicidal ideation, self-harm, and mental health hospitalizations observed in recent national surveys (Center for Collegiate Mental Health, 2016). Counseling centers often have insufficient resources to meet the extensive mental health needs on college campuses, resulting in long waitlists at understaffed facilities and problems with effectively triaging high versus lower acuity concerns (Prince, 2015). Thus, innovative approaches are needed to meet the diverse and growing mental health needs of college students.

Transdiagnostic intervention approaches are an important development given the heterogeneity and severity of concerns with which college students present (Prince, 2015). Transdiagnostic interventions address common processes that supposedly underlie a broad range of mental health problems, allowing a great deal of flexibility in their application to various presenting concerns. Psychological inflexibility (PI; Hayes, Strosahl, & Wilson, 2011) is one transdiagnostic process that is implicated in various problems that are common among college students, including depression, anxiety, substance use, and eating disorders (Levin et al., 2014). Briefly, PI involves deficits in behavior directed towards values and excesses in behavior directed at avoiding or controlling unwanted internal events (Hayes et al., 2011). Therapies with a focus on PI

appear to diminish functional impairment as well as distress in the most common mental health problems among college students (Ciarrochi, Bilich, & Godsell, 2010).

Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 2011) shows particular promise as a transdiagnostic intervention for PI among college students. ACT has been shown to ameliorate a variety of mental health problems common in college populations, including anxiety disorders (Arch et al., 2012), obsessive-compulsive disorder (Twohig, 2009), depression (Zettle, 2015), and addiction (Luoma, Kohlenberg, Hayes, & Fletcher, 2012), with effect sizes equal to other empirically-based interventions (A-Tjak et al., 2015). In addition, ACT showed potential effectiveness as transdiagnostic intervention for college students in the context of a web-based trial (e.g., Levin, Haeger, Pierce, & Twohig, 2016).

ACT is part of a broader family of interventions that take a functional and contextual perspective on client symptoms that increases its clinical flexibility when applied to a wide range of concerns. Functional-contextual interventions do not seek to alter the form or intensity of an experience or symptom, but rather to transform how the symptom influences behavior (Hayes et al., 2011). For example, a client whose thoughts of contamination occasion compulsive behavior and a client whose social worries occasion avoidance behavior may equally benefit from learning to respond to these thoughts as passing mental events instead of as literal facts. Similarly, clients with depressive symptoms and clients with anxiety-related symptoms may both achieve greater behavioral flexibility around these experiences, if they learn to respond to their symptoms with acceptance rather than ineffective avoidance strategies. Further, the same individual may benefit from responding with greater acceptance to sadness at one time



and to anger at another time, if these responses bring them closer to people they value. The functional-contextual approach taken in ACT thus aims to *transform the stimulus functions* of a client's experiences, with an emphasis on limiting the extent to which unwanted inner experiences (e.g., thoughts, feelings, memories, etc.) negatively impact a client's wellbeing and increasing the salience of personal values in choices. The purpose of ACT broadly is to increase behavior that approaches values and decrease behavior in the service of avoiding internal events (Hayes, et al., 2011). This approach seems especially advantageous for treating the heterogeneous mental health problems among college students and in the context of heterogeneous student identities, values, and goals for pursuing counseling.

While promising as a wide-reaching intervention for college students, it is unclear to what extent clients learn to respond functionally to their experiences instead of learning more generic skills (e.g., mindfulness skills). The effectiveness of ACT presumably hinges on the client's ability to identify the functions of their behavior and intervene appropriately (Westrup, 2014) and other functional-contextual interventions, such as Functional Analytic Psychotherapy (FAP; Kohlenberg & Tsai, 2012), aim to train clients to notice and change behavior with unwanted functions. From a therapeutic perspective, deficits in the ability to differentiate the functions of one's behavior based on its antecedents and consequences may significantly hamper transdiagnostic interventions such as ACT or FAP that take a functional emphasis. Clients may use functional skills ineffectively or even to the detriment of the therapeutic goals if they fail to identify instances of the target functions or mislabel these functions. However, this component of

functional-contextual interventions is not well studied despite important theoretical implications for transdiagnostic ACT interventions with college students.

### *Tacting as an Overlooked Behavioral Process*

Surprisingly little research has investigated the development of a repertoire for labeling the functions of behavior in functional-contextual interventions. Most research has focused on the ability to use ACT skills to transform the functions of experience without assessing whether such skills are applied in the appropriate contexts. ACT may prove inefficient or ineffective when clients are unable to develop a repertoire for labeling and differentiating what behaviors serve an avoidant, approach, values-directed, or other function. Similarly, functional-contextual interventions may not fulfill their transdiagnostic intent or be generalized if such labeling deficits are present. As such, this basic skills repertoire may be especially important for college students presenting with a wide range of concerns for therapy. Based on these considerations, it is worth operationalizing and investigating these labeling repertoires in conjunction with PI in the context of functional-contextual therapies such as ACT.

One way to define the skill of labeling the functions of behavior is as a specific *tacting* repertoire. Tacting refers to verbal behavior that is controlled by a non-verbal antecedent and reinforced by the responses of others in the social environment (Hamilton, 1988). This definition is consistent with the radical behavioral foundations of functional-contextual interventions for PI, which extends the notion of “behavior” to encompass both internal and overt actions (see, e.g., Hayes, Levin, Pumb-Villardaga, Villatte, & Pistorello, 2013 for a discussion of ACT and radical or contextual-behaviorism). Based on this extension, internal behavior such as thoughts and emotions are controlled by

antecedent and consequential stimuli in the same way as observable actions. Relatedly, internal events can serve antecedent and consequential functions in relation to overt behavior. Tacting of function (TOF) can therefore be defined from this perspective as a verbal response identifying the antecedents and consequences of one's behavior. For example, one may tact a behavior as "avoidant" because it has the effect of reducing a prior experience of anxiety.

Like other tacts, TOF is likely acquired through socially mediated reinforcement and then sustained independent of the direct response of a listener (Skinner, 1957). For example, a therapist may initially elicit tacts such as "avoidance" through direct questions and then offer nonspecific social reinforcement (e.g., indicating understanding or empathy) for emitting this tact under the appropriate conditions. As therapy ends, this reinforcement is faded and TOF becomes sustained by its antecedent stimuli (i.e., behavior with various functions) and the natural consequences of tacting the functions of one's behavior. Similar to other tacting behavior, the form of TOF likely changes from an overt statement that is overtly reinforced (e.g., a therapist stating, "well noticed" in response to a client's observation) to a covert behavior in the absence of an audience (e.g., the therapist) and in the context of naturally reinforcing consequences (e.g., "well noticed"). Unlike other tacting behavior, however, the rate of nonspecific social reinforcement for TOF outside of a therapy context may be limited; hence, this behavior may be more reliant on naturalistic consequences to be sustained.

TOF may serve a breadth of functions in interventions for PI. Tacting the function of a behavior may serve to block the process of negative reinforcement that sustains ineffective avoidance behavior. For example, when the behavior of distracting from

worries through web-surfing is accompanied with the appropriate tact of “avoidance,” the negative reinforcement derived from surfing the web may be interrupted as the tact reintroduces the aversive stimulus of worry as well as an additional aversive associated with the label “avoidance.” Similarly, tacting the function of “valued behavior” may increase persistence in that behavior by augmenting the reinforcement that accompanies moving towards personal values. For instance, recognizing that helping behavior is moving towards a value of friendship or connectedness may contribute to the sense of meaning behind the behavior, thus increasing persistence. Finally, tacts may acquire the antecedent function of cuing target therapeutic behaviors, such as the use of ACT skills, in the context of certain tacts.

The concept of clinically relevant behavior (CRB) in Functional Analytic Psychotherapy (FAP; Kohlenberg & Tsai, 2012) appears to enlist TOF to some extent. Briefly, FAP emphasizes defining CRB’s in-session based on their functional properties and uses the therapeutic context to reinforce effective interpersonal behavior (CRB1) and extinguish interpersonal behavior with problematic functions (CRB2). As such, FAP explicitly trains clients to attend to behavior with differing functions and supports clients in the behavior of differentiating CRB1 and CRB2 as a generalization strategy. Writing on FAP has defined this skill as a third class of clinically relevant behavior (CRB3; Abreu, Hubner, & Lucchese, 2012) that involves noticing instances of CRB1 and CRB2. Because the labels CRB1 and CRB2 serve as tacts for the functions of behavior targeted through FAP, CRB3’s seem to entail a form of TOF. Like TOF, however, CRB3’s have received little research attention in comparison with other clinically relevant behavior within FAP.

Like CRB3's, TOF may serve as a transdiagnostic skill in functional-contextual interventions that parallels and enhances that of other skills targeting PI among college students with diverse presenting concerns. TOF may be generalized to a variety of seemingly different behaviors that share common functions, and these functions may be present across a range of psychological disorders and in different contexts. For instance, drinking to avoid feelings of guilt and exercising to avoid feelings of anxiety both share the function of "avoidance," such that tacting this function may interrupt the process of negative reinforcement in both cases. As such, an ACT therapist may assess a student's repertoire for tacting function to inform the extent to which appropriate tacts (i.e., labels) should be practiced and reinforced in-session. Relatedly, a therapist may return to building this repertoire as a fundamental skill if progress in other skill domains is slow, given the potential antecedent role of tacts in cuing the use of other behavioral skills. Finally, college students may enter therapy at varying levels of development, which may be reflected in varying degrees of fluency in TOF that must be considered in a therapeutic context.

In summary, tacting the function of behavior may be a critical skill for transdiagnostic interventions for PI among college students. However, this skill has received minimal attention in research to-date, despite being referenced in writings on both ACT and FAP. Therefore, the present study attempts to measure and investigate TOF as a key behavioral mechanism for addressing PI in an online and app-based skills intervention for college students. The study relies on a therapeutic tool called the ACT Matrix to train TOF around psychologically inflexible and psychologically flexible

responses. This research hypothesizes that training students to tact avoidant and values-directed behavior, specifically, may be conducive to reducing PI and making changes to behavior consistent with a functional-contextual, ACT intervention model.

## CHAPTER II: REVIEW OF THE LITERATURE

### College Student Mental Health

Some have described the state of college student mental health a “crisis” given the ubiquity and increasing severity of student mental health concerns (Prince, 2015). Recent national surveys of college students and counseling centers suggest the symptoms present in counseling centers are more diverse, comorbid, and severe (Locke, Wallace, & Brunner, 2016). For instance, a recent (2013) nationally representative survey conducted by the American College Health Association (ACHA) found that 51.0% of students endorsed overwhelming anxiety, 44.8% endorsed feelings of hopelessness, 36.3% indicated feeling overwhelming anger, and 31.1% reported problems functioning due to depression within the past year. Relatedly, the number of students who seriously considered suicide was a staggering 7.4% (ACHA, 2013). These mental health symptoms appear to significantly impact performance, with stress, anxiety, and depression among the most often endorsed reasons for academic difficulties (ACHA, 2013). Corroborating these findings, a 2014 nationally representative sample of freshmen identified higher rates of depressive symptoms among first-year college students (9.5% endorsing “frequent” depression), with students also endorsing a greater impact of depressive symptoms on academic and social engagement (Eagan et al., 2014). Together, these findings suggest there is a high overall prevalence of mental health problems, with significant impacts on student functioning.

Particularly common among the mental health problems of college students are mood and anxiety disorders. The rates of these problems are difficult to assess based on nationally representative surveys, however past estimates using face-to-face methods and

DSM-IV criteria suggest rates of 11.9% for diagnosable anxiety disorders and 10.6% for diagnosable mood disorders (Blanco et al., 2008). Often described as “internalizing problems,” the symptoms of mood and anxiety disorders are highly comorbid (Carragher et al., 2015; Eisenberg, Gollust, Golberstein, & Heffner, 2007) and are both associated with a host of other psychosocial problems for students, including alcohol and substance use (e.g., Cranford, Eisenberg, & Serras, 2008), relationship problems (e.g., Drum, Brownson, Denmark, & Smith, 2009), and academic distress (e.g., Beiter et al., 2015). Given their prevalence, it is not surprising that mood and anxiety disorders are among the most common reasons given by students for seeking counseling services (Center for Collegiate Mental Health, 2016). However, as noted by Locke and colleagues (2016), the etiologies, symptom presentations, and concurrent problems associated with mood and anxiety symptoms are multidimensional, and presentations vary substantially from student to student.

College counseling centers are faced with the daunting prospects of adapting to meet the heterogenous needs of students, particularly those with mood and anxiety-related problems. This is accompanied by the need to triage and manage high-risk problems (e.g., suicidal intent) that frequently occur with severe mood and anxiety symptoms (Locke et al., 2016). A review of the National Survey of Counseling Center Directors (NSCCD) reported an increase in such problems between 2004 and 2011, and a greater focus of clinic directors on strategies for managing such concerns (Gallagher, 2012). This increase has been accompanied by an overall rise in the number of students seeking services, as well as an increase in the ratio of eligible students to counselors (1 counselor per 2081 students, on average; Gallagher, 2015). These demands have resulted



in increased waiting times, shorter session limits, and greater numbers of referrals to off-campus providers (Prince, 2015). These strategies may create barriers to treatment and are untenable long-term responses to the problem of increasing student demands.

A variety of factors may contribute to problems with meeting the mental health needs of students in college counselling centers. Beyond financial and staffing constraints (see, e.g., Prince, 2015), the need to effectively triage high-risk concerns while simultaneously addressing the rising numbers of students seeking counseling is frequently cited as an important challenge (Gallagher, 2012; Locke et al., 2016; Prince, 2015). Effective responses to this challenge are complicated by the diversity of problems with which students present (Locke et al., 2016). Regarding this challenge, several authors have advocated for approaches with increasing flexibility that can be implemented across a variety of concerns, freeing up resources for problems of more intensive demands (e.g., Locke et al., 2016; Prince, 2015). This suggestion is congruent with recent developments in *functional contextual* models of mental health, and related transdiagnostic interventions.

### **Functional Contextualism and College Mental Health**

A functional contextual approach has much to offer in meeting the demands on college counseling centers. Briefly, functional contextualism is a pragmatic philosophy of science that emphasizes the role of historical and situational contexts in behavioral events (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). The functional contextual perspective seeks generalizable behavioral processes that balance precision, scope, and influence in relation to psychological problems and other behavioral phenomena of interest (Biglan & Hayes, 1996). More specifically, this approach emphasizes the identification of the

behavioral roots (precision) of topographically diverse concerns (scope), which can be targeted through a common set of behavioral principles (influence). As applied to college student mental health, this approach suggests the identification of transdiagnostic principles that can inform wide-reaching interventions for the majority of student concerns, concurrent with a scaling-up or scaling-down of the interventions to match the level of student need. For instance, an intervention for depression and anxiety may be scaled-up for students with severe complaints, and scaled-down for more mild concerns, while focusing on a common transdiagnostic process for students at either level.

From a functional contextual perspective, the development of Relational Frame Theory (RFT; Torneke, 2010) has greatly facilitated the identification of transdiagnostic principles. RFT proposes that the foundation of human language and cognition is the learned ability to arbitrarily relate events that is shaped by one's situational and historical context (Torneke, 2010). An important contribution of RFT to the radical behavioral perspective on language is the notion of *derived relational responding*. In brief, this process refers to the transformation of the functions of a stimulus through its verbally-derived relations with other stimuli in a given "relational frame" (Torneke, 2010). For instance, if a student experiences a break-up during final exam season, then a relation may form between the experience of a break-up and the concept of "final exams." When the student later hears about future "final exams" in their class, they experience memories and feelings related to the break-up in the absence of direct conditioning between these stimuli. In this case, the internal experiences related to the break-up have entered into a relation of mutual entailment with the verbal concept of "final exams." As another example, a student may have learned the relation that being "gay" is "shameful" through

experiences of, and exposure to, homophobia and later experience shame when questioning their sexual orientation. In this case, the learned relation between “gay” and “shame” may have combined with a later relation between the student’s experience of self and “gay,” resulting in a derived relation between their experience of self and feelings of shame. The process of derived relational responding has been repeatedly demonstrated in lab-based settings (e.g., Wulfert & Hayes, 1988; Hayes & Hayes 1992), and may contribute to a broad range of mental health problems through the generalization of problematic stimulus functions.

### **Psychological Inflexibility as a Mechanism of Change**

Derived relational responding appears to be implicated in the development of excessive avoidance of internal events and deficient participation in values-directed behavior that characterize psychological inflexibility (PI). For instance, learned relations between certain internal events (e.g., anxiety) and negative evaluations (e.g., “bad” or “unacceptable”) may serve to generalize an aversive function across these internal events, such that also promotes generalized and excessive avoidant behavior (Hayes & Gifford, 1996). These patterns of avoidance subsequently dominate an individual’s actions to the detriment of personal values, resulting in a problematic behavioral constellation that is characteristic of a variety of psychological disorders (see Hayes et al., 2013, for a review). Consistent with this perspective, there is growing support for PI as a transdiagnostic treatment target in the most common mental health problems of college students.

Survey based research offers initial evidence for the implications of PI in the most prevalent problems among college students. A survey of college students by Levin and

colleagues (2014) found elevated levels of PI among students with a lifetime history of depression, anxiety, and eating disorders, as well as higher rates of PI among students with comorbidity among depression, anxiety, and substance use. Similarly, a survey by Masuda and Tully (2012) found moderate concurrent relations between PI and symptoms of anxiety, depression, and somatization in an ethnically diverse college sample. Further, a study of college counseling outpatients with suicidal ideation identified excess avoidance of internal events as the strongest explanatory variable for borderline symptoms (Iverson, Follette, Pistorello, & Fruzzetti, 2012). Another cross-sectional study examined current and past self-harm behaviors among college undergraduates, finding excesses of avoidant behavior in students with current and past self-harm (Anderson & Crowther, 2012). Altogether, cross-sectional findings suggest a potentially pervasive role of PI and related behavior in the most common and highest priority problems among college students.

The findings of cross-sectional studies of PI among college students are corroborated by prospective research with intensive longitudinal data. For instance, Machell and colleagues (2015) used a daily diary design that assessed experiences of positive and negative affect, enjoyment of activities, meaning in life, and avoidant responses to emotional experiences in a college sample. They found that higher state levels of avoidance predicted future decrements in positive affect and enjoyment as well as increases in negative affect. Similarly, Shahar and Herr (2011) assessed symptoms of depression, negative affect, and avoidant responses in a daily diary study of introductory psychology students, finding that individuals with greater depressive symptoms more strongly endorsed avoidant responses in the context of elevated negative affect. Together,

these studies offer preliminary evidence for PI as a maintaining factor in diminished wellbeing and elevated distress among college students with and without other symptoms.

Extant evidence also points to PI as a mediating process in functional-contextual interventions for the most common problems of college students. Specifically, studies of ACT point to reductions in PI predicting later reductions in depressive and anxiety symptoms in multiple randomized trials. For instance, Zettle, Rains, and Hayes (2009) re-analyzed data from a prior (1989) study and found that changes in a marker of PI (i.e., the believability of thoughts) predicted later changes in depressive symptoms. Similarly, Dalrymple and Herbert (2007) demonstrated that prior changes in experiential avoidance predicted changes in social avoidance in a controlled trial of ACT for social anxiety disorder. More recently, Arch, Wolitzky-Taylor, Eifert, & Craske (2012) showed that changes in PI-related processes were predictive of later behavioral avoidance, worry, depressive symptoms, and quality of life using multilevel mediation analyses of session-by-session data in ACT for anxiety disorders. Other studies of transdiagnostic app and web-based interventions for college students by Levin and colleagues suggest that ACT interventions can produce changes in PI commensurate with changes in various symptom domains (Levin, Haeger, Pierce, & Cruz, 2017; Levin, Haeger, Pierce, & Twohig, 2016). These studies did not establish temporal precedence of changes in PI predicting later changes in outcomes, however they were among the first to evaluate a fully *transdiagnostic* approach among college students that was not constrained to a specific symptom category. Collectively, these findings suggest PI may be a pertinent

transdiagnostic intervention target, around which interventions for college students could be developed.

### **ACT as a Functional Contextual Intervention**

Acceptance and Commitment Therapy (ACT) shows promise as an intervention for college student concerns. ACT is a model for practicing psychotherapy with the primary target of PI (Hayes et al., 2011). Therefore, it is neither a manualized intervention nor simply a collection of techniques. The ACT model as described by Hayes, Strosahl, and Wilson (2011) can be flexibly applied to address each client's unique concerns and to help them move towards their unique values. Thus, ACT may be especially equipped to handle the heterogeneous mental health problems encountered in college counseling settings.

The interventions of ACT are informed by RFT and are functional in nature, meaning that their goal is to alter the functions of symptoms rather than reduce or eliminate them. Broadly speaking, ACT seeks to reduce excesses in avoidant behavior under the control of inner events such as painful emotions or rigid, internalized rules, while increasing behavior in the service of personal values or meaning in life (Hayes et al., 2011). For example, ACT might intervene with problematic worry by having the client shift their relation to worrisome thoughts by stepping back and observing them, such that diminishes the need to avoid having the worrisome thoughts and facilitates the client's ability to pursue their career goals. ACT accomplishes its goals by focusing on six psychological flexibility processes (summarized in Table 1), so defined because each process is a collection of behaviors directed at reducing PI (Hayes et al., 2011). Each of the ACT processes addresses a collection of problematic functions that symptoms may

acquire, such that promotes flexibility in terms of the symptoms discussed but precision in the techniques used in the intervention.

The flexibility offered by the functional approach of ACT makes it an ideal intervention for settings such as college counseling centers, where students present with a diversity of problems of varying severity. The intensiveness of ACT can be scaled up or down to match the severity of a problem, and its techniques can be tailored to match the client's presenting concerns. For instance, Focused ACT (Strosahl, Robinson, & Gustavsson, 2012) is a very brief intervention that has been used in primary care settings to address mental health problems concurrent with physical complaints. On the other hand, lengthier courses of ACT have been proposed for more chronic problems, such as polysubstance abuse among clients addicted to opioids (Hayes et al., 2004). Within college counseling settings, this flexibility may be an important factor in reducing demands on practitioners while maintaining intervention effectiveness.

One way to maximize both the flexibility and precision of ACT is to ensure interventions are anchored to the target functional excesses and deficits characteristic of PI. Students trained to tact or label these functions may show an increased ability to respond functionally in the ways intended in ACT interventions, thus enhancing their precision as well as the student's ability to generalize the ACT skillset across symptom domains. There is some evidence to indirectly suggest such interventions are beneficial: Levin, Pierce, and Schoendorff (2017) found that prompting individuals to check-in on whether their actions moved "towards" personal values or "away" from unwanted internal experiences via smartphone increased the rate of "towards" moves as well as target health behavior over two weeks in a mixed undergraduate and community sample.

Similarly, a case report involving a client with complex chronic pain and opioid withdrawals demonstrated that practice with “sorting” between actions governed by pain and values facilitated a rapid increase in values-consistent behavior, as well as qualitative reports of increased meaning in the client’s behavior (Weinrib et al., 2017). Finally, a sample of 91 post-operative patients who received an average of 4.90 sessions of ACT that used a similar sorting paradigm demonstrated reductions in opioid use, pain interference, and depressive symptoms (Abid Azam et al., 2017). Collectively, these results point to the potential role of building a repertoire for tacting function (TOF) in the context of brief interventions and for severe symptoms (e.g., complex chronic pain and opioid withdrawal). Such interventions may fill an important niche in college counseling centers by offering a fundamental and generalizable skill (i.e., TOF) that can have rapid effects while also facilitating other ACT interventions.

### **Tacting as a Mechanism of Change**

Tacting in general appears to be implicated in all forms of psychotherapy to some extent, as the therapist necessarily talks about the client’s inner experiences of thoughts, emotions, and physical sensations as well as outer experiences and events (Hamilton, 1988). The client is encouraged to verbalize (i.e., tact) their inner experiences and the therapist may help the client to discriminate among specific aspects of this experience. For instance, a Cognitive-Behavioral therapist may elicit and reinforce tacting of thoughts and emotions as separate aspects of one’s experience (e.g., Hughes, 2008). Relatedly, emotional experiences are parsed into thoughts, emotions, and action urges in Dialectical Behavior Therapy (Linehan, 1993). These tacts are elicited and used in therapy to assist clients in conceptualizing their experiences, as well as for implementing behavioral skills.



Particular tacting deficits appear to be strongly implicated in certain clinical problems. Individuals with alexithymia appear to have problems experiencing or at least describing emotions, and alexithymia may be present in a variety of clinical concerns (Darrow & Follette, 2014). Individuals with alexythymic symptoms may have deficits in tacting emotional experiences that subsequently impedes social shaping of their emotional responses (Darrow & Follette, 2014). Relatedly, tacting among individuals raised in invalidating family environments may be deficient as emotional tacts may have been extinguished (Darrow & Follette, 2014; Linehan, 1993). Such environments and related problems tacting emotions have been related to the development of borderline personality disorder (Linehan, 1993).

Individuals may also refrain from tacting experiences to avoid contacting distress or may have a punishing learning history around tacting certain experiences (e.g., abuse; Darrow & Follette, 2014; Hamilton, 1988). For instance, an individual who is depressed may refrain from tacting any emotional experiences to avoid feeling a sense of sadness, loss, or grief. Similarly, an individual with an eating disorders may avoid tacting bodily stimuli because of avoidance of internalized body shame. On the other hand, tacting may be experienced as aversive if previous tacts have resulted in abuse, and hence may be avoided. Thus, while tacting deficits are characteristic of certain specific problems (e.g., alexithymia), they may be implicated in a wide range of mental health concerns.

Altogether, tacting appears to be reinforced in psychotherapy and deficits in tacting may be involved in a range of mental health phenomena. However, there is little empirical support for tacting as a transdiagnostic mechanism of change. One reason for this is that tacting is an incredibly broad behavior which may serve a variety of functions

in psychotherapy. From this perspective, tacting almost any aspect of experience may serve some function at some point in therapy. Conversely, TOF is a more specific repertoire that seems pertinent to functional contextual interventions such as ACT.

### *Tacting of Function within ACT*

Because of their functional basis, the target behavioral excesses and deficits in ACT can vary widely in form. Whereas one client may smoke marijuana in the service of a value of adventurousness, another client may smoke to avoid feeling sad about a recent break-up. Similarly, the same client may smoke marijuana for both of these reasons at different times. Thus, depending on their function, these behaviors may or may not be consistent with the notion of PI, and are defined as problematic based on their function. This distinction is rarely an intuitive one for clients (Hayes et al., 2011), therefore training clients in TOF may enhance the implementation of ACT through a foundation in the key functional discriminations addressed during the intervention. Relatedly, tacts of function (e.g., “avoidance”) may serve as antecedents to psychologically flexible responses, and may serve to alter the functions of relevant stimuli such as thoughts, emotions, and values, without further intervention.

Most of the core interventions in ACT seem to involve TOF. The processes of *acceptance* and *defusion* contain some element of tacting of behavior with the function of avoiding or responding to internal events such as emotions, thoughts, and rules. This tact may serve to alter the functions of the internal events and of the individual’s responses to them, diminishing the influence of unwanted internal events on behavior and potentially interrupting behavioral avoidance through its association with a negative or undesirable label. Similarly, the identification of *values* and patterns of *committed action* both seem

to require tacting of behavior that specifically approaches a sense of value or fulfillment. Tacting an action as “valued behavior” may in turn increase the salience of its reinforcer (i.e., moving towards personal values) and facilitate persistence in the behavior by association with a positive or desirable label.

Relatedly, several therapist behaviors in ACT may serve to prompt and reinforce tacting function. For instance, the simple question of “what do you do when anxiety is present?” may orient clients to begin responding to the functional properties of their actions (i.e., TOF). More complex interventions such as the “quicksand” metaphor serve to highlight key distinctions between inflexible behavior (e.g., trying to swim in quicksand) and flexible behavior (e.g., not fighting with the quicksand so you can float). These metaphors offer labels for TOF that clients may apply to future instances of their behavior (Stewart & Barnes-Holmes, 2001).

Altogether, TOF appears to be implicated in several core ACT processes and therapist behaviors within ACT. A prior foundation in TOF could diminish the complexity and time-intensiveness of later ACT interventions, as clients would already be versed in labeling target functions and changes in psychologically inflexible behavior may already have occurred. In some cases, certain ACT interventions may be superfluous beyond training in a basic repertoire of TOF. Consistent with this assertion, some have suggested one core function of ACT therapists is to encourage clients to identify and label the functions of their actions (e.g., Polk et al., 2016; Westrup, 2014), and some evidence exists to support this proposition from studies that train a functional labeling repertoire (e.g., Levin, Pierce, & Schoendorff, 2017). In sum, further investigation into TOF as a key mechanism of change within ACT seems warranted.

*Tacting of Function within FAP*

Functional analytic psychotherapy (FAP; Kohlenberg & Tsai, 2012) is another functional-contextual intervention that explicitly supports clients in identifying and changing behavior with unwanted interpersonal functions. Briefly, FAP emphasizes using the therapeutic relationship to help clients identify and change interpersonal behaviors that facilitate or frustrate moving towards their values. The role of the FAP therapist is to notice clients' in-session behavior that impedes movement towards values (CRB1) as well as behavior that supports their values and represents change from prior functioning (CRB2). Then, the therapist evokes and responds contingently to either CRB, with the goal of responding genuinely and reflecting back the consequences of each CRB to the client. Finally, the functional analytic therapist aims to shape the client's functional understanding of their CRB's, through noticing these functions with clients in-session. The ability to notice and respond to the functions of one's actions has been termed a third CRB (CRB3) that serves to promote generalization of changes in the client's behavior.

Recent theoretical papers (e.g., Abreu, Hubner, & Lucchese, 2012) have described CRB3's as "contingency-specifying stimuli" that serve to change the functions of the labels associated with a client's behavior (Abreu, Hubner, & Lucchese, 2012). Specifically, through connecting descriptors of a behavior with certain functions, CRB3's support clients in responding differently to the behaviors connected with those descriptors. For example, if "breaking eye-contact" is connected to both "avoidance of anxiety" and the actual behavior of avoiding eye-contact, then a client may respond differently to the descriptor of this behavior (i.e., "breaking eye-contact"), such as through resuming eye-contact in a social interaction. The CRB3 may in this way help the

client make changes to their actual behavior, when otherwise they may label this behavior appropriately as “breaking eye-contact” yet fail change it since no contingency was specified along with this action.

Given this framework, CRB3’s in FAP thus may serve a similar role to TOF in interventions for PI. TOF and CRB3’s may both function as “contingency-specifying stimuli” in the sense of making explicit the relation between a person’s behavior and their contexts. However, TOF implies that the “contingency specifying stimulus” is part of a class of behavior that emerges through prior social shaping and non-specific reinforcement, and then is sustained through an internalization of reinforcing consequences for emitting the tact. In other words, TOF points to the role of specifying the contingencies of one’s behavior as having a history of reinforcement that is similar to other tacts, in addition to serving as a “contingency specifying stimulus” that transforms the functions of the behavior via its connection to verbal descriptors of that behavior. Although theoretical writing exists on CRB3’s, no research to date has examined the role of CRB3’s specifically in therapeutic changes.

#### *The ACT Matrix as a Tacting-Focused Intervention*

The ACT Matrix was developed from within communities of ACT and FAP practitioners and incorporates noticing and labeling the functions of behavior as a focal skill (Figure 1; Polk et al., 2016). The Matrix distinguishes behavior under the control of values (the right-hand side of Figure 1) and behavior under the control of unwanted internal events (the left side of Figure 1). Using the Matrix visual, clients practice tacting these behaviors, their antecedents, and their consequences, particularly in terms of tacting valued and avoidant functions using the non-technical labels “towards” and “away.”

Based on this foundation, ACT interventions may then be introduced in the service of increasing the client's ability to engage in "towards moves" or appetitive behavior under the control of values while reducing the need to engage in "away moves" or aversive behavior under the control of unwanted thoughts, feelings, or other inner events.

The noticing and labeling skills within the Matrix offer a framework with which to examine the effects of TOF on psychological inflexibility. The Matrix supports both verbal and visually representing the contingencies of one's behavior, specifically through contextualizing these contingencies along a dimension of "away" and "towards" that corresponds with appetitive and aversive functions (see Figure 1). Using the Matrix point-of-view, clients are asked to label or tact their internal and 5-senses experiences; to label or tact the behaviors accompanying these experiences; and to sort their behaviors along the towards-away dimension of the visual. This practice is consistent with a definition of TOF as verbally specifying the antecedents (e.g., an inner or 5-senses experience) and consequences (e.g., moving "away" or "towards") of behavior (Pierce & Levin, 2019). In turn, the overarching goal of the Matrix as stated by Polk and colleagues (2016) is to help clients move "towards what is important" despite "internal barriers" (pp. 14). This goal is congruent with the notion of building psychological flexibility as the ability to move towards one's values independent of what unwanted thoughts and feelings are present (Hayes et al., 2011). Altogether, the contents, visual, and skills introduced through the Matrix are thus aligned with TOF, and its overarching goal is to build psychological flexibility or to reduce PI.

There is some evidence to support the Matrix as an intervention for PI among heterogeneous client populations. One study of a nine-session, Matrix-based group

intervention for adults with diverse presenting concerns found significant changes in PI concurrent with changes in mood and anxiety-related symptoms as well as quality of life (Miller, 2015). Relatedly, a study of group ACT for cancer survivors employed the Matrix during the first half of the intervention and found significant prior changes in PI predicting later changes in mood and anxiety-related symptoms (Arch & Mitchell, 2016). Further, published case studies using the Matrix have demonstrated concurrent changes in PI and in measures of psychosocial functioning with both diffuse and subclinical concerns (Wiggs & Drake, 2014) as well as more complex psychopathology (Weinrib et al., 2017). Based on these preliminary findings, the Matrix may be effective for a range of problems involving PI.

Conversely, no research has thoroughly investigated the mechanisms of change within the Matrix. Theoretical writings emphasize the process of labeling and discriminating the functions of behavior in the Matrix as the primary mechanism (e.g., Polk et al., 2016), suggesting TOF may be the proximal target of this approach relative to other ACT mechanisms (e.g., acceptance or defusion). In other words, TOF may reflect a fundamental skillset which precedes changes in PI in Matrix-based interventions, yet is not explicitly emphasized in other forms of ACT. If TOF is the primary mechanism of change in the Matrix, then changes in this process specifically can be investigated in relation to changes in PI. Evidence for TOF as a mechanism of change may then inform ACT interventions to maximize their efficacy in the context of diverse presenting concerns.

### **Web and App-based Adaptations of ACT**

Web and app-based adaptations of ACT provide a unique avenue for treatment delivery among college students and may serve to support the delivery of interventions that emphasize TOF. Such adaptations may also be more accessible for students who are otherwise unable or unwilling to access in-person services due to concerns related to stigma, cost, or lengthy wait times. Web or app-based modality has several advantages over in-person services including being immediately accessible, being able to repeat explanations or skills modules, and having a standardized or structured delivery of contents. While web and app-based adaptations lack the relational element of in-person interventions and are likely inappropriate for students in especially high distress or crisis, they may provide an avenue for students to develop skill in TOF and other functional-contextual skills that could provide transdiagnostic support for those in a middle-range of distress.

Studies of web and app-based adaptations of ACT interventions point to such interventions as being feasible and acceptable for students. This research has demonstrated the effectiveness of web or app-based adaptations of ACT for general distress in college students meeting a distress cutoff (Levin, Haeger, Pierce, & Twohig, 2017) and in non-clinical college samples (Levin, Pistorello, Seeley, & Hayes, 2014) and for specific outcomes such as smoking cessation (Bricker, Wyszynski, Comstock, & Heffner, 2013), depressive symptoms (Lappalainen, Langrial, Oinen-Kukkonen, Tolvanen, & Lappalainen, 2015) and improving health behavior (Levin, Pierce, & Schoendorff, 2016). The effect sizes demonstrated in such interventions are moderate (e.g., Pots et al., 2016) and the effects of web and app-based approaches are mediated through PI processes (e.g., Levin et al., 2017). Students have generally endorsed that such



interventions are acceptable, as indicated through system usability assessments (Levin et al., 2014). As such, these interventions provide one avenue for increasing access to functionally-anchored skills that can help with a breadth of concerns.

Web and app-based interventions also provide a structure for skills delivery that can increase their consistency and adherence to a functional perspective. This mode of intervention provides the opportunity to support clients on a regular basis in taking a functional perspective on their symptoms and experience, whereas an in-person counselor may only have the opportunity to elicit and reinforce functional responses in-session. For example, such interventions may be able to introduce the ACT skill of *acceptance* through having clients identify their unwanted thoughts and feelings while noticing if they respond to these experiences by feeling them openly or acting to move away from them. An online format may then provide the client an opportunity to notice and record these experiences while receiving interactive help over the course of a week. Conversely, an in-person therapist may only have the counseling session hour to introduce acceptance and then elicit and reinforce accepting behavior. As such, web and app-based interventions can offer several opportunities to learn and practice functionally-oriented skills, which may benefit individuals in a moderate range of distress who could benefit from support yet may not be able to access individual counseling or may experience equal benefits from online or app-based formats.

Given these considerations, web and app-based interventions provide a unique avenue for evaluating functional skills such as TOF, using a medium that is acceptable and has shown benefits for students. The evaluation of these skills through a web and/or app-based adaptation may in turn benefit interventions for students through identifying

functional targets most strongly related to changes in psychologically inflexible behavior and symptoms. For example, recent evidence points to potential benefits of tailoring app-based interventions based on responses to functionally-anchored questions in a college population (Levin, Navarro, Cruz, & Haeger, 2018). Altogether, this approach may be ideal for evaluating the role of TOF as a functionally-anchored skill in the context of a wide range of psychological concerns among college students.

### **The Present Study**

The Matrix offers a potentially promising, brief approach to building TOF as an intervention for PI among college students, and web and app-based interventions provide an avenue to deliver this intervention in a structured and consistent way to a broad population of students. The Matrix offers a heuristic framework of basic functional discriminations, using the accessible language of “away” and “towards” that college students could easily adopt, and has preliminary evidence with the most common mental health symptoms in this population (e.g., mood and anxiety symptoms; Miller, 2015). A web-based delivery of these skills would further increase the accessibility of these skills using a medium familiar to college students and includes advantages for training specific behavioral techniques, such as being able to return to intervention content or reinforce behavior in-vivo in a student’s experience. Students equipped with the tacting skills provided through the Matrix perspective may be equipped with a repertoire for navigating the transitions and mental health challenges that arise in college, as well as a tool for more easily changing psychologically inflexible behavior. The basic tacts provided through the Matrix are widely generalizable and may thus form the basis of a functional

contextual intervention for a broad scope of college student problems reducing burden on college counseling centers.

The present study investigates the potential for a web and app-based adaptation of the Matrix to build TOF as a foundational, functional skill for making changes in psychologically inflexible behavior. The intervention developed for the present study is focused around TOF skills as delivered through the Matrix point-of-view and does not incorporate other ACT processes such as defusion, acceptance, or mindfulness explicitly. It was newly developed by the research team based on the Matrix intervention manual (Polk et al., 2016) and has not been tested in prior research studies. In contrast to previous web and app-based studies (Levin, Pierce, & Schoendorff, 2016) and face-to-face interventions (Miller, 2015) using the Matrix or its components, the present intervention emphasizes building students' repertoire for TOF as the primary target and mechanism of change in relation to mental health concerns. This focus is supported through the web and app-based delivery of TOF skills through the Matrix, such that increases the consistency and precision in their presentation. Altogether, these components of the intervention support precision in the evaluation of TOF as a mechanism of change that has not in previous research been distinguished from other intervention processes as applied to college student mental health.

The study focuses primarily on students with elevated mood and anxiety symptoms, as these problems correspond with the most ubiquitous concerns treated at college counseling centers. It examines both the direct effects of TOF on students' symptoms and functioning, as well as the indirect effects of this process on outcomes in relation to changes in PI. Consistent with a functional contextual approach, it examines

both the symptomatic and functional outcomes most strongly implicated in mood and anxiety related problems, namely, symptoms of general anxiety and depressed mood, low behavioral activation, and diminished life satisfaction (Headey, Kelley, & Wearing, 1993; Kanter, Mulick, Busch, Berlin, & Martell, 2007). From a functional contextual perspective, changes in symptoms were considered concurrent with the ability to live a satisfying, valued life despite the internal symptoms of depression and anxiety (Hayes et al., 2011). Based on these goals, the following research questions are examined:

1. Does an online and app-based Matrix intervention cause changes in target symptoms, behavioral activation, and life satisfaction and quality among college students?
2. Do changes in tacting of function account for a portion of the intervention effects on target symptoms, behavioral activation, and life satisfaction and quality?
3. Do changes in psychological inflexibility account for a portion of the intervention effects on target symptoms, behavioral activation, and life satisfaction and quality? To what extent are these changes explained by changes in tacting of function?
4. What is the feasibility of the Matrix as a brief intervention for tacting of function, psychological inflexibility, and common college student concerns?

## CHAPTER III: METHOD

### Design

The present study involved a 2 condition (waitlist or intervention) by 5 measurement-occasion design, where participants were assigned to condition through a randomized-block procedure and the study period was eight-weeks. The active intervention period spanned across the first three weeks of the eight-week study. All variables were assessed bi-weekly across the study period; the first three bi-weekly assessments corresponded to baseline, mid-intervention, and post-intervention, while the final two bi-weekly assessments reflected two-week and four-week post-intervention follow-up assessments. The repeated measurement design allowed for the detection of both linear and quadratic changes in study measures over the full study-period to address Research Question 1, as well as for the detection of sequential changes in process variables followed by changes in the outcome variables across adjacent time-points to address Research Questions 2 and 3. The inclusion of five measurement occasions allowed for change in the process and outcome variables to be detected across different time spans in the study, such as across the intervention period only, across the post-intervention period only, or across both the intervention and post-intervention periods.

The primary outcome variable in the present study was symptoms of depression and anxiety, such that reflect the most common and co-occurring college student mental health concerns. The secondary outcomes included behavioral activation, quality of life, and satisfaction with life that assessed participants' overall engagement in patterns of vital living (i.e., valued action). The primary process variables included TOF as the proximal intervention target and psychological inflexibility as the primary mechanism of

change. The secondary process variables included tacting of inner experiences and mindfulness, which reflect skills that may be related to TOF and psychological inflexibility but were not targeted directly through the intervention.

### **Participants**

The present study recruited undergraduate and graduate students at a college in the Mountain West who had access to the internet and smartphones. Participants were recruited through fliers, online listings, and the research participation system at the college. Research advertisements provided participants with a link to an online study screening questionnaire which was used to assess participants' eligibility for the study. To enroll in the study, prospective participants were required to be enrolled in the college, 18 years of age or older, own a smartphone, and have an interest in improving their mental health. Participants also completed the Patient Health Questionnaire – Anxiety and Depression Scales (PHQ-ADS; Kroenke et al., 2016) as part of the screening questionnaire and had to score within the “mild” range (a score of 10 or higher; Kroenke et al., 2016) to be eligible for the study based on symptoms of anxiety and/or depression. Prospective participants were excluded from the study if they were under 18 years old, not enrolled in college, did not own a smartphone, did not meet symptom criteria, or were not interested in working on their mental health.

The study sample included 106 participants who completed the baseline survey and were assigned to either the intervention or waitlist condition. This sample was narrowed down from a broader group of 233 students who completed the screening questionnaire (Figure 2). The reasons for ineligibility among screened individuals included failing to complete the screening survey ( $n = 29$ ), scoring below the PHQ-ADS

clinical cutoff ( $n = 75$ ), seeing a therapist regularly or starting to see a therapist within two weeks of the study starting ( $n = 5$ ), being uninterested in working on mental or emotional health ( $n=5$ ), and non-fluency in English ( $n = 3$ ). Of those completing the screening questionnaire, 116 students were eligible for the study and 106 of these students completed the baseline questionnaire following the online consent form. 4 participants completed the informed consent but did not complete baseline, and 6 participants started but did not complete the baseline questionnaire. Following completion of the baseline questionnaire, 54 participants were assigned to the intervention condition and 52 were assigned to the waitlist control condition. None of the binary-coded demographic variables (i.e., gender, ethnicity, sexual/romantic orientation) was statistically significantly related to condition assignment, and age was similarly unrelated to assignment to condition.

The average age of the sample at baseline was 21.76 years old, with a range from 18 to 58 years ( $SD = 5.92$ ). The sample included 83.2% who self-identified as female, 16.8% of participants who self-identified as male. No participants endorsed a transgender, nonbinary, or nonconforming gender identity. Participants self-identified as 87.3% White or Caucasian ethnicity, 6.4% other European ethnicity (e.g., Slavic, Italian, Portuguese), 4.5% Latinx, 0.9% Asian, and 0.9% Mixed ethnic identities. When asked to self-identify sexual or romantic orientation, 78.8% of participants identified as heterosexual or “Straight,” 3.5% as Lesbian, 3.5% as Gay, 8.8% as Bisexual or Pansexual, 1.8% as Asexual, and 3.5% other sexual or romantic identities (e.g., no label, “none”). 12.5% of the sample endorsed having children. Participants endorsed a range of housing situations, with 39.3% renting an off-campus apartment or townhome, 21.4%

renting on-campus housing with roommates, 15.2% living with their parents, 13.4% renting an off-campus apartment or townhome with no roommates, 0.9% owning an off-campus townhome, and 9.8% endorsing “other” housing situations.

Considering baseline distress levels, participants eligible for the study had an average score of 25.23 (SD = 9.21) on the PHQ-ADS. This average fell within the “moderate” level of depressive and anxious symptoms established within norming samples for the PHQ-ADS (Kroenke et al., 2016). At baseline, 28.5% of participants endorsed a mild level of distress (score of 10-19), 44.9% scored in the moderate range of distress (score of 20-29), and 26.6% endorsed severe distress (score of 30+) due to depressive and anxious symptoms.

### **Procedures**

Study advertisements provided students with a link to an online screening questionnaire that assessed participants’ eligibility to enroll. Prospective participants who fell below the clinical cutoff on the PHQ-ADS or who were otherwise ineligible for the study were provided with information on other self-help and in-person mental health resources on and near the college campus.

Following the screening and informed consent process, participants completed a baseline questionnaire including all study measures and items asking participants to self-identify and report demographic information. After completing the baseline questionnaire, participants were either assigned to the online and app-based intervention (the intervention condition) for eight weeks or to wait eight weeks before having access to the online intervention and app (the waitlist condition). The random assignment procedure was based on a random number generator that assigned participants either 1 =



*intervention* or 2 = *waitlist* after they completed the baseline questionnaire. Participants received these numbers in blocks of four individuals that were counted based on their order of completing the baseline questionnaire; two participants were assigned to the *intervention* condition and two were assigned to *waitlist* for every four persons completing the baseline questionnaire. Participants were notified of their condition assignment following the baseline questionnaire through a text pop-up that was presented after the baseline questionnaire.

Participants assigned to the *intervention* were asked to complete three online sessions one week apart and use a supplemental app focused on building *tacting of function* (TOF) as an *intervention* for *psychological inflexibility* (PI). Participants in the *waitlist* condition were asked to wait eight weeks and then were provided the option to receive the online sessions and have access to the app. Participants in the *intervention* condition were provided with a link to the first online session through the text-based pop-up following the baseline *intervention*, and were subsequently emailed the links to the second and third online sessions at one-week and two-weeks after completing the baseline survey, respectively. If participants did not complete an online session, they were re-sent the link and received a follow-up call from the research assistant after 48 hours of receiving the original link.

Participants in both conditions completed online, bi-weekly assessments over the course of the study, starting two weeks after completing the baseline questionnaire and continuing until the end of the eight-week study period. Relative to the timing of the online *intervention*, the first three biweekly questionnaires were administered before the first online *intervention* session (time 1), immediately after the second online session

(time 2), and one week after the third online intervention session (time 3), respectively. The remaining two biweekly questionnaires were administered at three (time 4) and five (time 5) weeks after the last online intervention session. All questionnaires were identical across study conditions except for the final questionnaire (time 5). This final survey asked participants in the intervention condition to provide feedback on their experiences completing the online sessions during the first three weeks of the study and on using the app throughout the eight-week study period.

After the study period, participants were asked whether they wished to receive a study debriefing via phone or email. This debriefing revisited the study's purposes, procedures, and intended uses and potential benefits of the study, consistent with information provided in the informed consent document. The debriefing call or email also provided participants the opportunity to ask questions about any of the study purposes, procedures, or uses of the information they provided. This procedure allowed participants to revisit any questions that may have arisen during the study period and to provide a context for the procedures that they experienced. At this time, participants in the intervention condition were asked to uninstall the app from their phones and waitlist participants were provided links to the online sessions and download instructions for app.

All study procedures were approved by the Utah State University Institutional Review Board (Protocol #9020).

#### *Online and app-based Matrix Intervention*

The web and app-based Matrix intervention was informed by the structure for using the ACT Matrix described by Polk and colleagues (2016). The contents of the online sessions were distributed across three, 15- to 20-minute modules that were

introduced one week apart. Session contents included text-based, video-based, and interactive presentations of the contents of the ACT Matrix, such that allowed relevant TOF skills to be introduced through metaphors and examples as well as practiced based on one's own experiences. All online sessions were built through the online survey platform Qualtrics and included the option to re-visit sections or the entirety of a session.

The app contents included both push notifications and user-initiated contents that were programmed to change weekly according to the contents of each of the three online session. The push notifications were delivered twice daily and presented as a series of text-based questions or prompts to support participants with practicing the specific TOF skill associated with that week's online session. The user-initiated contents included both the TOF skills and a "skills help" section that supported participants in clarifying questions about the skills presented through push notifications. In addition, the app included a daily self-reflection prompt to support participants in attending to their sense of progress in using the TOF skills to support valued living. All app features encouraged participants to notice and label their experiences relative to the contents of that week's online session, and provided feedback based on participants' entries about their experiences. The LifeData experience sampling platform was used to deliver the app contents, which includes text-based, sliding scale report, and text-entry features.

Participants in the intervention condition were asked to complete all online sessions and to use the app regularly during the first three weeks in line with the intervention sessions. Intervention participants were then encouraged to use the app as-needed over the remaining five weeks of the study period.

*Online session 1.* The first session introduced the Matrix point-of-view and asked participants to generate examples of experiences that fit in each of the four quadrants of the Matrix. The session next introduced label for “away moves” and “towards moves” as a convenient way to discuss specific behaviors with avoidant or approach-based functions. Then the label of “stuck loops” was introduced to discuss patterns behavior dominated by an avoidant function. The session ended by asking participants to commit to practicing moving “towards” over the course of the intervention, and provided participants instructions for downloading the app to start noticing “away” and “towards” moves.

*Online session 2.* The second session reviewed “away” and “towards” moves and asked participants to give examples of “towards moves,” “away moves,” and “stuck loops” they noticed over the past week. The “hooks” metaphor (Polk et al., 2016) was used to frame how actions that served to avoid unwanted experiences (i.e., experiential avoidance) or involved literal responses to thoughts (i.e., fusion) could sustain stuck loops. Briefly, this metaphor relates thoughts and feelings to fish hooks which, if bitten, can influence how one behaves. The alternative of biting the hook is to swim through one’s hooks with enough awareness to notice them without “biting” them. Participants were asked to name “hooks” that arise in both their inner and five-senses experiences, as well as in what other people say, and to share what they did when they “bit” the hook. Participants were asked to practice noticing and sorting their hooks onto the Matrix as the second foundation of the intervention. App content following this session included noticing “away” and “towards” moves, as well as noticing “hooks” and “biting” since the previous prompt.

*Online session 3.* The third session reviewed concepts of “away-towards,” “stuck loops,” and “hooks” and introduced the skill of “verbal aikido” (Polk et al., 2016) as a comprehensive Matrix skill for practicing moving “towards” in the presence of one’s “hooks.” Briefly, verbal aikido involves walking through a series of questions designed to organize their experience in terms of the Matrix point-of-view and to support tacting both internal - 5-senses and towards - away dimensions of their experiences (Figure 1). Participants were then invited to practice verbal aikido with a “hook” they found especially difficult to navigate. Lastly, the session asked participants to set “towards” goals to pursue at differing levels of difficulty while practicing the “verbal aikido” skill. App content for this session included a walk-through of the “verbal aikido” skill and follow-up prompts to assess their progress towards goals.

## **Measures**

### *Demographics*

Participants were asked to complete a demographic questionnaire as part of the pre-intervention assessment. This questionnaire asked participants to report their age, gender, race, ethnicity, and sexual orientation as relevant identity variables, and their estimated annual income, relationship status, family structure, and form of housing as contextual variables. All identity variables were self-reported by participants, whereas contextual variables were selected from multiple choice items.

### *Processes of Change*

Participants were asked to report on awareness of private and sensory events, tacting of private events, TOF, and PI as key process variables.

*Awareness of private and sensory events.* The Mindful Awareness and Attention Scale (MAAS; Brown & Ryan, 2003) was used to assess awareness of private and sensory events (Cronbach's  $\alpha$  at baseline = .87 in the present sample). This scale asks participants to rate the truthfulness of statements relating to self-awareness, such as "I rush through activities without being really attentive to them," with the total score reflecting the extent to which one has attended to a range of experiences. The MAAS shows strong internal consistency and test-retest reliability (Brown & Ryan, 2003), and is related to mindfulness experience, distress, emotion regulation, and wellbeing in both clinical and non-clinical samples (Brown & Ryan, 2003; Carlson & Brown, 2005).

*Tacting of private events.* Participants completed the Describe subscale of the Five Factor Mindfulness Questionnaire (FFMQ; Baer et al., 2006) to report on the ability to tact or label private events ( $\alpha = .85$ ). This subscale asks participants to rate the extent to which they can describe a range of private events using words, for example, "I'm good at finding words to describe my feelings." The Describe subscale is positively related to overall psychological wellbeing and PI, and is negatively related to depressive symptoms (Bohlmeijer et al., 2011).

*Tacting of function (TOF).* Tacting of the functions of behaviors was assessed through the 10-item Tacting of Function Questionnaire (TOF; Pierce & Levin, 2019), which assesses perceived strengths and deficits in identifying avoidant and approach functions of behavior ( $\alpha = .79$ ). The validation study demonstrated adequate internal consistency in a sample of college students, and overall TOF scores were correlated with a range of ACT process and symptom measures. This measure had incremental validity in accounting for symptoms of depression and anxiety; social and academic impairment;

and valued living, beyond variance explained by the Acceptance and Action Questionnaire – II (Bond et al., 2010).

*Psychological inflexibility (PI)*. PI was measured using the Acceptance and Action Questionnaire – II (AAQ-II; Bond et al., 2011) and the Valuing Questionnaire (VQ; Smout et al., 2014). The AAQ-II ( $\alpha = .92$ ) assesses patterns of avoidance associated with unwanted inner experiences as well as costs to valued living. The AAQ-II has demonstrated adequate internal consistency and test-retest reliability, and concurrently and longitudinally predicted impairment in functioning in students, mental health outpatients, and financial service workers (Bond et al., 2011). The AAQ-II also shows incremental validity relative to measures of mindfulness in explaining depressive symptoms, anxious symptoms, and positive mental health (Fledderus, Oude Voshaar, ten Klooster, & Bohlmeijer, 2012).

The VQ assesses Progress ( $\alpha = .86$ ) and Obstruction ( $\alpha = .76$ ) to living in accordance with values and converged with related measures such as satisfaction with life, personal wellbeing, and distress in undergraduate samples (Smout et al., 2014). The Progress subscale assesses perceived movement towards one's values, while the Obstruction scale assesses perceived barriers to moving towards values. The subscales of the valuing questionnaire covary strongly with other measures of psychological (in)flexibility (Smout et al., 2014).

### *Outcome Measures*

*Target Symptoms*. Symptoms of depression and anxiety were the primary outcome of the intervention, given the ubiquity of these concerns in college student populations. Depressive and anxious symptoms were assessed using the nine-item

Depression scale and the seven-item Anxiety scale of the PHQ-ADS ( $\alpha = .90$ ). The PHQ-ADS has demonstrated unidimensionality and strong convergent validity relative to measures of other mental health concerns, disability, and quality of life (Kroenke et al., 2016). Similarly, the composite PHQ-ADS score shows sensitivity to change in classifying primary care patients as worse, stable, or improved (Kroenke et al., 2016).

*Behavioral activation.* The Behavioral Activation for Depression Scale (BADSD; Kanter, Rusch, Busch, & Sedivy, 2009) was used to assess the extent to which participants engaged in approach and avoidance behavior in relation to their symptoms (overall  $\alpha = .91$ ). The Activation ( $\alpha = .85$ ) subscale assesses perceived approach behaviors, whereas the Avoidance ( $\alpha = .86$ ) subscale assesses perceived avoidance behaviors related to symptoms. The BADSD also includes Work/School Impairment ( $\alpha = .81$ ) and Social Impairment ( $\alpha = .88$ ) subscales that were used to assess perceived impairment due to depressive and anxious symptoms, reflecting impairment in behavioral activation. Scores on the BADSD converged with measures of cognitive avoidance, social engagement, and depressive symptoms in a community sample (Kanter et al., 2009).

*Life quality and satisfaction.* Satisfaction with life was assessed using the Satisfaction with Life Scale (SWLS; Pavot & Deiner, 1993) and the Quality of Life Inventory (QOLI; Frisch, Cornell, Villanueva, & Retzlaff, 1992). The SWLS ( $\alpha = .90$ ) is a brief measure of overall life satisfaction which has shown strong internal consistency, temporal stability, and sensitivity to changes in life circumstances across clinical and non-clinical samples of various ages and ethnicities (Pavot & Deiner, 1993). The QOLI ( $\alpha = .87$ ) asks respondents to first rate the importance of sixteen life domains (e.g., health, self-esteem, goals and values, etc.) and then report their satisfaction with each domain.



Individuals' ratings of importance and satisfaction are then aggregated to provide an overall estimate of subjective quality of life. Scores on the QOLI converges with clinician-rated and peer-rated measures of life quality, as well as with measures of general distress and depression, in clinical and non-clinical samples (Frisch, et al., 1992).

### *Intervention Feedback*

Participants in the Matrix condition were asked to provide feedback on their experiences in the intervention through qualitative and quantitative items. These items were based on previous questionnaires used in prior web and app-based adaptations of ACT (Levin et al., 2017) that assess perceived satisfaction, feasibility, effectiveness, and acceptability for college students.

Quantitative items asked participants to provide feedback on their satisfaction with the intervention and perceived feasibility for students with depressive or anxious symptoms. Satisfaction was assessed based on three items asking participants to rate their perceptions of the helpfulness, quality, and length/volume of contents in the online sessions as well as three items asking about these same dimensions on the mobile app. Across all satisfaction questions as applied to the online sessions and app, participants selected ratings from 1 = *very dissatisfied* to 6 = *very satisfied*. To assess perceived feasibility, participants were asked to rate whether viewed the intervention as effective for symptoms of depression and anxiety, whether they would recommend it to other college students, and whether they would participate in the intervention if it was offered at a college counseling center, using a scale from 1 = *strongly disagree* to 7 = *strongly agree*.

The qualitative items asked participants to provide written responses to six questions about their experiences of the study. These open-ended questions asked participants “what aspects of the online sessions and app did you find most helpful” and “...least helpful;” what skills from the online sessions and app they noticed using in daily life; and what they would recommend to improve the online sessions and app contents. The final open-ended question asked participants if they believed other students would use the online sessions and app, as well as why they did or did not believe others would use them.

### **Analyses**

#### *Research Question 1*

Mixed effects models were used to examine changes in the dependent variables over time in the intervention condition, as compared with the waitlist control condition. A mixed effects modeling approach accounted for the nesting (i.e., non-independence) of repeated observations within participants (Goldstein et al., 2004); relaxed assumptions of homoskedasticity present in other approaches (i.e., repeated-measures ANOVA or ANCOVA; Tabachnick, Fidell, & Ullman, 2007); and allowed for missing data handling techniques such as full-information maximum likelihood estimation (Enders, 2010) to be applied. As applied to Research Question 1, this approach permitted the time variable to be treated continuously and allowed for between-participant variability in the intercepts and slopes (change over time). This allowed for both the quantification of an expected effect on the dependent variable per one-unit change in the time variable, as well as the estimation of the extent to which this effect varied depending on participants’ condition assignment as well as when condition was held constant at the waitlist group (i.e., the

reference condition). As the intervention effects may include both linear and quadratic elements, a mixed linear modeling approach allows for these elements to be distinguished and tested against statistical criteria through the inclusion of both linear and quadratic temporal effects.

Mixed effect models also permitted an assessment of first-order autoregressive effects, where adjacent observations are more strongly correlated than observations spaced farther apart, through comparisons of models including or excluding such effects. A failure to account for autoregressive effects may contribute to biases in estimates of the residuals and standard errors of model effects (Silber, Kjellsson, & Karlsson, 2009). As such, all models were run with first-order autoregressive effects (i.e., among adjacent observations) as well as no autoregressive effects in the dependent variables, and the best-fitting covariance structure was selected through comparison of the overall log likelihoods of models with and without such effects.

Research Question 1 was evaluated through computing the interaction between participant condition assignment and the within-person effect of time on the outcome and process variables. For these models, intervention condition was dummy-coded as 0 = *waitlist* and 1 = *intervention*, while the time variable was coded from 0 = *baseline* to 4 = *two-week follow-up*. A statistically significant condition by time interaction would indicate that trajectories of change varied systematically in relation to condition assignment. Graphical analyses of standardized scores on the dependent variable were used to interpret the shape of the interaction effect in the case of statistically significant interactions. In addition to the interaction term, significant condition or time effects in such models could be interpreted as reflecting marginal differences in the dependent

variable explained by either condition assignment or by the average estimated effect of time in the waitlist condition (i.e., when condition was at a value of zero in the model).

The parameter estimates, standard errors, and sampling distributions of the coefficients in these models were estimated based on a maximum likelihood estimation algorithm. These models were run in R (R Core Team, 2013) using the packages *lme4* version 1.1-21 (Bates, Maechler, Bolker, & Walker, 2015), to perform modeling procedures, as well as the *reghelper* package, version 0.3.4 (Hughes, 2018), to obtain standardized scores and parameter estimates.

To facilitate the interpretation of significant interactions involving quadratic effects, reliable change indices were computed across the pre- to post-intervention and pre-intervention to follow-up periods to characterize the magnitude of differences among groups across these time-spans (Zahra & Hedge, 2010). The reliable change index provides a categorical estimate of clinically significant change on a measure while adjusting for scale unreliability. Per Equation 1, the reliable change index is computed based on the ratio of the difference between two measurement occasions on a given variable to its variance, adjusted for unreliability in its measurement (Zahra & Hedge, 2010):

$$RCI = \frac{Y_2 - Y_1}{\sqrt{2(S_1\sqrt{1-r_{yy}})^2}} \quad \text{Equation 1}$$

In Equation 1,  $Y_2 - Y_1$  is the difference in scores on variable Y between occasion 2 and occasion 1,  $S_1$  is the standard-deviation of variable Y at measurement occasion 1, and  $r_{yy}$  is the alpha reliability estimate for variable Y. Based on this equation, the RCI forms a normal probability distribution, such that reliable changes can be interpreted as z-scores.

The proportion of participants with an RCI exceeding the 97.5 percentile point of a null distribution of reliable changes (i.e., participants whose  $RCI > 1.96$ ) was computed for each condition from pre to post-intervention (time 1 to time 3) and pre-intervention to the four-week follow-up (time 1 to time 5). These proportions were then compared across conditions using chi-square tests to assess the probability that differences in the proportions of participants showing reliable changes were due to chance variations. A statistically significant chi-square difference test thus indicated that more participants showed reliable changes across a given time-span in one condition as compared with the other. A chi-square test across the pre to post-intervention period was used to assess the significance of differences in reliable changes by condition associated with the immediate intervention effects, whereas a chi-square test across the pre-intervention to four-week follow-up was used to determine whether significant differences in the proportions of participants showing reliable changes were preserved to follow-up. As such, the RCI analyses helped to corroborate at what points during the study participants showed the largest changes in the context of interaction effects involving a quadratic term.

### *Research Question 2*

Mixed effects models were also used to evaluate the lagged relations between TOF and the outcome variables at the within-participant level, while accounting for differences in group assignment at the between-participant level. As applied to Research Question 2, these models permitted an examination of the indirect effect of condition assignment as a between-person variable on an outcome variable through its effects on TOF, while controlling for prior values of TOF and the outcome. In this framework, the effects of condition on the outcomes could be interpreted in terms of the extent to which

condition assignment accounted for *changes* in TOF that in turn accounted for *changes* in the outcomes across adjacent observations.

This approach differs from a traditional ANOVA, ANCOVA, or single-level mediation designs for evaluating intervention effects on outcome variables through targeted processes (e.g., a three measurement-occasion mediation design; Baron & Kenny, 1986), because the present design emphasizes the relations between sequential changes in the process and outcome variables across all pairs of adjacent measurement occasions, as compared with focusing on relations between static scores on the process and outcome measures or with focusing on changes in the process and outcome variables relative to participants' baseline scores alone. This enhances precision in assessing the conceptual theory associated with the process variables, which refers to the theory linking *changes* in the process variables to *changes* in the outcome variables, while preserving integrity in the test of the action theory defining the relation between the intervention itself and changes in the process variables (Fairchild & MacKinnon, 2009). This modeling approach also provided details about both the proportion of the effect of condition on an outcome accounted for by TOF (i.e., the proportion of variance explained) as well as the magnitude of change across adjacent occasions in the outcome expected through this effect (i.e., the effect size). These models were run in R using the *lme4* package, version 1.1-21 (Bates, Maechler, Bolker, & Walker, 2015), to estimate linear relations among condition assignment, TOF, and the outcome variables, and the *mediation* package, version 4.4.7 (Yamamoto, Tingley, Hirose, Keele, & Imai, 2014) to estimate the indirect effects of condition on the dependent variables through TOF.

Equations 2 and 3 describe the within-person portion of the two-level mixed model that considers the relation between prior changes in TOF and later changes in the outcome variables:

$$y_{jt} = b_{0yj} + b_{1yj}T_{jt} + b_{2yj}m_{jt-1} + a_{1yj}y_{jt-1} + e_{yjt} \quad \text{Equation 2}$$

$$m_{jt} = b_{0mj} + b_{1mj}T_{jt} + a_{1mj}m_{jt-1} + e_{mjt} \quad \text{Equation 3}$$

Equations 1 and 2 show the within-participant regression for a given outcome variable ( $y$ ) and TOF ( $m$ ) for participant  $j$  at time  $t$ . These equations include random coefficients for a time variable ( $T$ ), prior values of TOF ( $m_{jt-1}$ ), and prior values of the outcome variable ( $y_{jt-1}$ ). The coefficient of time ( $b_1$ ) accounts for linear growth trajectories in the TOF ( $m_{jt}$ ) and outcome variable ( $y_{jt}$ ), which may vary between participants. The first-order autoregressive coefficients ( $a_1$ ) account for stronger associations between measurements on adjacent occasions than among measurements from more distal occasions. These autoregressive coefficients are fixed over time yet may vary between participants. The error terms ( $e$ ) reflect random deviations from the expected values of  $y$  or  $m$  based on the predictors; the errors have a mean of zero and are uncorrelated with all other variables in the model.

Equations 4 to 10 describe the between-person level of the model, in which coefficients are modeled as a function of person-level intercepts, covariates, and deviation terms.

$$b_{0yj} = b_{00y} + b_{02y}C_j + u_{(b0)yj} \quad \text{Equation 4}$$

$$b_{0mj} = b_{00m} + b_{02m}C_j + u_{(b0)mj} \quad \text{Equation 5}$$

$$b_{1yj} = b_{10y} + u_{(b1)yj} \quad \text{Equation 6}$$

$$b_{1mj} = b_{10m} + u_{(b1)mj} \quad \text{Equation 7}$$

$$b_{2yj} = b_{20y} + u_{(b2)yj} \quad \text{Equation 8}$$

$$a_{1yj} = a_{10y} + u_{(a1)yj} \quad \text{Equation 9}$$

$$a_{1mj} = a_{10m} + u_{(a1)mj} \quad \text{Equation 10}$$

At the between-person level of the model, both within-person intercept terms are expressed as a function of differences in condition assignment ( $b_{02y}C_j$  and  $b_{02m}C_j$ ), where condition  $C = 0$  for the waitlist control group and  $C = 1$  for the intervention condition, random deviations due to between-person variability in TOF or the outcome variable ( $u_{(b0)yj}$  and  $u_{(b0)mj}$ ), and the between-person intercept of either TOF ( $b_{00m}$ ) or the outcome variable ( $b_{00y}$ ). The remaining within-person coefficients ( $b_{1yj}$ ,  $b_{1mj}$ ,  $b_{2yj}$ ,  $a_{1yj}$ ,  $a_{1mj}$ ) are expressed as random effects with between-person deviation and intercept terms, without a dependency on condition assignment. The intercept values  $b_{10y}$  and  $b_{10m}$  provide estimates of effects of time on TOF or the outcome variable that are not accounted for by condition assignment or prior values of these variables. The intercept  $b_{20y}$  provides an estimate of the average effect of prior TOF on later values of the outcome variable.

As applied to Research Question 2, the indirect effect of condition on the outcome variable through TOF was estimated through a product of coefficients approach (Yamamoto et al., 2014). To estimate the indirect effect, the between-person coefficient of condition predicting TOF ( $b_{02m}$ ) was multiplied with the average within-person coefficient for TOF predicting values of the outcome variable ( $b_{20y}$ ). Estimates of these coefficients were based on a restricted information maximum likelihood algorithm, while uncertainty associated with the product of these coefficients was estimated using a Bayesian “credibility interval” method (Biesanz, 2010). Briefly, the Bayesian approach



draws multiple estimates from the posterior distributions of each first-order coefficient to be multiplied, then constructs the credibility interval based on the cross-products of the first-order coefficients from each draw from their posterior sampling distributions. This approach was selected due to greater suitability for a small sample with a complex data structure (e.g., repeated measures) and its accuracy in replicating confidence intervals in prior simulation studies (Biesanz, 2010).

The indirect effect provided through the product of coefficients approach to Research Question 2 differs from that estimated via mediation analysis (see, e.g., Mackinnon, 2007). Specifically, the indirect captured through this approach includes the average effect across all adjacent observations of TOF predicting later changes in the outcome variable on the one hand, and the overall effect of condition predicting average changes in TOF across all observations on the other. Given this, the indirect effect is evaluated across all within-person occasions and is not associated with a specific occasion in the study as in a single-level mediation model. While this limits the strength of inference about causality in the timeline of the intervention, it provides greater flexibility of the model to accommodate all measurement occasions, enhances power to detect an indirect effect, and permits an assessment of (a) the relation between the intervention and changes in TOF as a target mechanism and (b) the relation between changes in TOF and changes in the outcome variables. The magnitude of this indirect effect was quantified based on the proportion of variance explained through changes in TOF in the relation between condition assignment and changes in the outcome variables. This proportion was computed based on the ratio of the estimated indirect effect to the

estimated total effect on changes in the outcome variables using the *mediation* package in R (Yamamoto et al., 2014).

### *Research Question 3*

The same statistical methods used to examine changes in TOF predicting changes in the outcomes were used to examine changes in PI predicting changes in the outcomes.

### *Research Question 4*

The feasibility of the intervention was evaluated based on descriptive statistics on usage of the online intervention sessions and app; descriptive statistics characterizing participants' responses to the quantitative items asking about satisfaction and feasibility; and qualitative coding of participants' open-ended responses. Information from each of these sources was integrated to provide an assessment of feasibility for students enrolled in the study.

Usage of the online sessions and app was drawn from records of completion of the online sessions provided through the Qualtrics online survey software as well as records of participants' responses to the app provided through the LifeData server. The frequencies of responses to each online session and app prompt over time were used to characterize to what extent and how consistently participants engaged in each intervention component.

The means, standard-deviations, and ranges were computed for each of the quantitative satisfaction and feasibility items as well as for the averages of these items within each intervention component (i.e., the online sessions and app) and across the entire intervention. These statistics provided an assessment of the central tendency and variability in participants' perceptions of helpfulness, quality, and length/volume of each

intervention component (i.e., the online sessions and app) separately and in their overall perceptions of the online sessions, the app, and the intervention. Similarly, this approach permitted an assessment of central tendency and variability in participants' ratings of feasibility for specific purposes (e.g., as applied to symptoms of depression/anxiety, to college students, or in a college counseling context) as well as in their perceptions of feasibility across these purposes.

For the qualitative, open-ended items, participants' responses were coded using a summative approach to content analysis (Hsieh & Shannon, 2005). Briefly, this approach involves first identifying prominent themes through counting of the themes in individuals' responses through keywords and then using the frequencies of each of the keywords and their synonyms to identify the most prominent themes. This initial summation stage was followed by an interpretive stage of analysis wherein responses associated with each prominent theme were reviewed to identify significant features within each theme. For example, if the theme of "skills" occurred frequently within participants' responses and included synonyms such as "techniques," "approaches," or "tools," the analyst may have then examined what "skills" participants mentioned often; how participants described using them; and in what contexts. This approach allowed for a distillation of the most salient feedback provided about the intervention and of relevant details in each area of feedback that were pertinent to the broader topic of feasibility of the online sessions and app for college students.

#### *Missing Data Approach*

Rates of missing values were assessed across all study variables. The proportion missing was computed for each study variable across all time points of the study.

Subsequently, linear regression analyses were used to examine the extent to which condition assignment as well as participants' average scores on the process and outcome variables were associated with the proportion of missing observations on these variables. This permitted an examination of whether attrition in responses was related to features of either the intervention or waitlist control condition, as well as whether missingness in participants' responses was non-random (i.e., dependent on the value of the missing variables). Differences in attrition by condition may lead to an underrepresentation of potential variability in the dependent variables by condition, such that could result in biased inferences about the significance, standard-errors, and effect-sizes associated with model parameters (e.g., participants in heightened distress could drop-out of the intervention condition earlier, resulting in an exaggerated estimate of the intervention effect at later time-points). Alternatively, if missingness on a variable depends on values of the variable itself, parameter estimates and standard-errors may be biased in the context of mixed linear models (Enders, 2010). For example, if a larger proportion of values in the lower or upper range of a variable are missing, then estimates of change due to the intervention effects may be downwardly biased relative to hypothetical population values that would include the full range of values on this measure (Little, 2013).

Missing data in the mixed linear models for Research Questions 1-3 were handled using restricted information maximum likelihood estimation (REML). REML estimates model parameters using participants with both complete and incomplete sets observations across measurement occasions, and shows minimal bias in the context of models with nested observations (Enders, 2010). REML estimation involves an iterative approach to maximizing the likelihood of the joint distribution of complete and incomplete

observations given the model parameters, assuming multivariate normality and missingness at random (MAR). The REML process is repeated until an optimal likelihood is reached for all parameters in the model; in the present analysis, this was defined as a minimal change across adjacent iterations of the likelihood estimation process (Enders, 2010). The REML approach used in the present analysis differs from a full-information maximum likelihood (FIML; Little, 2013) approach that includes exogenous variables (i.e. variables not included in the model to-be-estimated) in the estimation of model-estimated variance-covariance matrices. However, FIML and REML algorithms have similar approaches to handling repeated observations nested within participants when the entirety of variables are missing for certain measurement occasions (e.g., due to participants not completing a bi-weekly survey; Little, 2013).

## CHAPTER IV: RESULTS

### Participant Flow, Retention, and Adherence

Of the 106 participants who completed the baseline survey, 103 completed the subsequent 2-week survey. Following this survey, 70 participants completed the 4-week survey and 69 participants completed the 6-week survey. The final survey was completed by 81 participants and 67 participants completed all 5 surveys for the study. Within the intervention condition, 77.8% of participants completed the final survey and 47.1% completed all surveys, while in the waitlist control group 76.5% completed the final survey and 60.8% completed all surveys. Study dropout did not vary by condition ( $\chi^2 = 0.028, p = .878$ ), female versus male gender identity ( $\chi^2 = 0.230, p = .632$ ), white or underrepresented ethnicity ( $\chi^2 = 0.249, p = .618$ ), or hetero- sexual/romantic orientation versus non-hetero- sexual/romantic orientation ( $\chi^2 = 0.130, p = .719$ ).

Participants tended to complete the online assessments within 2 days of receiving the survey link, with 64.2% of responses completed within this timeframe. 16.2% of the online assessments were completed between 2-5 days of receiving the first link to the survey, 8.9% were completed between 5-7 days of receiving the link, and 5.7% were completed between 7-10 days after receiving the link. 4.9% of the online assessments were completed between 10-14 days after receiving the original survey link. As such, while most participants completed the online surveys promptly, there was some inconsistency in the temporal spacing among online assessments due to delayed responses in 19.6% of cases completing responses at five or more days past the intended assessment occasion. Possible implications of these departures from the intended assessment schedule are addressed in the Limitations section of Chapter 5.

### Assessment of Missing Data

Missing data were examined to determine both the extent of missingness and to assess to what extent missing values on the process and outcome variables depended on values of the variables themselves. Missingness in the data was characterized based on the proportion of missing values on each of the variables per participant. The average proportion missing across participants on the outcome variables ranged from 19.6% for the PHQ-ADS to 19.8% for the BADS, QOLS, and SWLS. The average proportions missing across participants on the process variables were 13.7% for the MAAS, 15.3% for the FFMQ-D, 17.2% for the TOF, 19.0% for the AAQ-II, and 19.6% for the VQ-O and VQ-P scales. All proportions missing were computed based on surveys that participants started and did not complete as well as surveys that participants did not start or complete.

The proportions of missing observations on each variable were regressed on a dummy variable for participants' condition assignment as well as participants' average scores on the same variable. This permitted an assessment of the extent to which missingness differed by condition as well as the extent to which missing observations were related to scores on the variable itself. None of the proportions missing on any of the outcome or process variables were statistically significantly associated with condition assignment (all  $p > .05$ ). However, the proportions missing on the BADS, QOLS, and SWLS were all statistically significantly associated with participants' average scores on these variables (all  $p < .01$ ). The proportion missing on the PHQ-ADS was not statistically significantly associated with participants' average PHQ-ADS scores. Among the process variables, only the VQ-Progress subscale was statistically significantly

associated with its proportion missing ( $p < .001$ ). Altogether, nonrandom missingness was more prevalent in the outcome variables than in the process variables, yet was not detected in the primary outcome (i.e., the PHQ-ADS) or the target process variables (i.e., the TOF and AAQ-II).

### **Measure Properties**

The means, standard-deviations, ranges, and reliabilities (computed as Cronbach's  $\alpha$ ) for all study variables at baseline are presented in Table 2. None of the study variables showed statistically significant skewness (all  $p > .05$ ) and all skewness statistics fell below a value of 1.00. None of the distributions of study variables appeared skewed upon visual inspection (i.e., all approximated a normal curve). Table 3 shows the means and standard-deviations of each variable across time-points and stratified by condition. None of the study variables varied significantly by condition at baseline (all  $p > .05$ ).

### **Correlational Analyses**

Correlational analyses were used to examine the preliminary associations among the study variables prior to running inferential models. These analyses were used to verify expected bivariate associations among the study variables, as well as identify issues related to collinearity among measures.

Bivariate correlations among the process variables are presented in Table 4. Tacting of function (TOF) was significantly, moderately associated with tacting of private events (FFMQ-D) and progress in valued living (VQ-P), and significantly weakly related to obstruction in valued living (VQ-P) in expected directions. The relations among the psychological flexibility variables (the AAQ-II, VQ-O, and VQ-P), tacting private events (FFMQ-D), and mindful awareness (MAAS) were mostly significant and



in expected directions, such that greater inflexibility was related to lower valued living, tacting of private events, and mindful awareness.

All bivariate correlations among the outcome variables were statistically significant, as shown in Table 5. The largest correlations (over  $r = .70$ ) were observed between behavioral activation (BADs) and quality of life (QOLS); and between behavioral activation and symptoms of depression and anxiety (PHQ-ADS). All other associations were in the moderate-large range.

As displayed in Table 6, tacting of function (TOF), tacting of private events (FFMQ-D), psychological inflexibility (AAQ-II), mindful awareness (MAAS), and progress (VQ-P) and obstruction (VQ-O) in valued living were statistically significantly associated with all of the outcome variables. All correlations were in the expected directions, such that higher scores on measures of distress (e.g., the PHQ-ADS) were associated with lower scores on measures associated with psychological skills or growth (e.g., the TOF, FFMQ-D, MAAS, and VQ-P) and higher psychological inflexibility scores (the AAQ-II and VQ-O).

### **Tests for Linear Change by Condition**

To address Research Question 1, mixed effects models were used to examine change in the process and outcome variables. These analyses examined the interaction between condition and time to examine differences in participants' average trajectories of change on the outcome and process variables by condition. Time was modeled both as a linear and quadratic effect to allow for constant as well as tapering or curvilinear slopes of change. All regression coefficients were converted to a metric of standard-deviation units on the dependent variables to assess effect-size.

*Models Assessing Change in the Outcome Variables*

Table 7 shows the results of models assessing both linear and quadratic trajectories of change over time for the outcome variables. There was a statistically significant, quadratic time-by-condition interaction for the targeted symptoms of anxiety and depression as measured by the PHQ-ADS. Symptoms of depression and anxiety statistically significantly declined in a linear trajectory over time in both conditions, however there were larger initial decreases in these symptoms among participants in the intervention condition as compared with the waitlist condition (Figure 3). Consistent with this finding, there was a statistically significant difference in PHQ-ADS scores by condition at time 3 ( $t(68) = 2.23, p = .028, d = .433$ ) but not at time 5 ( $t(79) = 0.97, p = .334, d = .267$ ).

Reliable change indices (Zahra & Hedge, 2010) were calculated for participants' PHQ-ADS scores to assess the rates of clinically significant change from time 1 to time 3, and from time 1 to time 5. Based on this index, 28.7% of waitlist participants and 50.0% of intervention participants showed clinically significant declines on the PHQ-ADS from time 1 to time 3 ( $\chi^2 = 3.761, p = .044$ ), while 46.1% of waitlist participants and 54.5% of intervention participants showed clinically significant declines from time 1 to time 5 ( $\chi^2 = 0.446, p = .386$ ). These findings are consistent with the quadratic trajectory of change estimated in the mixed linear model and displayed in Figure 3. Overall, greater change was observed in the intervention condition while participants were receiving the online sessions, and the largest and statistically significant between-groups difference in reliable change rates was observed across the active intervention period.

There was no statistically significant linear or quadratic time-by-condition interaction for behavioral activation as measured by the BADS, however there was a statistically significant linear increase in behavioral activation over time across participants in both conditions, with an expected 0.09 standard-deviation increase in behavioral activation for each unit increase in the time variable. Average scores on behavioral activation did not significantly differ by condition. Similar to behavioral activation, there were statistically significant, linear increases in life quality (the QOLS) and satisfaction (the SWLS) across the assessment points, yet neither of these variables showed a statistically significant time-by-condition interaction. As such, participants' life quality and life satisfaction appeared to increase across the assessment points irrespective of condition assignment.

Altogether, these results provide support for the effects of the intervention condition on the targeted symptoms (PHQ-ADS), and suggest the effects on symptoms were largest during the active intervention period but tapered off following the post-intervention assessment. However, intervention effects were not supported for behavioral activation or life satisfaction and quality.

#### *Models Assessing Change in the Process Variables*

Table 8 shows the results of models assessing linear and quadratic trajectories of change over time for the process variables. Tacting of function as measured by the TOF showed no statistically significant linear or quadratic time-by-condition interaction, no significant linear or quadratic change over time, and no statistically significant differences by condition assignment. There was a statistically significant, linear time-by-condition interaction for tacting of inner experiences, as measured by the FFMQ-D, such

that greater increases in tacting of inner experiences were observed in the intervention condition as compared with the waitlist condition. As displayed in Figure 4, there was on average a 0.108 standard-deviation increase in FFMQ-D scores across each two-week period in the intervention condition, and a near-zero slope of time in the waitlist control condition.

The models including psychological inflexibility as measured by the AAQ-II, obstruction to valued living as measured by the VQ-Obstruction scale, and mindful awareness as measured by the MAAS showed statistically significant linear time-by-condition interactions. As displayed in Figure 5, there was a larger decrease in psychological inflexibility in the intervention condition over time, with an expected 0.16 SD decrease over each two-week period in the intervention condition versus a 0.06 SD decline over each two-week period in the waitlist control condition. Figure 6 shows the interaction between time and condition predicting VQ-Obstruction scores, such that participants in the intervention condition had an expected decrease of 0.17 SD units in perceived obstruction to valued living across each two-week assessment period while participants in the waitlist control condition had an expected decrease of 0.03 SD units in this measure. As shown in Figure 7, there was a larger average increase in mindfulness over time in the intervention condition as compared with the waitlist control group, with an expected 0.21 SD increase in the intervention condition across each biweekly survey and an expected 0.08 SD increase in the waitlist control condition across each biweekly survey. Based on these results, the online and app-based intervention appeared to have a general versus mechanism-specific effect on the process variables, and the intervention did not seem to produce changes in the target mechanism of TOF.

### Analyses of Mechanisms of Change

Analyses for Research Questions 2 and 3 were performed in a mixed effects framework to estimate the indirect effects of the intervention condition on the outcome variables through either tacting of function or psychological inflexibility. These models controlled for prior measurement occasions of the process and outcome variables so that the temporal effects estimated between the condition, process, and outcome variables were based on deviations from previous values. As such, these models examined specifically whether condition assignment was associated with differential changes in the process and outcome variables across adjacent time-points, and whether prior changes in a process variable were associated with later changes in the outcome variable of interest. The time variable, scored from 0 = *baseline* to 4 = *final survey*, was included as a random effect in each of these models to account for linear change across occasions in the process and outcome variables, independent of the indirect effects.

The indirect effects were evaluated through the TOF and AAQ-II as primary measures of inflexibility and tacting of function, respectively. No statistically significant indirect effects emerged for changes in TOF intervening in the relation between condition assignment and any of the outcome variables, therefore these results are not presented here. However, changes in the AAQ-II explained a statistically significant proportion of the association between condition assignment and changes in the PHQ-ADS, BADS, and SWLS. Table 9 presents estimates of the indirect effect of condition through the AAQ-II on these outcome measures, where  $b_{02m}$  indicates the effect of condition on the AAQ-II intercept,  $b_{20y}$  indicates the average effect of the AAQ-II on later changes in the outcome variable,  $b_{02y}$  indicates the effect of condition on the intercept for the outcome variable

independent of the AAQ-II, and “Total Effect” denotes the total effect of condition on the outcome variable. This table also displays the cross-products estimate ( $b_{02m} * b_{20y}$ ), 95% “credibility intervals,” and proportion of the total effect of condition on the outcome variable explained through the AAQ-II.

As displayed in Table 9, 16.5% of the effect of intervention condition on changes in PHQ-ADS scores was explained through changes in the AAQ-II across adjacent time-points. Participants in the intervention condition experienced significantly larger declines in psychological inflexibility (the AAQ-II) across adjacent time-points, and declines in psychological inflexibility across adjacent time-points were significantly associated with later declines in symptoms of depression and anxiety (the PHQ-ADS). As such, belonging to the intervention condition as compared with the waitlist control condition was associated with reductions in depressive and anxious symptoms that were partially explained through reductions in psychological inflexibility.

For the BADS, 25.2% of the effect of intervention condition on change across adjacent time-points was explained through changes in the AAQ-II. Belonging to the intervention condition was significantly associated with larger declines in psychological inflexibility across adjacent which in turn significantly explained later increases in behavioral activation across adjacent time-points (the BADS). Condition assignment was therefore positively related to later increases in behavioral activation across adjacent time-points that were explained through prior reductions in psychological inflexibility.

Similarly, 23.6% of the effect of intervention condition on changes in the SWLS was explained through changes in the AAQ-II, such that the effects of condition assignment on later increases in satisfaction with life explained through reductions in the

AAQ-II. Neither condition assignment nor changes in psychological inflexibility appeared to explain variance in changes in quality of life (the QOLS) across adjacent time-points.

Table 9 also provides estimates of the significance of total effects associated with condition predicting average changes in scores across adjacent time-points on the outcome variable (i.e., predicting the within-person intercept). It is noteworthy that the total effect for condition predicting changes in the BADS was non-significant, and that effects associated with the PHQ-ADS and QOLS were marginal. In such cases, it may be that the total effect of condition assignment on changes in the outcome variable was inconsistent, or inconsequential, outside of the proportion of this effect accounted for by the AAQ-II. A theoretical account for this phenomenon is provided in Zhao, Lynch, & Chen's (2010), who show that indirect effects can support a significant indirect influence of a variable despite the direction, magnitude, or significance of the total effect differing from the indirect estimate.

Altogether, these findings suggest that prior changes in psychological inflexibility accounted for a portion of the relationship between condition assignment and later changes in symptoms of depression and anxiety, behavioral activation, and satisfaction with life. These indirect effects were in the expected direction such that condition assignment predicted reductions in inflexibility that, in turn, predicted later increases in behavioral activation and satisfaction with life, and decreases in symptoms of depression and anxiety.

### **Analyses of Feasibility and Satisfaction**

To address Research Question 4, engagement with the online sessions and app, ratings of satisfaction and perceived feasibility of the intervention, and responses to qualitative feedback questions were analyzed descriptively for participants in the intervention condition.

### **Engagement Analyses**

Of the 54 participants assigned to the intervention condition, 79.17% completed all 3 online intervention sessions and 40 (74.07%) used the app at least once. Of the remaining participants in the intervention condition, 10.42% completed 2 of the online intervention sessions and 10.42% completed only 1. Statistically significant correlations were identified between session completion and online survey completion ( $r = 0.793$ ,  $p < .001$ ), app use (coded 1 = *used the app*, 0 = *did not use the app*) and online survey completion (point-biserial  $r = 0.454$ ,  $p < .001$ ), and session completion and app use (point-biserial  $r = 0.583$ ,  $p < .001$ ). No statistically significant correlations were observed among online session completion or app use and binary gender, binary ethnicity, binary sexual/romantic orientation, and participant age.

Descriptive statistics for participants' app use are presented in Table 10. Participants used the app for an average of 6 weeks, with a maximum of 8 weeks (112 prompts). Participants completed an average of 28.6% of "notification initiated" skills delivered via push notifications, while the app was installed on their phones. Six of the participants using the app, or 15.0%, completed fewer than three such prompts; 15 participants (37.5%) completed between 10 and 30 prompts; and 15 participants (37.5%) completed over 30 prompts. Over half (61.8%) of participants had used the app 21 or more times over the first three weeks of the study, consistent with instructions to use the



app once daily during the intervention period. Figure 8 shows the number of participants responding to each notification, by notification number, where a response is defined as opening and completing an app session. As illustrated Figure 8, responses tended to become less frequent after the thirtieth prompt delivered, which corresponds to two weeks of prompts (14 prompts \* 2 weeks = 28 prompts). Prompts 0 through 30 elicited an average of 19.15 responses (a 63.8% response rate), while prompts 30 through 60 elicited responses from an average of 9.44 participants (31.47% response rate) and those delivered after prompt 60 received an average of 4.54 responses (7.4% response rate).

Participants tended to respond to prompts at a similar rate across the skill types (noticing away-towards, noticing hooks, verbal aikido) over time. However, participants provided more responses to the verbal aikido skill in total because prompts for this skill extended across the final four weeks of the study as compared with one week for the noticing away-towards and noticing hooks skills. The user-initiated sessions that participants selected were most commonly the sorting away-towards or “skills help” sessions.

### **Quantitative Analyses of Feasibility and Satisfaction Measures**

Table 11 shows participants’ responses to the questions about their satisfaction with the intervention and their perceptions of the feasibility of the intervention to support college students. The satisfaction questions asked participants about the helpfulness, quality, and length and frequency of the online session and app, respectively. The feasibility questions assessed participants’ perceptions of the effectiveness of the intervention, whether they would recommend the intervention to others with

mood/anxiety related concerns, and whether they would participate in such an intervention if offered at a college counseling center.

On average, participants' average satisfaction with the online sessions and app together across helpfulness, quality, and length/frequency items fell between 4 = *slightly satisfied* and 5 = *satisfied*. Participants' average satisfaction rating across items asking about the online sessions fell between 4 = *slightly satisfied* and 5 = *satisfied* while participants' average satisfaction rating across items asking about the app fell between 3 = *slightly dissatisfied* and 4 = *slightly satisfied*.

When asked about feasibility, participants average ratings fell between 5 = *somewhat agree* and 6 = *agree* when collapsed across ratings of the three items.

Participants most strongly endorsed that they would recommend the online sessions and app to others, with slightly lower endorsement of perceived effectiveness for their concerns and the lowest endorsement of whether they would participate in the intervention if offered at a college counseling center.

### **Qualitative Analyses of Open-Ended Feedback Questions**

The qualitative feedback elicited from participants provided further detail about what participants found more or less helpful, what they would improve, how they used the online sessions/app, and their perceptions of the feasibility of the app for college students. To interpret these responses, the researcher identified common themes within each qualitative item and organized them based on their conceptual associations. Then, the frequencies with which the different themes emerged from participants' responses were used to identify the most prominent feedback for each question.

In considering what was most helpful, four broad themes emerged in people's responses. Participants most often described the ability to self-reflect and actively consider their thoughts and feelings as the most helpful aspect of the online sessions and app (13 participants or 30.9%). Focusing on skills, techniques, and metaphors to change behavior was the second most commonly expressed theme (8 participants or 19.0%). Next, participants endorsed that receiving reminders to use skills, reflect, or take perspective was helpful (6 participants or 14.3%). Lastly, three participants (7.1%) noted that the contents of the online sessions and app helped introduce new points-of-view. 12 participants or 28.6% did not indicate a response to this question. One participant's description of the "away-towards" online session summarizes what several echoed about what was most helpful in the intervention:

"The session that taught me about toward and away moves were very helpful. It gave me a new perspective and helped me change my actions if I needed to."

In considering what was unhelpful or challenging about the online sessions and app, participants noted three common themes. The most common feedback provided was that the app prompts were too repetitive, "annoying," or frequent (13 participants or 30.9% completing the final survey). Four participants (9.5%) indicated it was not helpful to receive app prompts when they were experiencing depressive symptoms or when they were not experiencing distress. Next, three or 7.1% of participants reported concerns that the explanation of concepts or skills in the online sessions or app were either confusing, too general, or both, and three participants (7.1%) provided responses indicating that the contents of the app and online sessions could be made more personal or tailored. One participant (2.4%) noted that struggling with technology issues related to the app was

frustrating. One participant indicated they “didn’t find much [they] would change” and 13 participants or 30.9% did not respond to this question.

When asked what skills they used most from the online sessions and app, participants offered a range of responses. Five participants or 11.9% noted using the “towards-away” skill most often; four participants or 9.5% identified using “noticing hooks”; and four or 9.5% noted “verbal aikido” as their most commonly-used skill. In addition to these specific skills, five participants or 11.9% provided responses related to the general Matrix point-of-view such as noticing the difference between inner and 5-senses experiencing, connecting with values, and acknowledging their emotional experiences. Two participants or 4.8% denied using skills from the study and one participant (2.4%) reported reflecting on their goals, which was not directly targeted through the intervention. 14 participants or 33.3% did not respond to this question.

When considering what they would improve about the online sessions and app, participants identified increasing the personalization, variety, and number of skills as means to improve the intervention. Five participants or 11.9% suggested personalizing the online sessions and app to offer more specific suggestions or skills. Five participants or 11.9% also commented on improving the app contents through either reduced frequency of the prompts or increasing the variety and specificity of questions asked. Feedback about the online sessions included shortening the sessions (2 participants or 4.8%) and distributing the contents across more sessions to provide more skills (one participant or 2.4%). One participant also noted that the contents of the online session seemed dismissive of their struggles and asked for greater validation in the delivery of

skills. Four participants (9.5%) indicated they had no feedback in this section or provided an unrelated response, and 17 or 40.5% of participants did not respond to this question.

All but one participant who responded to the final open-ended question (28 or 96.6% of those who responded) indicated they would recommend the intervention to students experiencing mood and anxiety concerns. 13 or 30.9% of participants did not respond to this question. Participants noted that the intervention could be helpful because of its convenience (five participants or 11.9% of all participants) and ability to overcome mental health stigma associated with seeking in-person counseling (five participants or 11.9%). Three participants (7.1%) noted that the online sessions and app could be helpful for addressing general distress prior to seeking face-to-face services. One participant (2.4%) who did not endorse the intervention as well as one participant who did not directly respond to this question both expressed again that the app prompts were too frequent.

## CHAPTER V: DISCUSSION

### General Discussion

The present study examined the role of tacting of function (TOF) as a specific mechanism of change and psychological inflexibility (PI) as a general mechanism within an online and app-based intervention for symptoms of depression and anxiety among college students. The study sought to develop an intervention based largely on the skill of tacting the functions of one's actions, centered around the distinction between moving towards values and moving away from internal experiences presented through the ACT Matrix and consistent with the broader pathological process of PI. The study used a waitlist-control design and examined participants' overall trajectories of change as well as specific relations between changes in target mechanisms and changes in outcome measures using mixed linear modeling across five measurement occasions. Random assignment helped to mitigate imbalances in participant characteristics or levels of distress across conditions and allowed for changes in the process and outcome variables in the intervention condition to be compared with rates of change in these variables due to the natural trajectories of symptoms (e.g., spontaneous remission or regression to a mean value) in the waitlist condition. Repeated measurement allowed for a nuanced evaluation of the shapes and differential trajectories of changes in the process and outcome variables across the study conditions, as well as permitted an examination of the relations between condition assignment and changes in the outcome variables as explained by changes in the process variables. The present study also investigated perceptions of feasibility and effectiveness among the recipients of the intervention

through usage data, self-report ratings, and qualitative feedback to assess the feasibility and perceived effectiveness of the intervention approach for a college student population.

#### *Overall Intervention Effects*

The intervention appeared to have short-term effects on symptoms of depression and anxiety as measured by the PHQ-ADS. Participants in the intervention condition experienced the largest reductions and a higher frequency of clinically significant changes in symptoms of depression and anxiety across the pre to post-intervention assessments. The results support short-term intervention effects on symptoms of depression and anxiety while participants were actively completing the online sessions and using the app. The magnitude and frequency of clinically significant changes in symptoms of depression and anxiety for participants in the waitlist condition appeared to converge with those in the intervention condition by the 5-week follow-up assessment. This is consistent with findings on spontaneous remission in 75-85% of individuals with moderate depressive symptoms after one year (Whiteford et al., 2013), although rates of spontaneous remission with anxiety disorders tend to be much lower (Yonkers, Bruce, Dyck, & Keller, 2003). In either case, the present intervention may have supported a more rapid recovery from symptoms which may have persisted for a larger portion of the academic semester.

Conversely, the lack of statistically significant changes observed in the behavioral activation and life quality and satisfaction measures raises the question about the impacts of changes in depressive and anxious symptoms on functioning. All participants showed linear improvements in behavioral activation, life quality, and life satisfaction across the 8-week study period, and the rate of change did not appear to vary by intervention

condition. This finding may be an artefact of naturally increasing behavioral engagement over the course of the academic semester in which the study was run, such that may have confounded the ability to detect differences in behavioral activation and life quality and satisfaction in the absence of increasing academic involvement and demands. However, this result also indicates that changes in the symptoms of depression and anxiety were not commensurate with changes in behavior or perceptions of one's life. This finding is consistent with a functional dimensional perspective that emphasizes a distinction between the presence of symptoms and their functional impacts on a person's life (Hayes et al., 1996).

Surprisingly, the intervention had little impact on TOF as the primary mechanism of change. It is unclear the extent to which that the intervention failed to target TOF as a behavioral skill, failed to support generalization of TOF beyond intervention or app sessions, or failed on both accounts to produce expected changes in this process variable. While the ACT Matrix provides a visual framework and language that is theoretically consistent with the notion of TOF, it may not in effect target this behavior and may instead train other skills such as defusion, tacting of private events, or a contextual view on the self (Polk et al., 2016). The ACT Matrix was designed by practitioners as a tool for building psychological flexibility, however no research has formally evaluated the mechanisms through which this is accomplished. At the time of this study, all writing on the mechanisms through which the ACT Matrix supports flexibility has been speculative or theoretical in nature. The lack of specificity in the present intervention effects concurrent with the lack of changes in TOF suggests a range of potential mechanisms despite the face-validity of this tool for helping people notice and label the functions of



their actions. More specific training in TOF may have produced a more focused, mechanism-specific effect.

The format of the present intervention may have also limited its potential effects on TOF. Given an online and app-based delivery of the ACT Matrix, participants may have had fewer opportunities to practice the target TOF skills spontaneously as one might in a therapy session. For instance, a therapist and client may practice sorting the contingencies of in-session behavior onto the ACT Matrix to support tacting in real-time. In contrast, the online sessions and app were much more structured and relied more heavily on participants to generate examples of the different contingencies and behaviors that could be associated with relevant tacts. This may have contributed to less direct and supervised practice of the target skills and a greater chance that participants' actual behavior in response to the online sessions and app prompts drifted to other contingencies, such as participants' labels or cognitions about what the online sessions and app were "supposed" to be targeting. As such, given the online and app-based format of the intervention participants may have had fewer opportunities for feedback and refinement of the TOF skills targeted by the intervention, resulting in potentially more non-specific intervention effects.

It is similarly possible that the intervention may have trained TOF yet this was not detected through the self-report measure of this skill. While the TOF measure appeared to covary with several of the relevant process and outcome variables, it may have been insensitive to change over time. For example, although participants showed evidence of engagement in the skills offered through the online sessions and app, this engagement did not correspond to changes in the measure. However, the sensitivity of this scale to

changes over time has not previously been investigated so it is difficult to assess whether this could be a concern in the present findings. An alternative explanation is that the TOF measure failed to assess this skill in a symptomatic sample, as its primary validation sample included students at a breadth of distress levels (Pierce & Levin, 2019).

On the other hand, intervention effects were apparent in four of the five other process measures that assessed more general psychological skills and processes. The intervention was associated with larger linear reductions in PI over the five bi-weekly assessments, suggesting that participants were able to relate to their experience with fewer efforts to control, suppress, or otherwise change affective and cognitive states and potentially greater clarity and direction in terms of values. Consistent with this finding, there were larger declines in perceived obstruction to valued living among participants in the intervention condition. These effects in PI processes did not appear to generalize to greater progress in valued living, however, suggesting the intervention may have been more effective for reducing unhelpful responses to unwanted inner experiences rather than increasing values-consistent patterns of action. This finding corroborates results showing that symptoms declined more rapidly for the intervention condition but did not coincide with changes in behavioral activation or perceptions of life quality and satisfaction.

Participants in the intervention condition also endorsed larger changes in the measures of mindful awareness and tacting of private events. It appears that the intervention potentially affected changes in more general tacting behavior, namely, tacting one's internal and external experiences and awareness of these experiences in daily life. These changes may represent a greater attunement to one's present-moment

experiences as a function of applying skills such as the ACT Matrix in daily life. This may have provided participants with a foundation for responding more flexibly to painful or unwanted inner experiences due to heightened sensitivity to a broader range of contingencies. Consistent with this finding, literature on the effects of mindfulness shows that practice actively noticing one's inner and external experiences in a non-judgmental way can heighten tolerance of painful or unwanted affective or cognitive states (Roemer, Williston, & Collins, 2015).

#### *Findings on Mechanisms of Change*

The mechanisms of change analyses examined the effects of condition assignment on changes in the outcome measures across adjacent time-points, as explained through prior changes in the target mechanisms across adjacent time-points. Consistent with the mixed linear models examining change over all time-points, changes in TOF failed to account for any effects of condition assignment on changes in the outcome variables. This may again be explained through an insensitivity of the TOF measure to detect changes across adjacent time-points or a failure of the intervention to produce expected changes or generalization in the behavior of tacting the functions of one's actions. This finding corroborates the notion that, despite theoretical reasons to examine TOF, the present study failed to support this behavioral skill as a pertinent target for intervention.

By contrast, changes in PI accounted for a portion of the relation between condition assignment and later changes in three of the four outcome measures. Assignment to the intervention condition was associated with larger reductions in PI, on average, across adjacent time-points, as compared with the waitlist condition. In turn, these reductions explained a portion of later changes in symptoms of depression and

anxiety, behavioral activation, and satisfaction with life in expected directions. These findings are consistent with previous research showing that PI mediates intervention effects on symptom measures (Ciarrochi, Bilich, & Godsell, 2010) and measures of behavior change (e.g., Sairanen et al., 2017; Scott, Hann, & McCracken, 2016) in ACT interventions.

It is noteworthy that the mechanisms of change analyses showed indirect effects of condition through changes in PI on changes in behavioral activation and life satisfaction, but condition assignment failed to explain variance in these outcomes in models assessing change over the entirety of the study period. This discrepancy may be explained by differences in how temporal effects were modeled and in the conceptualization of the indirect effects in the mechanisms of change analyses versus direct effects in the previous models. Whereas the prior models examined linear and quadratic trajectories of change in the process and outcome variables, the mechanisms of change analyses examined change across adjacent observations in the process and outcome variables. Thus, it was possible that significant changes across adjacent time-points could be explained by condition assignment while overall linear trajectories may not be significant. Moreover, the indirect effect was assessed based on the extent to which condition assignment explained differences in changes in the intervening process variable that also explained change in the outcome variables. As such, while condition assignment failed to explain variance in changes in behavioral activation or satisfaction with life directly, such changes appear to have followed change in PI that were associated with assignment to condition.

The discrepancy in findings for the effects of condition assignment on behavioral activation and life satisfaction in the mechanisms of change models, as compared with the models assessing linear change, may also have substantive implications. The intervention may have produced changes in inflexibility among a subset of participants and these participants may have in turn benefitted most from the intervention in terms of behavioral activation and satisfaction with life. Conversely, participants who did not experience reductions in PI in the intervention condition may not have experienced such benefits. This finding lends support for changes in PI as the primary mechanism of change for the intervention and as a necessary condition for improvement in secondary outcomes related to behavioral activation and life satisfaction. However, it raises questions about whether a tacting-focused intervention can affect changes in PI consistently across participants, such that potentially results in inconsistent intervention effects. Further, this result raises questions about what conditions allow participants to benefit most from this form of intervention.

In contrast to the other outcome measures, changes in PI due to the intervention were not significantly associated with changes in quality of life in the mechanisms of change analyses. It may be the case that participants who gained flexibility through the intervention were able to see improvements in their overall behavioral activity, a reduction in symptoms, and experienced greater satisfaction in their actions, yet did not perceive an overall improvement in life quality in terms of the domains evaluated by the QOLS. Another explanation for this result is the breadth with which life quality was assessed; the QOLS includes items asking about participants' financial and health status, such that may have changed little over the course of the intervention. Finally, because the

intervention was largely focused on inner experiences and values, participants may not have addressed facets of their experience that were associated with externally challenging or oppressive situations. While certain examples included in the online intervention addressed issues of external stressors or oppressive conditions, the intervention did not explicitly target responses to these facets of participants' environments.

#### *Online and App Content Usage, Feasibility, and Satisfaction*

Participants' experiences of completing the online sessions and using the app were evaluated through usage measures as well as quantitative and qualitative self-report measures. Considering use of the intervention and app, over three-quarters of participants in the intervention condition completed all online sessions, while just over half of participants achieved the recommended engagement with the app. These rates of adherence are consistent with those observed for web-based mental health resources (Gill, Contreras, Muñoz, & Leykin, 2014; White et al., 2010) and slightly lower than rates of retention in studies of commercially available, mental health mobile apps (Donker et al., 2013; Zhao, Freeman, & Li, 2016), respectively. These results suggest the online sessions may have been more feasible and engaging for students as compared with the app. Participants may have experienced greater barriers to app use, such as unfamiliarity with apps versus online media, problems with network connectivity, or other logistic issues with using or installing the app. In addition, participants may have concerns about privacy in responding to app prompts in public (Levin, Stocke, Pierce, & Levin, 2018).

Further, there were some participants who engaged very little in the intervention and app overall, while others completed all online sessions and sustained use of the app

until the end of the eight-week study period. While engagement was not associated with the identity variables or symptoms assessed at baseline, there may be other factors influencing engagement. For example, previous research has identified match with students' learning styles, self-regulation ability, and motivation to engage in online content as predictive of student success in online and other technology-mediated instruction (Kauffman, 2015); these factors may have similarly impacted students' ability, willingness, and consistency with completing the online sessions and using the app.

Participants' ratings of satisfaction and perceived feasibility provided further context for the app usage measures. Participants tended to be most strongly satisfied with the online sessions as compared with the app. This finding was corroborated with qualitative responses suggesting the app was "annoying" at times or that reminders were "repetitive." Although the app reminders were set to change on a weekly basis across the first three weeks, the app prompts within each week were identical and the user interface was quite simple. It is possible that greater engagement in and satisfaction with the app may have been observed given more variability in the prompts within each week and a more refined visual interface.

Participants rated the intervention as feasible, on average. Participants endorsed the intervention as feasible for symptoms of depression and anxiety and agreed that they would recommend it to others. As such, it appears that the students participating in the study saw the intervention as helpful and as potentially effective for others in a student role. Participants also endorsed that they would engage in such a program if offered at a counseling center, although this item was rated somewhat less highly than ratings of

perceived effectiveness and applicability to other students. Participants may have perceived the intervention to be helpful yet may view the intervention as serving a different helping role than what is offered through face-to-face services at counseling centers. Consistent with this interpretation, previous research has demonstrated that students view online and app-based mental health interventions as helpful yet do not see such approaches as a replacement for face-to-face therapy (Levin, Stocke, et al., 2018).

Participants' qualitative responses provided greater insight into what they saw as more or less helpful, as well as ways they might change the intervention to improve feasibility and acceptability in a college student population. Consistent with the notion of tacting one's experiences, participants frequently identified self-reflection on their thoughts, feeling, and actions as the most helpful aspect of the intervention as well as having a new perspective on their experiences. These responses aligned with using the ACT Matrix point-of-view as a "perspective" through which to notice, label, and change one's responses to various experiences. In addition, participants identified learning skills as another important facet of the intervention, and identified concepts such as "away-towards," "hooks," and "verbal aikido" as helpful facets of the intervention. Such feedback is consistent with the notion that building a tacting repertoire for one's experience can facilitate change, although it is unclear whether this included TOF or a more general tacting repertoire (e.g., whether participants tacted their internal "hooks" only or were able to tact the function of these "hooks" in relation to their behavior).

Participants also identified ways in which repetitiveness, a lack of variability, and limited personalization constituted barriers to engagement in the app and online sessions. While the app prompts were designed to focus on specific skills and included decision



logic based on participants' responses, the specificity in focus may have resulted in a repetitive feel with the prompts. The participants may have also experienced this feature as contributing to a lack of personalization in the contents. As such, participants may have preferred a tailored delivery of skills through the app based on their experiences in-the-moment of prompting. Similarly, while the online modules incorporated some personalization, their contents were delivered in a similar structure across participants. In this component, participants may have benefitted from a more "dashboard-like" feel where they could more flexibly navigate the contents of the intervention, or a "choose-your-direction" style that offers different skills contingent on participants' responses at the beginning of each online session. This approach would likely distribute the online contents across more online sessions, yet may facilitate a more graduated delivery of information to support a greater depth of acquisition of the target tacting behavior and may also assist with more effectively shaping the targeted tacting skills (Olaff, Ona, & Holth, 2017). While such customization in the online sessions and app was limited given the platforms on which these components were developed, this may be an avenue for future research. For instance, a recent study of an app-based ecological momentary ACT intervention among college students found that the intervention was most effective when skills were delivered contingent on what participants rated they were struggling with in-the-moment (Levin, Navarro, Cruz, & Haeger, 2019).

Greater response-contingent delivery of the intervention content could also more consistently reinforce the use of tacting skills. Specifically, if participants recognize that the intervention will tailor skills based on their assessment of their experiences, this may provide an external reinforcer for practicing noticing and labeling their thoughts, feelings,

and actions. While this feature of online and app-based interventions has not been discussed in the literature, it may be especially important for tacting-focused interventions that rely initially on external contingencies (e.g., app prompts) to establish new tacting responses (e.g., labeling an action as “away” or “towards”).

### **Implications**

The overarching implications of the present study can be understood in both clinical and theoretical terms. From a clinical standpoint, the present study lends support for a relatively brief, online and app-based intervention based on the ACT Matrix for effecting short-term changes in symptoms of depression and anxiety among college students. It also lends support for the effectiveness for such an intervention in targeting PI and secondary process variables of mindful awareness and tacting of private events in this population. These processes represent psychological skills that can support students in responding to current or future symptoms of depression or anxiety such that mitigates their negative impacts on later social and academic functioning. However, the present intervention did not seem to directly improve students’ ability to engage in valued actions that would increase behavioral activity, life satisfaction, or life quality. Given this, an online and app-based, ACT Matrix intervention may be helpful for mitigating negative impacts of students’ symptoms yet have limited influence on positive behavior as defined by values-consistent action.

This pattern of results may have broader implications for interventions focused on PI beyond student groups. Training in the skill of noticing and responding to internal experiences and values (i.e., tacting these experiences) may reduce PI and barriers to valued living, however this training may not facilitate progress in valued action directly.

As such, this form of training may be most beneficial for clients with difficulties in responding to unwanted inner states, while individuals struggling to move towards personal values may benefit from additional therapeutic support. This additional support may include practitioners assisting clients in defining valued action and setting values-based, behavioral goals each session. Relatedly, it may be insufficient for practitioners to simply assist clients in naming the contingencies of their actions; building motivation and supportive accountability in therapy could play an important role in shifting from inflexible “away moves” focused on avoiding unwanted inner experiences to more flexible “towards moves” in the service of one’s values.

In the context of addressing a growing need for services in college counseling centers, an online and app-based, ACT Matrix intervention may be integrated with a behavioral intervention for valued action for optimal results. Students appear to be most willing to engage in such interventions in the context of tailored and variable content, therefore providing options to tailor the intervention skills and tools to students’ unique values and concerns may be crucial to achieving a broad impact on students experiencing anxious and depressive symptoms. The present study suggests an online and app-based intervention can help students experience a remission in symptoms more rapidly than in the absence of intervention, such that may effectively support students in moderate distress while reducing demands on counseling centers.

From a theoretical standpoint, these results raise questions about the role of TOF in relation to PI processes. Specifically, in the present study participants experienced changes in PI in the absence of concurrent or prior changes in TOF. Thus, participants may have been able to respond more flexibly to their internal experiences without

labeling and responding contingently to the functions of behavior (e.g., responding to a behavior labeled as “avoidant” or as an “away-move”). This could occur through learning to respond contingently to other aspects of one’s experience, such as responding to distress or racing thoughts by practicing mindful awareness and connecting with one’s values. Alternatively, the intervention may have allowed participants to develop other rules or contingencies around their behavior unrelated to its functions that nevertheless supported flexible responding. For instance, participants may have learned to identify a specific behavior based on its form (e.g., biting one’s nails) instead of its function (e.g., avoiding anxiety), and may have replaced this behavior with an alternative, more effective response (e.g., choosing to re-engage in studying as an alternative to biting one’s nails) that was still conducive to building flexibility.

An additional empirical question raised by the present results pertains to the measurement of specific tacting repertoires. As noted previously, it is unclear whether the lack of significant findings on TOF is associated with problems measuring this behavioral skill through a self-report scale. Participants may have difficulties judging their ability to notice and label the functions of their actions, consistent with research demonstrating people perform poorly when asked to self-assess in new domains of learning (Dunning, Heath, & Suls, 2004). Further, this assessment may have been influenced through the secondary impacts of symptoms such as negative self-perception (e.g., in major depression; American Psychiatric Association [APA], 2013) or difficulties with focus and concentration (e.g., in generalized anxiety; APA, 2013). Such experiences may have skewed participants’ self-report of their ability to notice “when my actions are in-line with the person I want to be” or of their ability to notice “when my actions fall short of

my intentions” due to responding more to their internal processes than item contents. Because eligibility for the study entailed at least mild symptoms of depression and anxiety, such biases in self-report due to symptoms would be difficult to detect through conventional methods of assessing differential item functioning. Altogether, a specific category of behavioral skill such as TOF may be more effectively assessed through observational methods or transcriptions of language used in face-to-face therapy sessions.

More broadly, the present findings illustrate the potential for behavioral theory to bridge between transdiagnostic processes implicated in people’s suffering and behavioral skills to be trained to mitigate suffering. Proposing that deficits in a certain tacting repertoire may contribute to PI allows interventions such as the ACT Matrix to be delivered and evaluated based on a more specific mechanism of action. The present study yielded inconclusive findings on whether building a repertoire for tacting the functions of one’s behavior was related to the transdiagnostic process and was limited in its approach to measuring this target repertoire. However, the conceptualization of TOF as a potentially relevant behavioral skill in functional-contextual interventions may help orient future researchers to define, measure, and evaluate how therapists help clients to respond more functionally and effectively to their experiences.

### **Limitations**

The present study was limited in the extent to which the sample, measurement, and analytic approaches fulfilled necessary conditions to draw strong conclusions from the data. Each of these limitations is noteworthy in considering the interpretations provided for the findings and in exploring alternative ways to understand the results.

From a sampling standpoint, those participating in the study tended to occupy very similar social locations. Specifically, most participants self-identified as white, cisgender, and heterosexual and by default had some college education and were fluent in English based on enrollment criteria. Given this, variability in participants' experiences of social privilege, oppression, and marginalization was restricted to individuals with several identities that align with a Eurocentric cis- and hetero-normative majority culture. The extent to which participants experienced systemic oppression was thus limited and hence the generalizability of the results to people occupying more marginal or underrepresented social positions is questionable. Similarly, from a global cultural perspective this study was conducted in a society valuing an individualistic perspective and individual merit more so than collectivism or interdependence (La Roche, Fuentes, & Hinton, 2015). Interventions such as the ACT Matrix that center an individual's "chosen values" as a primary reinforcer may not be effective in contexts where individualistic choice is de-emphasized. Thus, modifications to the conceptualization of this intervention may be important in contexts where such perspectives are either less valued or where meritocracy and individualistic striving fail to account for an individual's capacity to move "towards" their values (i.e., in contexts where an individual does not have the autonomy or means to do so). As implied, it would be inappropriate to generalize the present results and conclusions to such contexts.

An additional limitation in sampling was imposed by the PHQ-ADS as a screening instrument. While this measure was necessary to assess participants' levels of distress, the conceptualization of "distress" was limited to symptoms of depression and anxiety. As such, participants experiencing or expressing other forms of distress (e.g.,

interpersonal distress, physical symptoms, chronic pain, tics, etc.) may have been screened out of the study. Theoretically such participants could similarly benefit from an intervention focused on PI (Hayes et al., 2006), however it is unclear if the present results would be applicable to such concerns given they were not explicitly included in the sample.

Other participant identities and experiences were not assessed that could have offered more clarity in terms of the generalization of the findings. In terms of identities, participant ability and religious affiliation could have provided valuable information with which to characterize the experiences of the sample. Differences in ability may influence how participants engage with the intervention, such that may influence the accessibility and applicability of the online and app-based contents. For example, how long and through what media contents are delivered could impact who is able to receive the benefits of such an intervention. Differences in religious affiliation in the sample may have been especially relevant to participants' experiences of distress given the study was conducted in a majority religious state. Such information would provide greater information about participant social position in the local area, such that is relevant to how easily participants can move "towards" given values. For example, a nonreligious student seeking connectedness outside of the majority religious community may face more barriers than someone inside this community. Conversely, a transgender student seeking support from within a religious community that de-values trans identities may similarly have far fewer opportunities to move "towards" values of social connection or relatedness. Finally, participants were not asked whether they had previous therapy experience outside of the screening questionnaire. Given this, there may have been

unmeasured heterogeneity in participants' experiences previously learning skills like those presenting in the present intervention. Students with previous therapy experience may have a more elaborate tacting repertoire to draw from when asked to notice and label their responses to affects, thoughts, and external events.

From the perspective of measurement, there was only one scale assessing the target process of TOF. This scale has only received preliminary validation in a general college student sample (Pierce & Levin, 2019), therefore its performance in a college sample reporting mild to moderate distress may be in question. Moreover, the capacity for this scale to detect clinically-relevant change in tacting the functions of one's behavior has not been evaluated. The extent to which this scale can detect changes in TOF could be further assessed through comparing TOF scores with external means of validation such as measures of TOF drawn from therapy or interview transcripts over time. In addition, statistical models that distinguish between state and trait variability as well as growth trajectories in scale scores could be used to determine the extent to which scale ratings are influenced by occasion-specific factors versus more stable trait influences or growth trends (e.g., Geiser, Keller, Lockhart, Eid, Cole, & Koch, 2015).

In general, the present study was heavily reliant on self-report measures for the target process and outcome variables. This limitation may be especially pertinent when considering the measures of participants perceived behavioral activation and valued activity. Measures asking participants to report on behavior tend not to correspond with actual behavioral observations, and biases in self-assessment tend to change with skill development as well as with self-perception relative to one's peers (Gross & Latham, 2007). Behavioral activation records or diaries recording instances of valued action could



provide greater insight into the magnitude of behavior change and into the correspondence between responses on the BADS or VQ and recorded rates of behavior.

In addition, while the analytic approaches used in the present study examined participants' trajectories of change and change across adjacent time-points in an overall sense, they were limited in the extent to which they could account for individual differences in the shape of change over time or temporal variability in the rate of change. For instance, participants in the intervention condition who experienced immediate changes in symptoms, those whose symptoms changed more slowly, and those who experienced a latency in symptom remission were treated the same in the models assessing linear and curvilinear trajectories of change. Models that allow greater flexibility in the expected shape and rate of change across individuals may have provided a more nuanced interpretation of participants' responses to intervention (e.g., Brunton, Proctor, & Kutz, 2016). However, such models would require a much larger sample size than included in the present study.

Similarly, in the process of change analyses it was assumed that a lag of  $t + 1$  was sufficient to capture delayed relations between changes in the process and outcome variables. The process of change analyses also assumed that a two-week lag was sufficient to capture change in the process variables that would subsequently predict change across an equal span in the outcome variables. Participants may have experienced relevant changes in the process variables across a different or unmeasured span of time (e.g., three weeks), or could have experienced slower or more rapid changes in the outcome variables as compared with the process measures. These issues could have been examined through testing more complex structures of lagged associations, however this

would require a much larger sample and would be quite computationally “expensive” to evaluate the number of permutations possible in more complex lagged relations.

Relatedly, an important limitation is that roughly 20% of responses to the online surveys were collected at five or more days past the intended measurement occasion. This raises questions as to the extent to which departures from the biweekly measurement schedule impacts the interpretability of the results. Importantly, all analyses assumed equal spacing between observations and the actual spacing between observations violated this assumption, resulting in differential timespans being represented by a “one-unit change” in time in the models. Departure from this assumption may have introduced additional error in the estimation of participants’ rate of change and associations between changes in the process and outcome variables that may have attenuated or exaggerated such associations. It is also possible that the timing of participants’ completion of surveys in the studies may have depended on the values of certain process or outcome variables, such that may have introduced a non-random source of error in these dependent variables. This may have influenced the magnitude of standard errors associated with parameters for participants with slower or faster response times on the surveys.

It is noteworthy that missingness on three of the four outcome variables and one of the six process measures occurred non-randomly, in that the proportion missing on these measures were related to values of the measures themselves. This pattern of missingness may have attenuated the variances and covariances observed on these measures in the present sample, such that may have limited the associations that could have been detected in the present study (e.g., all variables with non-random patterns of missingness did not significantly vary depending on condition assignment). This missing

data pattern may have also deflated the standard errors leading to exaggerated estimates of association in the mixed linear models. Finally, while missing data handling techniques such as FIML estimation or multiple imputation are able to better replicate population variance-covariance matrices given missingness that is predictable from other variables, patterns of missingness that depend on values of the missing variables themselves will introduce bias even when such techniques are used (Enders, 2010).

Finally, it is worth noting that participants' experiences of the online sessions and app may have been influenced by their experiences on other websites and apps available through commercial platforms. The online sessions and app were both developed through surveying platforms rather than being formally designed by experts and technicians in website or app development. Participants may have experienced the contents as less engaging, smooth, or visually appealing in comparison to what is commercially available in apps such as Headspace (Economides, Martman, Bell, & Sanderson, 2018) or websites that are designed to present materials in a more engaging format; for instance, websites and apps may offer forms of gamification or interactive media that are not feasible to present through the Qualtrics or LifeData interfaces. This may have applied more strongly to participants' experiences and ratings of the app, given that mobile app production and quality is rapidly advancing in conjunction with increasingly powerful and sophisticated mobile technologies (e.g., Furber, 2017). Participants may have had several alternative apps to choose from that could have offered a more engaging experience, such that potentially distracted from their engagement in the intervention app.

## **Conclusion**

The present study examined the effects of an online and app-based, ACT Matrix intervention with an emphasis on noticing and labeling the functions of one's behavior (i.e., tacting of function) on depressive and anxious symptoms, behavioral engagement, and quality of life among college students. The results of the study suggested the intervention produced a more rapid remission of symptoms, reductions in PI, and improved ability to notice and label internal events. The intervention also explained changes in behavioral activity and life satisfaction through changes in PI although it did not have a direct effect on these outcomes. The intervention did not appear to influence self-reported ability to notice and label the functions of one's behavior and did not influence life quality. As such, the present findings supported the effects of ACT Matrix training on PI and students' symptoms, yet raise questions about whether such training effectively targets the ability to notice and label the functions of one's behavior. In addition, the present results raise questions about the measurement of this process in the context of self-report and whether training focused on noticing and labeling the functions of one's behavior can contribute to increasing valued action as opposed to decreasing inflexible avoidance strategies.

The findings of the present study offer some support for using a brief ACT Matrix-based intervention delivered through online and app-based media to address symptoms of depression and anxiety in a college student population. This approach to intervention may be most effective if coupled with contents that more explicitly emphasize behavioral activation through values-consistent choices. In addition, students' feedback in the present study suggests personalization and variety may be important features to improve the acceptability of such interventions in a college-age sample. This

conclusion must be tapered given the limited breadth of social identities represented in the present sample which may hamper the generalizability of such findings.

From a theoretical perspective, the present study raises questions about whether the development of a repertoire for tacting the functions of one's behavior is necessary for changing behavior of a given functional category. Despite many psychological interventions being mostly verbal endeavors, it may be the case that changing unhelpful avoidance behavior does not require an explicit, verbal labeling of the behavior to be changed. Consistent with a functional theory on behavior change, contact with other contingencies or the development of verbal rules may account for changes in inflexible response patterns beyond learning to explicitly label these patterns or their contingencies.

The present research adds to existing literature on functional contextual interventions through a preliminary evaluation of the role of TOF in learning to responding functionally to one's experience. While the results were inconclusive in relation to this process, the present study hopes to contribute to a thoughtful assessment of the verbal and behavioral processes that make up a person's ability to respond functionally and flexibly to their ongoing experience. A more refined conceptualization of these processes can support the development of increasingly precise and impactful interventions for PI that can address a breadth of needs among individuals seeking emotional help.

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**APPENDICES**

## APPENDIX A: TABLES

Table 1.

*The six psychological flexibility processes within ACT*

Process	Description	Target Behavior	Example
Acceptance	A willingness to fully experience the internal events occasioned by one's present circumstance as well as one's history	Ineffective and costly efforts to control or alter one's internal experiences	Allowing oneself to feel anxiety during a conversation with one's boss, locating where one feels emotions in the body
Defusion	A shift in the way one relates to thoughts to reduce their influence over behavior. Experiencing these events as internal signals versus literal truths.	"Fusion," responding to thoughts as literal truths, as rules to be followed, or as threats to wellbeing	Observing one's thoughts as passing leaves on a stream, instead of doing what they say
Present Moment	Non-judgmental awareness of ongoing internal and external events as they occur.	Lack of contact with immediate contingencies, behavior on "autopilot"	Noticing internal and external sensations while having a conversation.
Self-as-Context	Awareness of one's ongoing experiences without identification. A relational frame that includes one's inner experiences, yet distinguishes them from one's self-concept.	Self-as-content, over identification with one's ongoing experiences	Noticing that one notices feelings of inferiority, and that one's "self" is distinct from them

Table 1 (Cont.).

*The six psychological flexibility processes within ACT.*

Values	Qualities of action that are chosen by the individual, which enhance a sense of meaning and reinforcement that is derived from that action.	Unclear values, a lack of sense of direction or purposiveness in one's actions	Keeping a record of meaningful events, and identifying valued life directions based on what one observes
Committed Action	A commitment to building larger and larger patterns of effective behavior that brings one in contact with one's important values.	A lack of committed action, ineffective behavioral patterns, and impulsive behavior governed by avoidance	Setting a series of exposure goals that are aligned with moving "towards" friendship values

Table 2.

*Descriptive statistics and alpha reliabilities for all study variables at time t=1*

Study Variable	M	SD	Range
Tacting of Function Questionnaire	4.60	0.86	2.40-6.40
Five Factor Mindfulness Scale – Describe	2.87	0.78	1.25-5.00
Acceptance and Action Questionnaire	4.77	1.28	1.57-7.00
Mindful Awareness and Attention Scale	3.14	0.78	1.00-5.67
PHQ – Anxiety and Depression Scale	2.68	0.61	1.27-4.00
Behavioral Activation for Depression Scale	3.86	0.97	1.52-5.84
Activation	3.70	1.17	1.00-6.57
Avoidance /Rumination	4.38	1.23	1.00-7.00
Work / School Impairment	4.04	1.37	1.00-6.60
Social Impairment	3.61	1.58	1.00-7.00
Valuing Questionnaire			
Progress	4.37	1.27	1.00-7.00
Obstruction	3.85	1.28	1..50-7.00
Quality of Life Scale	2.96	0.65	1.29-4.64
Satisfaction with Life Scale	3.87	1.53	1.00-7.00

Table 3.

*Means and standard deviations for each study variable across time point, by condition*

Study Variable	Baseline M (SD)	2-Week M (SD)	4-Week M (SD)	6-Week M (SD)	8-Week M (SD)
TOF (Int)	46.35 (7.47)	44.53 (7.06)	47.11 (7.64)	47.60 (8.41)	46.27 (8.64)
TOF (Wait)	45.73 (9.34)	44.59 (7.96)	45.21 (8.21)	46.70 (8.78)	46.77 (8.41)
FFMQ (Int)	21.54 (6.09)	22.30 (6.04)	22.50 (5.55)	22.84 (5.73)	22.32 (6.64)
FFMQ (Wait)	24.33 (6.32)	23.91 (6.55)	24.33 (7.25)	23.97 (7.35)	25.23 (7.02)
AAQ-II (Int)	33.57 (8.80)	29.25 (8.93)	29.11 (8.52)	28.91 (9.05)	27.14 (8.78)
AAQ-II (Wait)	32.94 (9.19)	32.04 (8.23)	33.05 (7.72)	32.52 (8.40)	31.00 (8.91)
MAAS (Int)	46.19 (11.96)	48.50 (12.38)	51.33 (12.31)	53.31 (13.58)	55.77 (15.12)
MAAS (Wait)	47.25 (11.82)	46.05 (10.54)	47.14 (11.41)	48.48 (13.46)	49.50 (14.23)
VQ-P (Int)	16.00 (5.10)	16.54 (4.72)	17.54 (5.16)	17.09 (5.07)	18.17 (5.84)
VQ-P (Wait)	14.84 (5.11)	16.14 (6.25)	15.71 (5.03)	16.00 (5.75)	17.73 (5.02)
VQ-O (Int)	17.57 (5.35)	16.31 (4.77)	15.67 (4.46)	15.19 (4.13)	13.91 (4.59)
VQ-O (Wait)	17.12 (4.82)	16.73 (4.50)	17.45 (4.91)	15.94 (5.18)	16.85 (4.96)
PHQ (Int)	26.04 (8.87)	20.99 (10.00)	20.44 (9.13)	19.72 (10.79)	18.05 (9.80)
PHQ (Wait)	24.51 (9.32)	24.18 (10.81)	23.83 (10.61)	22.45 (10.95)	20.73 (9.79)
BADS (Int)	97.23 (22.17)	105.31 (21.94)	106.72 (21.25)	107.69 (23.40)	108.86 (24.65)
BADS (Wait)	96.60 (25.50)	101.66 (26.03)	101.02 (25.27)	104.26 (27.97)	102.57 (29.52)
QOLS (Int)	41.79 (9.61)	46.52 (8.76)	45.86 (9.70)	45.81 (8.97)	49.72 (9.90)
QOLS (Wait)	41.22 (8.55)	42.05 (10.08)	42.83 (9.45)	45.06 (11.70)	44.50 (10.30)
SWLS (Int)	20.30 (7.33)	21.64 (7.71)	22.25 (6.78)	22.94 (6.93)	22.32 (7.56)
SWLS (Wait)	18.25 (7.88)	19.25 (8.46)	19.29 (8.29)	20.35 (8.36)	20.69 (7.92)

*Note.* TOF = Tacting of Function Scale. FFMQ = Five Factor Mindfulness Scale – Describe Subscale (tacting of private events). AAQ-II = Acceptance and Action Questionnaire – II. MAAS = Mindful Awareness and Attention Scale. PHQ = Patient Health Questionnaire – Anxiety and Depression Scale. BADS = Behavioral Activation for Depression. VQ = Valuing Questionnaire. QOLS = Quality of Life Scale. SWLS = Satisfaction with Life Scale. Int = Intervention condition. Wait = Waitlist control condition.

Table 4.

*Correlations among process variables*

	TOF	AAQ-II	FFMQ-D	MAAS	VQ-P
AAQ-II	-.182				
FFMQ-D	.431**	-.320**			
MAAS	.184	-.502**	.364**		
VQ-P	.410**	-.378**	.175	.268**	
VQ-O	-.246*	.566**	-.309**	-.536**	-.390**

*Note.* \* $p < .05$ . \*\* $p < .01$ . TOF = Tacting of Function Scale. AAQ-II = Acceptance and Action Questionnaire – II. FFMQ-D = Five Factor Mindfulness Scale – Describe Subscale (tacting of private events). MAAS = Mindful Awareness and Attention Scale. VQ = Valuing Questionnaire (P = Progress, O = Obstruction).

Table 5.

*Correlations among the outcome variables*

	BADS	QOLS	SWLS
QOLS	.734**		
SWLS	.583**	.582**	
PHQ-ADS	-.709**	-.558**	-.454**

*Note.* \* $p < .05$ . \*\* $p < .01$ . BADS = Behavioral Activation for Depression. QOLS = Quality of Life Scale. SWLS = Satisfaction with Life Scale. PHQ-ADS = Patient Health Questionnaire – Anxiety and Depression Scale.



Table 6.

*Correlations between process and outcome variables*

	BADS	QOLS	SWLS	PHQ-ADS
TOF	.362**	.248*	.388**	-.200*
FFMQ-D	.340**	.267**	.403**	-.322**
AAQ-II	-.663**	-.511**	-.497**	.684**
MAAS	.552**	.424**	.298**	-.642**
VQ-P	.586**	.570**	.544**	-.385**
VQ-O	-.674**	-.497**	-.393**	.681**

*Note.* \* $p < .05$ . \*\* $p < .01$ . TOF = Tacting of Function Scale. AAQ-II = Acceptance and Action Questionnaire – II. FFMQ-D = Five Factor Mindfulness Scale – Describe Subscale (tacting of private events). MAAS = Mindful Awareness and Attention Scale. VQ = Valuing Questionnaire (P = Progress, O = Obstruction). BADS = Behavioral Activation for Depression. QOLS = Quality of Life Scale. SWLS = Satisfaction with Life Scale. PHQ-ADS = Patient Health Questionnaire – Anxiety and Depression Scale.

Table 7.

*Mixed effects models testing linear and quadratic effects on the outcome variables*

Model Predictor	$\beta$	S.E.	$z$	$p$
<b>PHQ-ADS Linear</b>				
Within-Person Time	-0.103	0.032	-3.189	.002
Between-Person	-0.118	0.017	-0.685	.316
Condition				
Time*Condition	-0.069	0.046	-1.496	.130
Log Likelihood	-420.203	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .720	R <sup>2</sup> <sub>marg</sub> = .046		
<b>PHQ-ADS Quadratic</b>				
Within-Person Time	-0.106	0.032	-3.351	.001
Within-Person Time <sup>2</sup>	-0.043	0.025	-1.734	.089
Between-Person	-0.324	0.212	-1.530	.123
Condition				
Time * Condition	-0.065	0.046	-1.417	.146
Time <sup>2</sup> * Condition	0.087	0.036	2.454	.020
Log Likelihood	-417.112*	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .756	R <sup>2</sup> <sub>marg</sub> = .053		
<b>BADS Linear</b>				
Within-Person Time	0.089	0.033	2.674	.010
Between-Person	0.025	0.177	0.139	.395
Condition				
Time*Condition	0.019	0.048	0.398	.369
Log Likelihood	-415.675	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .755	R <sup>2</sup> <sub>marg</sub> = .021		
<b>BADS Quadratic</b>				
Within-Person Time	0.087	0.033	2.600	.014
Within-Person Time <sup>2</sup>	-0.015	0.023	-0.644	.324
Between-Person	0.081	0.196	0.413	.366
Condition				
Time * Condition	0.019	0.048	0.405	.369
Time <sup>2</sup> * Condition	-0.021	0.032	-0.642	.324
Log Likelihood	-419.284	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .765	R <sup>2</sup> <sub>marg</sub> = .023		
<b>QOLS Linear</b>				
Within-Person Time	0.105	0.029	3.687	<.001
Between-Person	0.177	0.179	0.986	.245
Condition				

Time*Condition	0.042	0.041	1.034	.234
Log Likelihood	-407.942	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .751    R <sup>2</sup> <sub>marg</sub> = .040			
QOLS Quadratic				
Within-Person Time	0.107	0.028	3.786	<.001
Within-Person Time <sup>2</sup>	0.020	0.026	0.765	.297
Between-Person	0.241	0.205	1.171	.200
Condition				
Time * Condition	0.039	0.040	0.977	.247
Time <sup>2</sup> * Condition	-0.029	0.038	-0.775	.495
Log Likelihood	-409.064	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .794    R <sup>2</sup> <sub>marg</sub> = .041			
SWLS Linear				
Within-Person Time	0.068	0.026	2.611	.013
Between-Person	0.268	0.181	1.480	.133
Condition				
Time*Condition	0.008	0.037	0.200	.391
Log Likelihood	-370.681	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .817    R <sup>2</sup> <sub>marg</sub> = .029			
SWLS Quadratic				
Within-Person Time	0.069	0.026	2.685	.011
Within-Person Time <sup>2</sup>	-0.005	0.020	-0.230	.389
Between-Person	0.306	0.202	1.514	.127
Condition				
Time * Condition	0.007	0.037	0.188	.392
Time <sup>2</sup> * Condition	-0.014	0.029	-0.499	.352
Log Likelihood	-374.410	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .830    R <sup>2</sup> <sub>marg</sub> = .031			

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*Note.* PHQ-ADS = Patient Health Questionnaire – Anxiety and Depression Scale. BADS = Behavioral Activation for Depression. QOLS = Quality of Life Scale. SWLS = Satisfaction with Life Scale. \*-2 Loglikelihood difference is significant at  $p < .05$ , comparing the quadratic model to the linear model for that variable.

Table 8.

*Mixed effects models testing linear and quadratic effects on the process variables.*

Model Predictor	$\beta$ (LL)	S.E.	$z$	$p$
TOF Linear				
Within-Person Time	0.008	0.036	0.217	.389
Between-Person	0.175	0.177	0.987	.245
Condition				
Time*Condition	0.061	0.051	1.191	.196
Log Likelihood	-426.929	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .768	R <sup>2</sup> <sub>marg</sub> = .011		
TOF Quadratic				
Within-Person Time	0.009	0.036	0.267	0.384
Within-Person Time <sup>2</sup>	0.022	0.022	1.003	0.241
Between-Person	0.185	0.188	0.983	0.246
Condition				
Time * Condition	0.060	0.051	1.172	0.201
Time <sup>2</sup> * Condition	-0.007	0.031	-0.221	0.389
Log Likelihood	-431.643	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .768	R <sup>2</sup> <sub>marg</sub> = .012		
FFMQ-D Linear				
Within-Person Time	-0.001	0.031	-0.039	.399
Between-Person	-0.116	0.183	-0.630	.327
Condition				
Time*Condition	0.109	0.045	2.422	.021
Log Likelihood	-400.531	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .823	R <sup>2</sup> <sub>marg</sub> = .017		
FFMQ-D Quadratic				
Within-Person Time	-0.001	0.140	0.743	.302
Within-Person Time <sup>2</sup>	-0.011	0.019	-0.112	.396
Between-Person	-0.023	0.200	-0.036	.399
Condition				
Time * Condition	0.105	0.045	2.337	.026
Time <sup>2</sup> * Condition	-0.039	0.028	-1.361	.158
Log Likelihood	-403.477	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .840	R <sup>2</sup> <sub>marg</sub> = .018		
AAQ-II Linear				
Within-Person Time	-0.058	0.035	-1.666	.100
Between-Person	-0.189	0.173	-1.088	.221
Condition				

Time*Condition	-0.105	0.049	-2.127	.042
Log Likelihood	-420.677	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .753	R <sup>2</sup> <sub>marg</sub> = .038		
AAQ-II Quadratic				
Within-Person Time	-0.063	0.034	-1.826	.075
Within-Person Time <sup>2</sup>	0.022	0.023	-0.987	.245
Between-Person	-0.323	0.195	-1.651	.102
Condition				
Time * Condition	-0.101	0.049	-2.057	.048
Time <sup>2</sup> * Condition	0.056	0.032	1.712	.092
Log Likelihood	-422.467	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .773	R <sup>2</sup> <sub>marg</sub> = .043		
MAAS Linear				
Within-Person Time	0.083	0.034	2.471	.019
Between-Person	0.213	0.177	1.205	.193
Condition				
Time*Condition	0.130	0.048	2.707	.010
Log Likelihood	-427.527	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .786	R <sup>2</sup> <sub>marg</sub> = .064		
MAAS Quadratic				
Within-Person Time	0.088	0.034	2.618	.013
Within-Person Time <sup>2</sup>	0.046	0.022	2.080	.046
Between-Person	0.289	0.189	1.526	.125
Condition				
Time * Condition	0.127	0.048	2.650	.012
Time <sup>2</sup> * Condition	-0.037	0.032	-1.169	.201
Log Likelihood	-427.587	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .811	R <sup>2</sup> <sub>marg</sub> = .069		
VQ-P Linear				
Within-Person Time	0.107	0.034	3.120	.003
Between-Person	0.110	0.178	0.621	.329
Condition				
Time*Condition	-0.030	0.049	-0.610	.331
Log Likelihood	-537.250	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .722	R <sup>2</sup> <sub>marg</sub> = .021		
VQ-P Quadratic				
Within-Person Time	0.111	0.034	3.270	.002
Within-Person Time <sup>2</sup>	0.024	0.025	0.944	.256
Between-Person	0.160	0.210	0.762	.298
Condition				
Time * Condition	-0.031	0.049	-0.632	.327

Time <sup>2</sup> * Condition	-0.021	0.035	-0.596	.334
Log Likelihood	-537.476	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .747    R <sup>2</sup> <sub>marg</sub> = .023			
VQ-O Linear				
Within-Person Time	-0.037	0.041	-0.918	.918
Between-Person	-0.189	0.161	-1.168	.201
Condition				
Time*Condition	-0.136	0.057	-2.339	.026
Log Likelihood	-533.961	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .633    R <sup>2</sup> <sub>marg</sub> = .039			
VQ-O Quadratic				
Within-Person Time	-0.038	0.040	-0.938	.257
Within-Person Time <sup>2</sup>	-0.011	0.029	-0.407	.367
Between-Person	-0.193	0.192	-1.003	.241
Condition				
Time * Condition	-0.137	0.058	-2.378	.024
Time <sup>2</sup> * Condition	0.002	0.041	0.054	.398
Log Likelihood	-537.568	-	-	-
Pseudo R <sup>2</sup>	R <sup>2</sup> <sub>cond</sub> = .665    R <sup>2</sup> <sub>marg</sub> = .040			

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*Note.* TOF = Tacting of Function Scale. FFMQ-D = Five Factor Mindfulness Scale – Describe Subscale (tacting of private events). AAQ-II = Acceptance and Action Questionnaire – II. MAAS = Mindful Awareness and Attention Scale. VQ = Valuing Questionnaire (P = Progress, O = Obstruction). \*-2 Loglikelihood difference is significant at  $p < .05$ , comparing the quadratic model to the linear model for that variable. \*\*-2 Loglikelihood difference between quadratic and linear models is significant at  $p < .001$ .

Table 9.

*Indirect effects of intervention condition through psychological inflexibility (AAQ-II) on the outcome variables.*

Outcome Variable	$b_{02m}$	$b_{20y}$	$b_{02y}$	Total Effect	$b_{02m} * b_{20y}$	95% CI	Proportion Explained
PHQ-ADS	-0.232*	0.071*	-0.066	-0.115†	-0.024*	-0.054, -0.001	.165
BADS	-0.232*	-0.101*	0.006	0.124	0.034*	0.004, 0.080	.252
QOLS	-0.232*	-0.048*	0.070	0.106†	0.010	-0.026, 0.025	.010
SWLS	-0.232*	-0.153**	0.105	0.100*	0.045*	0.009, 0.090	.236

*Note.* † $p < .10$ . \* $p < .05$ . \*\* $p < .01$ . PHQ-ADS = Patient Health Questionnaire – Anxiety and Depression Scale. BADS = Behavioral Activation for Depression. QOLS = Quality of Life Scale. SWLS = Satisfaction with Life Scale. Models control for prior values on the AAQ and the outcome variable at t-1, and linear effects of time (range 0-4).  $b_{02m}$  = association between intervention condition (0 = waitlist, 1 = intervention) and changes in psychological inflexibility (the AAQ-II).  $b_{20y}$  = association between prior psychological inflexibility and later changes in the outcome variable.  $b_{02y}$  = association between intervention condition and the changes in the outcome variable, controlling for prior values of psychological inflexibility.  $b_{02m} * b_{20y}$  = cross-product of coefficients estimating the indirect effect of intervention condition on the outcome variable through psychological inflexibility. 95% CI = 95% “credibility interval” of the cross-product. “Proportion Explained” refers to the proportion of the indirect effect explained through psychological inflexibility.

Table 10.

*App use statistics for participants who used the app.*

Usage Variable	M	SD	Range	% of Prompts
Prompts per participant	87.61	35.47	3-112	78.22% <sup>a</sup>
“Notification initiated” skills completed	22.95	27.21	1-97	28.63% <sup>b</sup>
Towards-Away	4.61	3.86	0-13	40.39% <sup>b</sup>
Noticing Hooks	4.05	3.79	0-14	30.10% <sup>b</sup>
Verbal Aikido	9.49	13.17	0-62	21.54% <sup>b,c</sup>
“User initiated” skills completed	5.20	5.54	0-26	-
Towards-Away	2.73	2.56	0-12	-
Noticing Hooks	0.62	1.09	0-5	-
Verbal Aikido	0.54	1.28	0-6	-
Skills Help	1.73	1.87	0-7	-

*Note.* <sup>a</sup> This value is the percentage of prompts received, on average, out of the maximum possible number that participants could receive. <sup>b</sup> This percentage reflects the proportion of prompts completed out of those which participants received of this kind. <sup>c</sup> Verbal Aikido prompts were delivered across 5 weeks. As such, there was a larger possible number of prompts that participants could receive of this kind.



Table 11.

*Measures of perceived satisfaction and feasibility of the intervention.*

Measure	M	SD	Range
Overall Satisfaction (6 items, $\alpha = .830$ )	4.17	0.78	2.83-5.83
Satisfaction with Online Sessions (3 items, $\alpha = .753$ )	4.51	0.71	3.33-6.00
Helpfulness	4.52	0.67	3.00-6.00
Quality	4.64	0.74	3.00-6.00
Length	4.39	1.12	2.00-6.00
Satisfaction with the App (3 items, $\alpha = .889$ )	3.83	1.10	1.67-5.67
Helpfulness	4.06	1.09	2.00-6.00
Quality	4.09	1.13	2.00-6.00
Frequency	3.33	1.40	1.00-5.00
Overall Feasibility (3 items, $\alpha = .923$ )	5.14	1.25	2.00-7.00
Perceived effectiveness	5.18	1.24	2.00-7.00
Recommend to others	5.30	1.40	2.00-7.00
Participate if offered	4.94	1.39	2.00-7.00

## APPENDIX B: FIGURES

Figure 1.

Example ACT matrix with prompting questions and hypothetical responses.

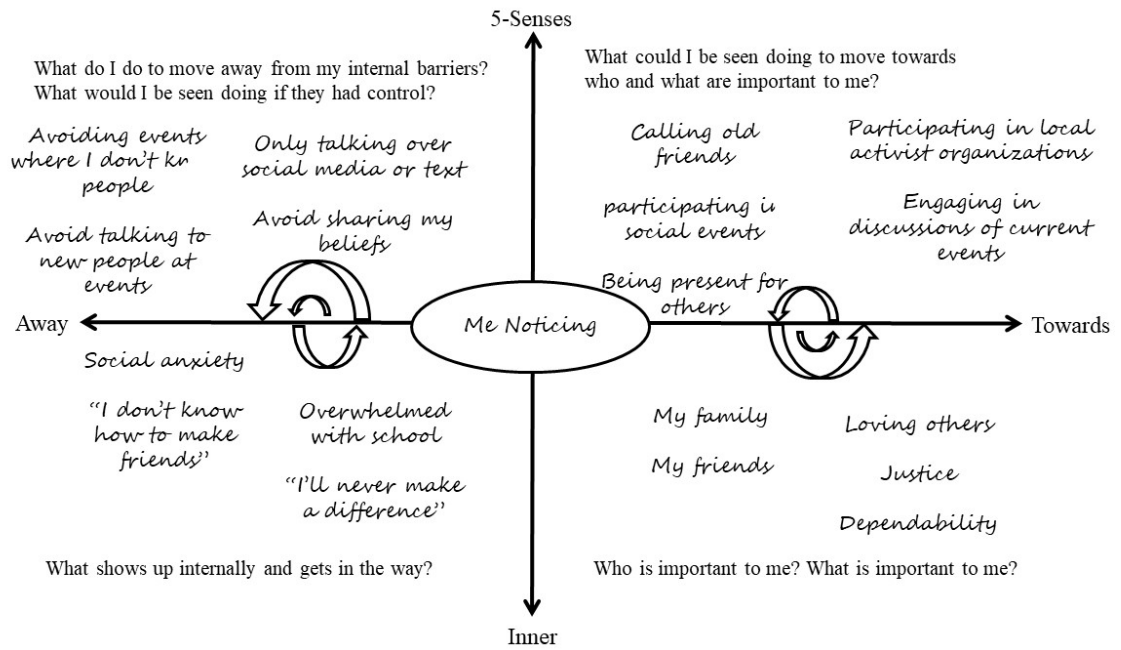


Figure 2.

*CONSORT diagram showing participant flow from screening to condition assignment.*

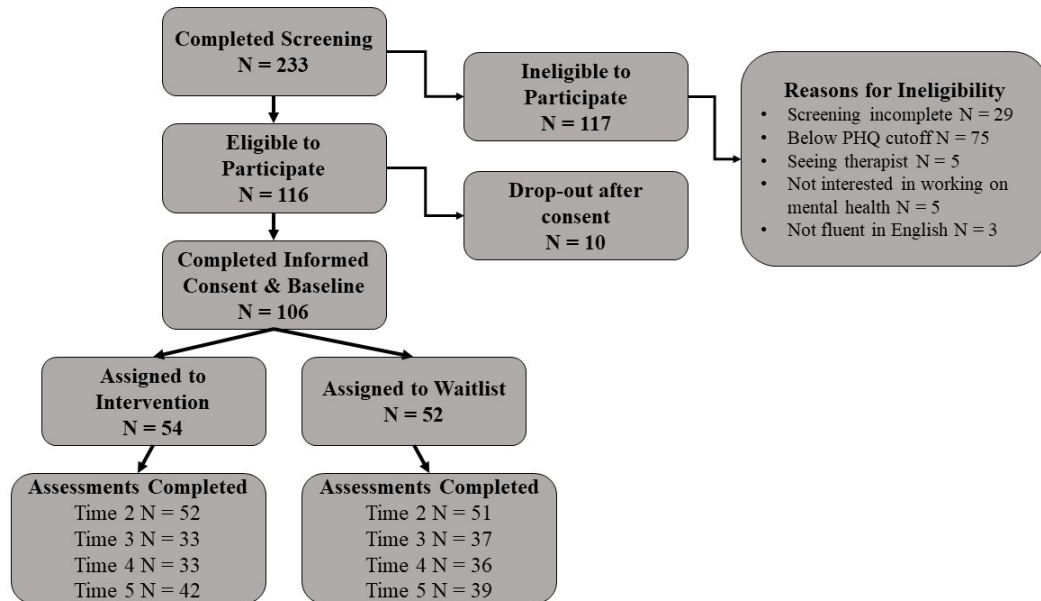


Figure 3.

*Standardized values of the PHQ-ADS as a function of the quadratic time\*condition interaction.*

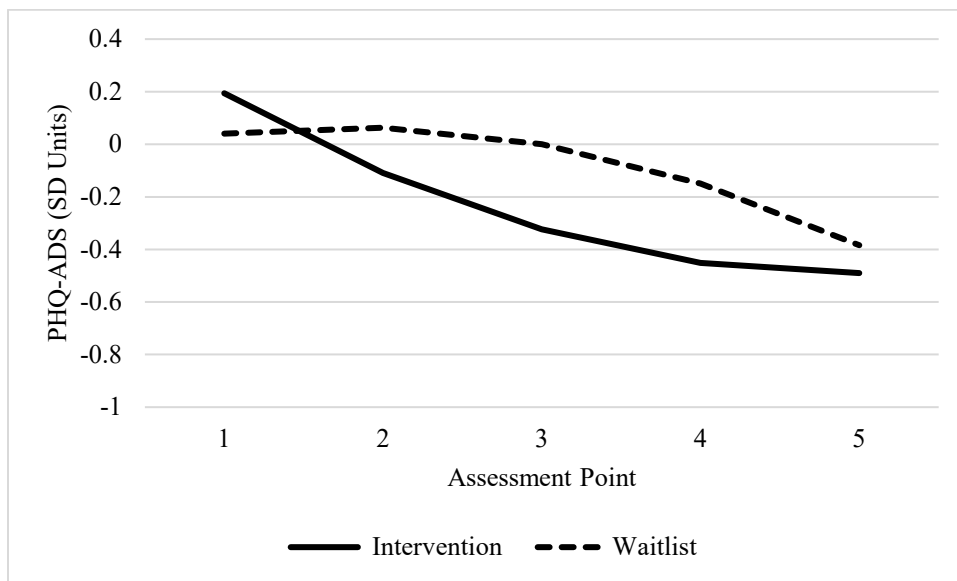


Figure 4.

*Standardized values of the FFMQ-Describe scale as a function of the time\*condition interaction.*

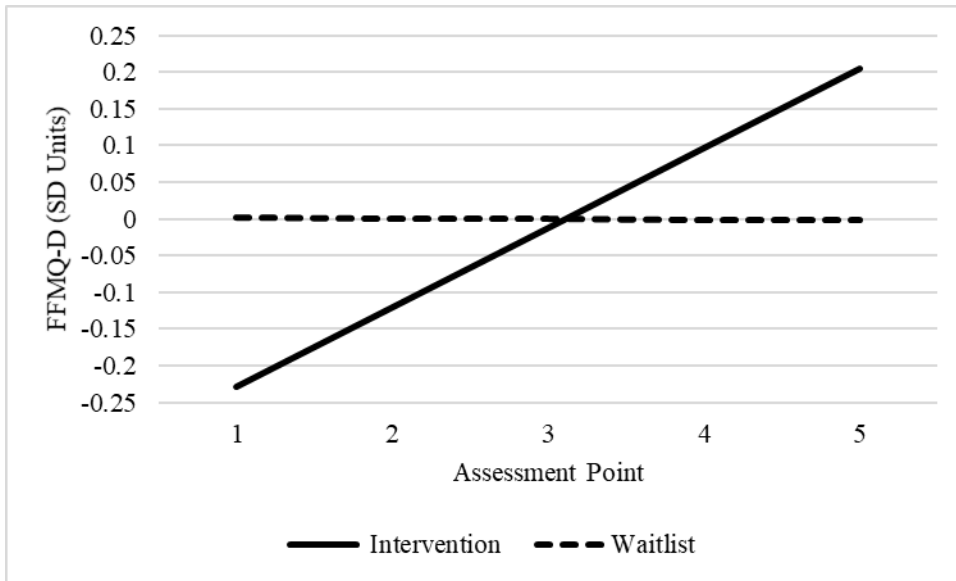


Figure 5.

*Standardized values of the AAQ-II as a function of the linear time\*condition interaction.*

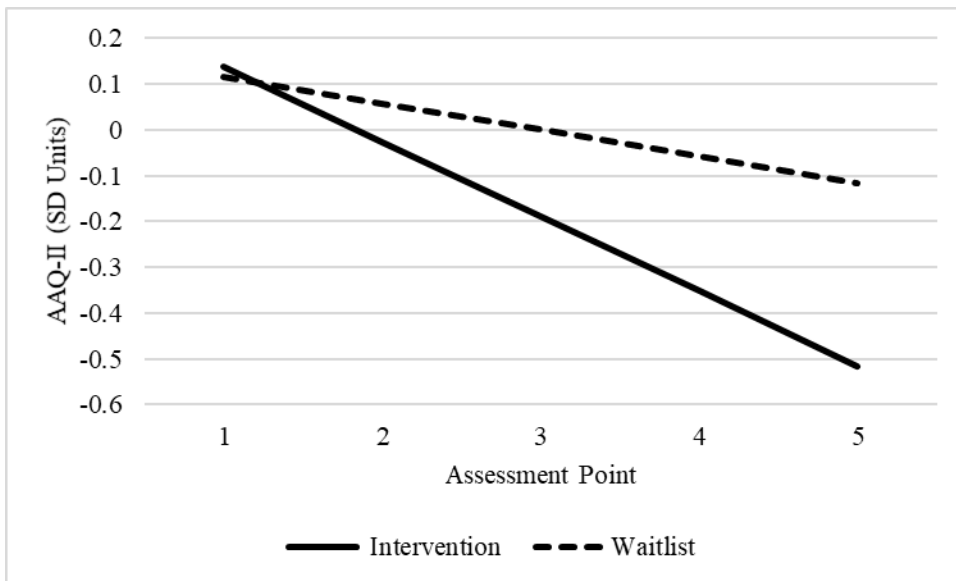


Figure 6.

*Standardized values of VQ-Obstruction scores as a function of the time\*condition interaction.*

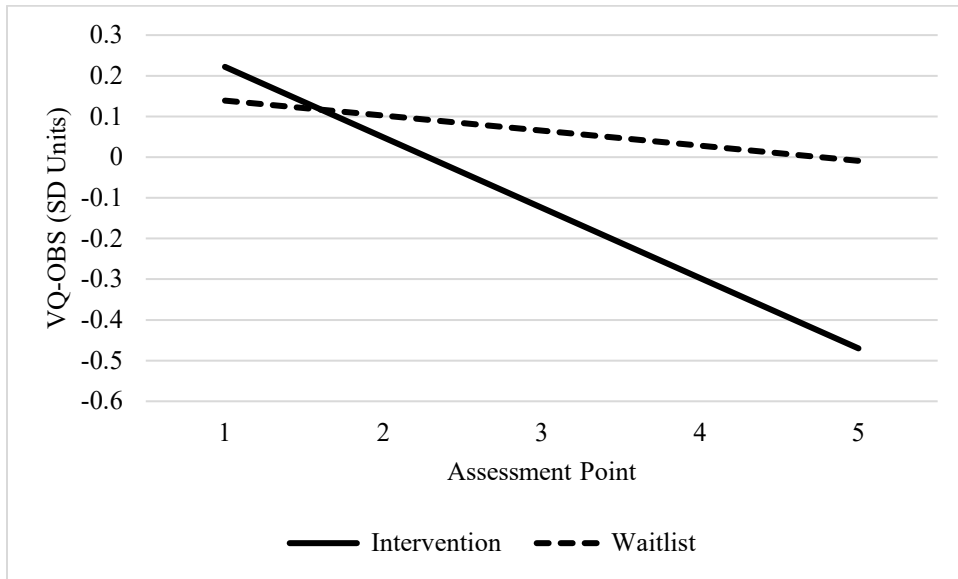




Figure 7.

*Standardized values of the MAAS as a function of the linear time\*condition interaction.*

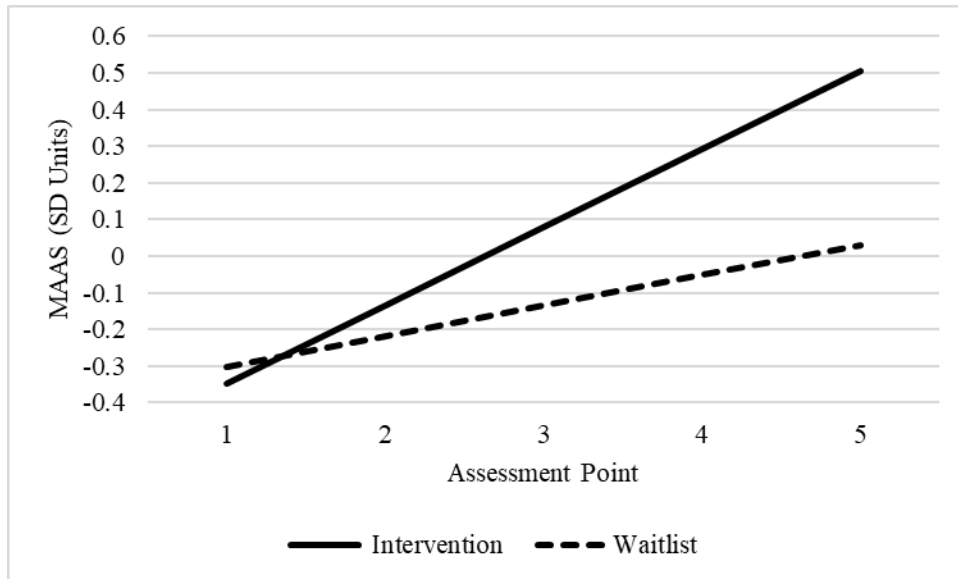
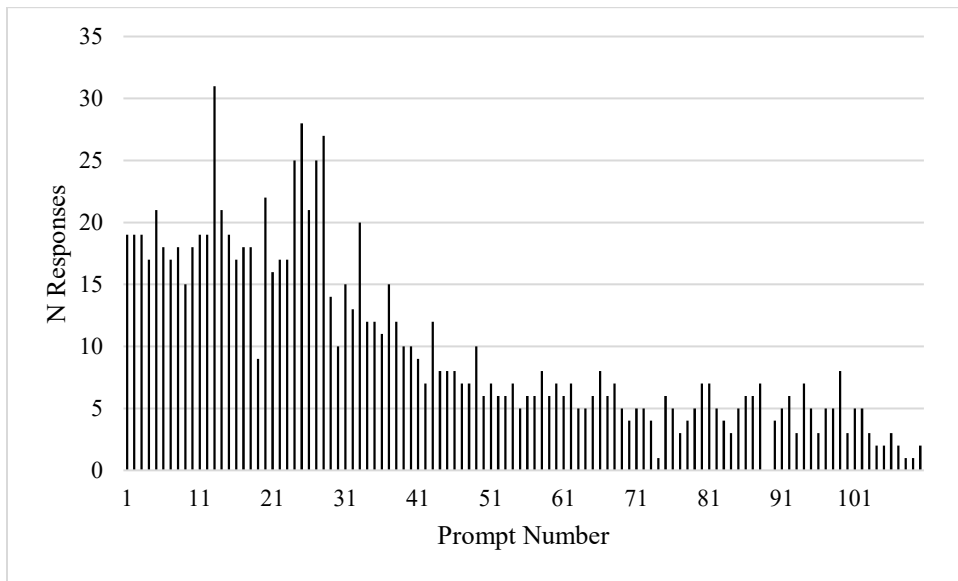


Figure 8.

*Number of participants responding to app notification, by prompt number.*



APPENDIX C: CURRICULUM VITA

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## Ben Pierce

Doctoral Candidate, Combined Psychology Program  
Utah State University

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### Formal Education

Utah State University

Ph. D. in Combined Clinical, Counseling, and School Psychology

Doctorate (Ph. D.) in Psychology completed August 2019

Master of Science (M.S.) in Psychology completed May 2015

University of British Columbia

Bachelor of Arts (B.A.) in Psychology completed August 2012

### Research & Professional Experiences

#### Research Assistant

April 2015-May 2017

*Contextual Behavioral Science Lab*

Supervisor: Dr. Michael Levin

- I assisted with designing and implementing research on web and app-based Acceptance and Commitment Therapy (ACT) interventions.
- I performed a range of statistical analyses with survey-based, intensive longitudinal, and intervention data, using latent variable modeling (SEM) and mixed/multilevel linear modeling (MLM) frameworks to address questions of measurement, longitudinal processes, time-varying effects, and heterogeneity in intervention outcomes.
- I wrote manuscripts for publication and provided consultation to peers on writing research methods and results sections.

#### Content Writer

January 2015-April 2015

*Contextual Change LLC, Collaboration among Utah State University and the University of Nevada, Reno*

Supervisors: Dr. Michael Levin, Dr. Crissa Levin, Dr. Jacquie Pistorello, Dr. Steven Hayes

- I wrote contents for a tailored online implementation of Acceptance and Commitment Therapy (ACT) and an online psychoeducational session, based on outlines of session content.

- I collaborated with a multi-site research team on the delivery and review of contents.

**Professional Officer**

**January 2015-January 2016**

*Journal of Contextual Behavioral Science*

Supervisor: Dr. Joseph Ciarrochi

- I tracked the manuscript review process, provided summary reports and evaluations of review times, and wrote journal-related contents for the Association for Contextual Behavioral Science (ACBS) website.
- I wrote journal-related contents for the ACBS website, focused on the dissemination of scientific findings published within the ACBS community.

**Research Assistant**

**August 2013-December 2014**

*Context and Methodology Lab, Utah State University*

Supervisor: Dr. Courtenay Barrett

- I assisted with research on contextual effects, inequality, and systemic problems among youth in American schools and contributed to manuscripts and presentations pertaining to health and service inequities among students in schools.
- I performed a range of mixed/multilevel linear analyses on secondary data from the National Longitudinal Study of Adolescent Health to address research questions pertaining to the effects of higher-level (e.g., school-level) variables on individual level (e.g., student-level) responses.
- I wrote up the results of analyses pertaining to school-level moderators of the effects of student-level risk factors on academic, social, and mental health outcomes.

**Clinical Experience**

**University of Pennsylvania Counseling and Psychological Services**

**August 2018-July 2019**

Supervisors: Dr. Michal Saraf, Dr. Cyndy Boyd

- I provided weekly individual counseling, group counseling, and outreach services to students at the University of Pennsylvania.
- I supervised an extern on a weekly basis and presented my work in group supervision meetings.
- I participated in multidisciplinary teams including the Eating Concerns Treatment Team, LGBT Health Working Group, and the Sexual Trauma Treatment, Outreach, and Prevention Team. I was also responsible for leading a multidisciplinary case group.

**Utah State University Counseling and Psychological Services**

**September 2015-April 2016, September 2017-May 2018**

Supervisors: Dr. Charles Bentley, Dr. Cameron Staley, Dr. Luann Helms, Dr. David Bush, Dr. Mark Nafziger

- I provided biweekly individual counseling, weekly group counseling, and outreach services to students attending Utah State University.

### **Bear River Head Start Family Counseling Services**

**May 2016-June 2017**

Supervisors: Dr. Melanie M. Domenech Rodríguez, Dr. Sara Boghosian

- I provided counseling to parents, children (ages 2-5), and couples in families served by the Head Start program in home visits, schools, and center-based contexts.

### **Utah State University Anxiety Clinic**

**August 2016-May 2017**

Supervisor: Dr. Michael P. Twohig

- I provided therapy to adults and adolescents with a range of anxiety, tic, and obsessive compulsive and related symptoms.

### **Utah State University Psychology Community Clinic**

**September 2014 – September 2015, May-August 2017**

Supervisor: Dr. Sara Boghosian, Dr. Susan Crowley, Dr. Julie Pelletier

- I provided therapy to a community population of adult, adolescent, and child clients for a range of concerns, including depression, anxiety, trauma, and child behavioral problems.

## **Extracurricular Activities**

### **Statistics Consultant**

**August 2014-Present**

*Utah State University*

- I provide consultation to peers on advanced statistical analyses, missing data techniques, complex sampling, the graphical presentation of data, and coding for programs such as R, MPlus, and SPSS.
- I have tutored graduate students for statistics classes and presented on specific statistical techniques to peers using real data examples.

### **Multicultural Trainer for Students**

**November 2016-May 2017**

*Utah State University*

- I participated in a team that organized and presented multicultural civility trainings to elementary and middle school students in the Cache Valley area.
- I provided multicultural competency trainings to undergraduate students in an introductory psychology class.
- My peer supervision focused on creating a supportive environment for students to address issues of privilege, oppression, and microaggressions.

**Psychology Student Representative****August 2016-May 2017***Utah State University*

- I attended bi-monthly meetings of faculty and staff pertaining to program logistics, changes, and social climate; organized monthly student meetings; and served as a liaison between students and staff to advocate for student concerns.

**Allies on Campus****March 2014-July 2018***Utah State University*

- I attended workshops that included didactic instruction, group discussion, self-application and self-evaluation exercises addressing subjects of equality, privilege, and effective “Ally” behavior.
- I participated and volunteered in annual Pride festivals, protests/advocacy, and LGBT+ initiatives held across Northern Utah.

**Professional Organizations****Association for Contextual Behavioral Science****January 2015-Present**

Graduate Student Member

Gender and Sexual Diversity SIG

**American Psychological Association****August 2013-Present**

Graduate Student Affiliate

**Publications**

Pierce, B. & Levin, M. E. (2019, in press). Preliminary evidence for the factor structure and reliability of a 10-item tacting of function scale. *Journal of Contextual Behavioral Science*.

Ong, C. W., Pierce, B., Woods, D. W., Twohig, M. P., & Levin, M. E. (2018). The Acceptance and Action Questionnaire – II: An item response theory analysis. *Journal of Psychopathology and Behavioral Assessment*, *41*, 123-134.

Levin, M. E., Krafft, J., Pierce, B. & Potts, S. (2018). When is experiential avoidance harmful in the moment? Examining global experiential avoidance as a moderator. *Journal of Behavior Therapy and Experimental Psychiatry*, *61*, 158-163.

Levin, M. E., Pierce, B., & Schoendorff, B. (2017). The acceptance and commitment therapy matrix mobile app: A pilot randomized trial on health behaviors. *Journal of Contextual Behavioral Science*, *6*, 268-275.

- Levin, M. E., Haeger, J., Pierce, B., & Cruz, R. A. (2017). Evaluating an adjunctive mobile app to enhance psychological flexibility in acceptance and commitment therapy. *Behavior Modification, 41*, 846-867.
- Pierce, B., Twohig, M., & Levin, M. E. (2016). Implementation of acceptance and commitment therapy-based mobile apps: Results from a survey of students and professionals. *Journal of Contextual Behavioral Science, 5*, 215-224.
- Levin, M. E., Haeger, J., Pierce, B., & Twohig, M. (2016). Web-based acceptance and commitment therapy for mental health problems in college students: A randomized controlled trial. *Behavioral Modification, 41*, 141-162.

### **Book & Encyclopedia Chapters**

- Lee, E.B., Pierce, B., Twohig, M.P. & Levin, M.E. (2018). Acceptance and commitment therapy. In A. Wenzel (Ed.), *APA Handbook of Cognitive Behavioral Therapies*. American Psychological Association.
- Pierce, B. & Levin, M. (2016). Acceptance. In *The SAGE Encyclopedia of Abnormal and Clinical Psychology*. Thousand Oaks, CA: SAGE publications.

### **Presentations**

- Pierce, B., & Levin, M. E. (2018, July) *Does momentary affect matter? An investigation of momentary affective discrimination and its relation to psychological flexibility processes*. Symposium paper presented at the 2018 Association for Contextual Behavioral Science conference, Montréal, QC, Canada.
- Pierce, B., Potts, S., & Levin, M. E. (2017, March) *Stigma, privilege, and “sorting things out” in the context of weight-related discrimination: An applied perspective*. Symposium paper presented at the 2017 Association for Women in Psychology Conference, Milwaukee, WI.
- Pierce, B., Levin, M. E., & Schoendorff, B. (2016, June). *Prompting the “away-towards” distinction in matrix-based health behavior change*. Symposium paper accepted for presentation at the 14<sup>th</sup> annual World Conference of the Association for Contextual Behavioral Science, Seattle, WA.
- Pierce, B., Haeger, J. A., & Levin, M. E. (2015, October). *ACT daily: Design and preliminary outcomes of an adjunctive application for Acceptance and Commitment Therapy*. Symposium paper presented at the 2015 Rocky Mountain ACBS (RMACBS) Chapter Regional Conference, Salt Lake City, UT.
- Levin, M. E., Haeger, J. A., & Pierce, B. (2015, October). *Integrating acceptance and mindfulness-based mobile apps into your clinical work*. Workshop presented at the 2015 RMACBS Chapter Regional Conference, Salt Lake City, UT.



- Pierce, B. (2015, August). *At the Intersection of Ethnic Composition and School Structure: Outcomes for Latinx Youths*. Poster presented at the APA 2015 Convention, Toronto, Ontario, Canada.
- Haeger, J., Levin, M., & Pierce, B. (2015, July). *Examining facets of psychological inflexibility as transdiagnostic predictors of psychological problems with college students*. Symposium paper presented at the 13th annual World Conference of the Association for Contextual and Behavioral Sciences, Berlin, Germany.
- Potts, S., Haeger, J., Pierce, B., & Levin, M. (2015, July). *Weight Self-Stigma and Problem Eating Behaviors: Multiple Predictors, Unique Associations, and the Centrality of Psychological Flexibility in a College Sample*. Poster presentation at the 13th annual World Conference of the Association for Contextual and Behavioral Science, Berlin, Germany.