Several models of suicidal behavior posit that in order to transition from suicidal ideation to attempting suicide, individuals must have an acquired capability for suicide (ACS). ACS is hypothesized to develop through exposure to painful and provocative experiences which lead to elevations in fearlessness about death and physical pain tolerance, thus preparing a person to enact serious self-harm. Although ACS is hypothesized to increase monotonically, recent research suggests that ACS may exhibit decreases over the short-term for some individuals (Zuromski, Cero, & Witte, 2015), and that ACS may have a “set point” to which it returns following fluctuations (Bryan, Sinclair, & Heron, 2015). The current study examined the nature of change in ACS over time within a sample of eating disorder inpatients. Growth mixture modeling to test models of fearlessness about death and pain tolerance identified that for both factors, a one-class intercept-only model was the best-fitting model, suggesting that patients entered treatment with mid-level ACS and experienced no significant linear change over the course of treatment. These findings suggest that ACS may be more stable than previously hypothesized, drawing attention to the importance of future research examining ACS across different time scales.
EXAMINING PATTERNS OF CHANGE IN THE ACQUIRED CAPABILITY FOR SUICIDE

A Thesis

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Introduction

Suicide is the tenth leading cause of death in the United States, resulting in nearly 43,000 deaths in 2014, and therefore poses a significant public health concern. Nonetheless, suicide remains a relatively rare event, with only 13 deaths by suicide per 100,000. Although correlates of suicide have been identified, such as depression and prior self-injury, most such correlates provide only marginal improvement in the power to predict suicide, and it remains difficult to predict which individuals will die by suicide (Ribeiro et al., 2016). Furthermore, many commonly-cited correlates of suicide do not differentiate those who attempt suicide from those who think about suicide but do not act on those thoughts (May & Klonsky, 2016). Researchers are working to identify risk factors that distinguish those who only think about suicide from those who will die by suicide. Recent theories of suicide (Joiner, 2005; Joiner et al., 2009; Klonsky & May, 2015; O’Connor, 2011; Van Orden, Witte, Cukrowicz, Braithwaite, Selby, & Joiner, 2010) have developed the hypothesis that suicide attempters can be distinguished from suicide ideators by one important factor: the capability to engage in lethal self-harm. This study will examine how this capacity develops over time in a sample of eating disorder patients.

The Interpersonal-Psychological Theory of Suicide

The Interpersonal-Psychological Theory of Suicide (IPTS; Joiner, 2005; Joiner et al., 2009; Van Orden et al., 2010) proposes that the risk for suicidal behavior is greatest when individuals not only actively desire death by suicide but also have acquired the capacity for lethal self-harm. Within the mechanisms of opponent-process theory (Solomon, 1980; Solomon & Corbit, 1974), repeated exposure to painful and frightening experiences leads to conditioning and habituation to these stimuli, resulting in reduced fearfulness and greater pain tolerance. Together, this fearlessness about death (FAD) and elevated pain tolerance comprise the acquired capability for suicide (ACS), which enables individuals to attempt lethal self-harm.

Notably, because each frightening or painful event incrementally increases ACS, the IPTS does not propose any mechanism by which ACS could decrease. Thus, ACS should show a pattern of either stability or monotonic increase over time. Although the rate of change may vary due to changing exposure to painful and frightening experiences, ACS should never decrease.
Theories of Change in ACS Over Time

Essential to the IPTS is this hypothesis of monotonic increase, with the rate of increase determined by exposure to painful and frightening experiences. While this claim remains largely untested, there has been some theorizing to the contrary.

Similar to the IPTS, the Three-Step Theory (Klonsky & May, 2015) suggests that the capability for suicide is a prerequisite for a suicidal individual to make an attempt, and proposes three types of variables that contribute to an individual’s capability for suicide. Dispositional factors are enduring traits, including fearlessness and pain tolerance, that may be influenced by genetics and predispose some individuals to a high risk for suicide. Acquired factors are those proposed by the IPTS: FAD and pain tolerance that develop through opponent processes. Practical factors include those variables which make suicide possible, including knowledge of and access to lethal means. Together, dispositional, acquired, and practical factors determine an individual’s capability for suicide at any given time. Klonsky and May’s (2015) model of suicide does not explicitly state hypotheses about the nature of change in their conceptualization of capability for suicide, however, predictions can be inferred from the nature of the factors described. The practical factors might be expected to fluctuate over time, and therefore this model does not preclude a decrease in overall capability over time. However, the “person-level” factors, dispositional and acquired, would not be anticipated to decrease.

The diathesis-stress model of ACS (Smith & Cukrowicz, 2010) proposes that certain vulnerabilities, when impinged upon by stressors, increase capability. Vulnerability may involve biological (e.g., reduced serotonergic activity influencing proneness toward aggression and impulsivity) and physiological (e.g., more rapid habituation, allowing speedier development of pain tolerance and FAD) factors. Within this model, vulnerability is expressed following exposure to physically painful and psychologically provocative events, especially those that are analogous to suicide, such as suicide attempts and non-suicidal self-injury (NSSI).

Importantly, these authors suggest that ACS may involve components of both short- and long-term capability. Within this model, the diathesis (biological and physiological vulnerability) and the stressor (repeated painful and provocative events) contribute to an individual’s ability to initiate a suicide attempt. Individuals may experience residual fear and pain sensitivity upon initiating an attempt, making a short-term increase in capability necessary to follow-through on the attempt. Factors which may increase short-term capability include intoxication, rehearsal of the attempt, NSSI, acute mania, and/or efforts that increasingly come close to the attempt (e.g., pacing a ledge from which one plans to
jump and coming closer to the edge each time). Smith and Cukrowicz (2010) conclude that “while the capability for suicide does, on average, involve an increasing upward trend that is a function of exposure to painful and provocative life events, it also involves a degree of moment-to- moment variability” (p. 273). Thus, this model of suicide suggests that ACS should monotonically increase when examined at a macroscopic, long-term level, but may show fluctuations, including decreases, when examined at a microscopic, short- term level, particularly following acute elevations in ACS during an immediate suicidal crisis.

Fluid vulnerability theory (Rudd, 2006; Bryan & Rudd, 2016) proposes that risk for suicide is dynamic across time and is influenced by the interactions of both risk and protective factors. Some risk and protective factors are hypothesized to be stable over time, such as race and enduring personality traits. Other factors such as mood and life stressors are more dynamic. This theory suggests that static factors ought to differentiate suicide attempters from ideators. Individuals with more static risk factors (or fewer protective factors) may be more vulnerable to experiencing suicidality in the first place, and, in the face of acute risk factors, may be more likely to transition from ideation to action than individuals with lower risk. Essential to this theory is the prediction that static and dynamic risk and protective factors interact with one another, and that change in one factor can contribute to change in another factor. Furthermore, acute risk is determined not by the severity of any given risk factor(s), but rather by coordinated change in several risk factors over a short period of time. Therefore, someone with active suicidal desire and high ACS is considered capable of making a suicide attempt, but will do so at the point when a number of protective and risk factors change in coordination.

The three preceding models of suicide (the Three-Step Theory, the diathesis-stress model of capability for suicide, and fluid vulnerability theory) and the IPTS agree that what differentiates ideators from attempters is not the severity of suicidal desire but rather the capacity to enact such self-harm. These three models all suggest that the capability for suicide involves elements of both chronic (i.e., dispositional, long-term, or static) and acute (i.e., acquired and practical, short-term, or dynamic) risk factors. This is not entirely dissimilar from the IPTS, which proposes that although individuals must acquire the ability to enact lethal self-harm (nobody is born capable of suicide), some individuals may have certain qualities (personality traits or genetic determinants of risk) which predispose them to develop this capability more easily or more rapidly (Smith et al., 2012). However, these alternate models propose mechanisms by which the capability for suicide might decrease over time, whereas the IPTS does not. This question about the nature of change in ACS over time remains
Empirical Tests of ACS Over Time

No mechanism is proposed in the IPTS whereby ACS should decrease, and therefore ACS should at least remain stable across time. Remarkably little research has been conducted examining this claim. Bryan, Sinclair, and Heron (2015) conducted one of two studies examining change in ACS. Specifically, they examined ACS in a sample of military personnel followed from pre-deployment training through one year after deployment to Iraq. Assessments of ACS and combat exposure were administered at six time points: before and after training, and at 1, 3, 6, and 12 months after deployment. There was an increase in ACS from pre-training to post-training, but then an unexpected return to original levels at the following assessment. Although combat exposure would be expected to increase ACS, combat exposure during deployment was unrelated to change in ACS during deployment, and indeed, combat exposure during deployment was positively correlated with ACS both before and after deployment. Such an association between combat exposure during deployment and pre-deployment suggests that high ACS may be associated with a tendency to engage in and perhaps even seek out potentially painful and frightening experiences. Moreover, there was no significant overall change in ACS over time, a finding which contradicts the hypothesis that ACS ought to increase over time in the presence of painful and provocative events such as combat.

Bryan and colleagues (2015) used dynamical systems theory to describe and test the possible patterns of change in ACS over time. Within dynamical systems theory, constructs that tend to return to a set point after changes are attractors, whereas those that tend to easily move away from a set point to a new state when perturbed are repellers. Attractors resist change and show a pattern of temporal stability, whereas repellers are easily influenced to change. According to the IPTS, ACS ought to be a repeller state, in which small perturbations (resulting from exposure to painful and provocative experiences) lead to lasting change. In order to test this hypothesis in this military sample, Bryan and colleagues (2015) computed the difference in ACS from one time point to the next time point, and modeled this difference score as the outcome, with previous ACS as the predictor. In this model, positive correlation indicated instability (i.e., that ACS is a repeller state), whereas negative correlation indicated stability (i.e., that ACS is an attractor state). Contrary to hypotheses, there was a significant negative correlation, indicating that when scores were above the baseline “set point,” they tended to decrease at the next time point, whereas scores below the
set point tended to increase at the next measurement. Overall, these findings suggest that ACS may remain more stable than previously hypothesized, even in the face of exposure to painful and frightening experiences.

One other study has attempted to address the question about the nature of change in ACS over time. Zuromski, Cero, and Witte (2015) examined ACS over a short time period, with six assessments over 15 days. Using a 7-item scale measuring FAD but not pain tolerance (Ribeiro et al., 2014), the authors used latent class growth analysis in order to identify classes of change in FAD scores over time, with the hypothesis that there would be two classes: one showing increases in FAD scores over time and one showing stability. Additionally, they predicted that greater lifetime exposure to painful and provocative experiences would predict membership in the first class. Contrary to hypotheses, the best-fitting model included three classes: one with high and increasing FAD, one with moderate and stable FAD, and one with low and decreasing FAD. Males were more likely to be in the first two classes, as were individuals who had experienced painful and provocative experiences. However, those with exposure to traumatic events (i.e., abuse) were more likely to be in the third class. Whereas the identification of the first two classes is consistent with theory, the last class contradicts essential suppositions of the IPTS and suggests that FAD may decrease over short periods of time.

Longitudinal research with ACS is lacking, and these studies (Bryan, Sinclair, & Heron, 2015; Zuromski, Cero, & Witte, 2015) begin to provide insight into how ACS develops over time. However, each of these studies has limitations. The first (Bryan, Sinclair, & Heron, 2015) used long and differing time periods between assessment points, with a gap of nine months between the second and third assessments, while personnel were deployed. Additionally, the analyses used in this study assessed mean-level change in ACS for the entire sample. This variable-centered approach to analyses assumes that the individuals in the sample come from a single population, and that ACS shows the same pattern of change for all individuals. Person-centered approaches (such as latent class growth analysis, used by Zuromski et al. [2015]) are sensitive to individual differences in patterns of change over time. Zuromski, Cero, and Witte (2015) used frequent measurements, but only assessed a two-week time period, making it impossible to draw conclusions about patterns of change across a larger time scale. Furthermore, these authors used the 7-item FAD scale, but did not assess for the second element of ACS, pain tolerance. It may be that the two components of ACS show different patterns of change, but this could not be determined from their study.

This literature review identifies a fundamental weakness in the ACS literature: there is
limited longitudinal research examining ACS. ACS is hypothesized to be the essential factor in differentiating suicide ideators from attempters, and therefore, understanding the nature of this variable has implications for clinical risk assessment and ought to be a priority.

**Eating Disorders and ACS**

Suicidality is common among individuals with eating disorders (EDs), with this population having elevated rates of ideation (Favaro & Santonastaso, 1997; Swanson, Crow, le Grange, Swendsen, & Merikangas, 2011), attempts (Franko & Keel, 2006; Swanson et al., 2011), and death (Arcelus, Mitchell, Wales, & Nielsen, 2011; Crow et al., 2009; Preti, Rocchi, Sisti, Camboni, & Miotto, 2011). Given the high rate of suicidal behavior among this population, studying suicidality within this population may be particularly fruitful in providing insight into how suicidal behavior develops.

The IPTS suggests that at least part of this elevated risk is the result of increases in ACS ensuing from ED behaviors. Indeed, individuals with anorexia nervosa (AN) or bulimia nervosa (BN) have higher pain threshold than healthy controls (Papežová, Yamamotova, & Uher, 2005), and pain endurance is higher among individuals with disordered eating than among controls (St. Germain & Hooley, 2013). Furthermore, self-induced vomiting is associated with both pain tolerance and FAD (Witte et al., 2016), laxative use is associated with FAD (Witte et al., 2016), and engagement in over-exercise predicts higher ACS at a later time point (Smith et al., 2013). Thus, research suggests that ED behaviors are associated with the components of ACS.

While rates of suicidal ideation are fairly similar across ED diagnoses (Milos, Spindler, Hepp, & Schnyder, 2004), risk of death by suicide is consistently higher among individuals with AN than other ED diagnoses (Arcelus et al., 2011; Preti et al., 2011), suggesting that features of this disorder may be particularly important in spurring the transition from ideation to suicidal behavior. The IPTS proposes that while ED behaviors such as binge eating and vomiting may be painful and provocative, the extreme dietary restriction and resulting starvation that characterize AN is especially painful, resulting in particularly elevated ACS in individuals with AN.

Some research contradicts the IPTS hypothesis that dietary restriction is the key driver of suicidality in AN through elevated ACS. For instance, Witte and colleagues (2016) found that restrictive eating was associated with suicide attempts but not ACS. Additionally, Zuromski and Witte (2015) found that individuals who had fasted (i.e., gone without eating for eight hours or more) within the past three months were more likely to have a history of suicide.
attempts than non-fasters, but that these groups did not differ on ACS. Moreover, when comparing women with AN, BN, and other specified feeding and eating disorders (OSFED), Smith and colleagues (2016) found no differences on FAD. Although these studies do not support the hypothesis that the association between restrictive eating and suicide attempts is driven by elevations in ACS, they are limited by their cross-sectional design. Prospective designs, however, may reveal a unique role of restriction and diagnostic status in predicting change in ACS over time. The current study will attempt to address this question by testing whether ED diagnoses (e.g., AN vs. BN and OSFED) are associated with different patterns of change in ACS.

Aims of the Current Study

The current study will build upon previous research examining the nature of change in ACS over time by using growth mixture modeling to identify classes of change in ACS in a sample of eating disorder inpatients. Such a person-centered approach to analyses will allow for the identification of possible sub-populations for whom ACS develops differently over time. In order to address gaps in the literature, I will test models for both FAD and pain tolerance. I hypothesize, based upon the initial claims of the IPTS, that there will be two classes of change in ACS: one with high and increasing ACS, and one with moderate and stable ACS. Moreover, greater lifetime exposure to painful and provocative experiences (including ED behaviors, suicide attempts, and non-suicidal self-injury) will predict membership in the class with increasing ACS. Lastly, I predict that individuals with an intake diagnosis of AN will be more likely to be in the increasing ACS class, compared to those with a diagnosis of BN or OSFED.

Method

The present study is a secondary analysis of data from a larger study; however, the hypotheses and analyses for the current study are unique. The procedures for data collection were approved by appropriate Institutional Review Boards, and the current analyses were approved by the Miami University Institutional Review Board. Only the procedures relevant to the current analyses are presented in the method section below.
Participants

One hundred female patients enrolled in ED treatment at a residential facility in the southeastern United States were invited to participate. Participants’ ages ranged from 18 to 58 ($M = 26.92, SD = 7.86$). The majority of participants were non-Hispanic ($n = 96$). Most participants identified as white ($n = 94$); the remaining participants identified as Black or African-American ($n = 2$), Native Hawaiian or Other Pacific Islander ($n = 1$), and American Indian or Alaska Native ($n = 1$). Following administration of a semi-structured clinical interview and the Eating Disorders Examination Questionnaire (EDEQ; Fairburn & Beglin, 1994), participants were assigned clinical diagnoses according to the Diagnostic and Statistical Manual for Mental Disorders, Fifth Edition, (DSM-5; American Psychiatric Association, 2013). Approximately one-third of participants met criteria for AN ($n = 34$), BN ($n = 27$), and other specified feeding or eating disorder (OSFED; $n = 30$). OSFED diagnoses varied; five participants met criteria for atypical AN (i.e., met criteria for AN but had a current body mass index over 19), 15 participants met criteria for BN of low frequency or limited duration (i.e., met criteria for BN, but engagement in bingeing and/or compensatory behaviors occurred less than once a week or for fewer than three months), and 10 participants met criteria for purging disorder (i.e., engaged in purging behaviors in the absence of binge episodes). One participant met criteria for BED, and the remaining participants ($n = 8$) met criteria for unspecified feeding or eating disorder (UFED).

Procedures

As part of the treatment facility’s intake procedure, all patients were informed about the study and invited to participate. Interested individuals were given details about the study and provided written informed consent. Some data for the current study were collected as part of the routine intake procedure; remaining baseline questionnaires were collected via an online survey within four days of admission. Participants completed questionnaires weekly during admission and at discharge. The number of weekly assessments completed varied due to differences in length of treatment stay. Five participants did not complete any weekly assessments; one completed 30 weekly assessments (mean number of assessments = 8.17, $SD = 5.5$).
Materials

Acquired Capability for Suicide Scale (ACSS). The Acquired Capability for Suicide Scale is a self-report questionnaire used to measure ACS. Two versions of this scale were administered as part of this study: a 20-item version was administered at intake and discharge, and a 9-item version was used for weekly assessments. The 20-item version contains all 9 items from the short version. Psychometric testing of the ACSS since the time of data collection has derived a 7-item FAD subscale (Ribeiro et al., 2014), three items of which were included in the weekly assessments for the present study. These three items (“The fact that I am going to die does not affect me,” “The prospect of my own death arouses anxiety in me,” and “I am very much afraid to die”) were reverse-scored as necessary and averaged for use in the FAD model (described below). An additional item assessing for subjective pain tolerance (“I can tolerate a lot more pain than most people”) was used for a model examining pain tolerance. Participants were asked to indicate how much the statement is like them on a scale from 1 (Not at all like me) to 5 (Very much like me), such that higher scores indicate greater ACS. In the current sample, internal reliability for the averaged FAD items varied by week to week, ranging from acceptable (Cronbach’s $\alpha = 0.73$) to excellent (Cronbach’s $\alpha = 0.92$).

Painful and Provocative Events Scale (PPES). The Painful and Provocative Events Scale is an unvalidated 26-item scale assessing for lifetime exposure to a variety of painful and frightening experiences. The PPES was administered at intake and discharge; the data from intake were used as a predictor of class membership. Sample items include “Have you had surgery?” and “Have you shot a gun?” Participants were asked to indicate how many times they had engaged in a given behavior on an ordinal scale from 1 (Never) to 5 (More than 20 times) and a total score was calculated by summing all responses such that higher scores on the PPES indicate greater exposure to frightening or painful experiences.

Eating Disorder Painful and Provocative Events Scale (EPPES). The Eating Disorder Painful and Provocative Events Scale is an unvalidated 20-item scale assessing for lifetime exposure to painful and frightening ED behaviors such as laxative use and self-induced vomiting. The EPPES was administered at intake and discharge, and data from intake were used as a predictor of class membership. Participants were asked to indicate how many times they have engaged in a given behavior on an ordinal scale from 1 (Never) to 5 (More than 20 times) and a total score was calculated by summing all responses such that higher scores on the EPPES indicate greater exposure to frightening or painful ED behaviors.
Suicide attempts. Four questions were used to assess for history of suicide attempts. Participants were asked to indicate "Yes" or "No" in response to the question "Have you ever made an actual attempt to kill yourself in which you had at least some intent to die?" Those who answered "Yes" then completed follow-up questions regarding the number of previous suicide attempts, whether any attempts resulted in hospitalization, and how many attempts resulted in hospitalization. These questions were completed at both intake and discharge. Number of lifetime suicide attempts reported at intake were used as a predictor of class membership.

Results

Data Screening

Non-normality. The averaged FAD items and single pain tolerance item were examined for cases of non-normality. All absolute values of skew and kurtosis were below 0.99, suggesting that the data were distributed normally. See Table 1 for descriptive statistics.

Missing data. Little's missing completely at random (MCAR) test was conducted to describe the pattern of missingness in the sample in the first eight weeks of data. This test was non-significant ($p = 0.99$), suggesting that the data were consistent with a pattern of MCAR. Therefore, missing data were handled using the default setting in Mplus, which is full-information maximum likelihood (FIML).

Growth Mixture Modeling

Growth mixture modeling (GMM) is a person-centered approach to modeling change which aims to identify between-person differences in within-person change over time. Differences in trajectory between individuals are assumed to be the results of membership in latent classes. GMM identifies classes which differ from one another in their pattern of growth over time (i.e., intercept and slope parameters). Data from baseline and seven weekly assessments of FAD and pain tolerance were used as indicators of ACS, because the percent of missing data fell near 50% at the eighth weekly assessment and models initially fit to include this week failed to converge. Models examining FAD and pain tolerance were tested separately using Mplus version 7 (Muthén & Muthén, 2015). In order to establish a baseline model prior to beginning the class enumeration process, model testing began with a one-class intercept-only model, followed by testing a one-class linear growth model. The linear model is nested within
the intercept-only model, allowing for direct comparison of these models in order to select which model is better-fitting prior to adding classes within the growth mixture modeling framework.

FAD model. Testing of the FAD model began by examining the pattern of group means across the eight weeks of data. Visual inspection of the group means across eight weeks of data showed little change over time (see Figure 1); however, when sub-populations within a sample have different patterns of change (e.g., one group increasing and another group decreasing), this can be obscured by examining mean-level change. Therefore, the absence of mean-level growth does not eliminate the necessity of further examining the nature of change and testing for groups.

Given that the group means appeared to remain stable across time, the first model tested was a one-class intercept-only model (see Figure 2), in which the only latent parameter estimated is an intercept (Berlin, Parra, & Williams, 2014; Curran, Obeidat, & Losardo, 2010). According to traditional measures of model fit, this model provided acceptable fit to the data (see Table 2 for all fit statistics). Note that although RMSEA and SRMR were above the values that are typically considered acceptable, other indicators suggested that this model provides acceptable fit. The intercept latent variable parameter estimate in this model was 3.16 ($SE = 0.11, p < 0.001$), with significant individual variance around this intercept ($p < 0.001$). The parameter estimates provided are in the scale of the original measure which ranges from 1-5, indicating that participants entered treatment with FAD scores near the midpoint of the scale.

The next model tested was a one-class linear growth model, which is nested within the intercept-only model, allowing for a direct test of model fit via a chi-square test. In specifying the one-class linear growth model, the zero point for time was specified as baseline, and factor loadings for the slope were set to 1, 2, 3, 4, 5, 6, and 7 for the remaining weeks of data. According to traditional measures of model fit, this model provided acceptable fit to the data (see Table 2). As was the case for the intercept-only model, values of RMSEA and SRMR were slightly higher than is conventionally considered acceptable, but other measures of model fit indicated that this model provided acceptable fit to the data. This model had an intercept of 3.08 ($SE = 0.12, p < 0.001$) and slope of 0.03 ($SE = 0.01, p = 0.06$), with significant variance ($p < 0.001$) around both the intercept and slope. The chi-square difference test of model fit was significant: $114.16(41) - 67.04(38) = 47.13(3)$, indicating that the intercept-only model provides a better fit to the data than the linear model. Therefore, the one-class intercept-only model was selected as the best-fitting baseline model for the
class enumeration process.

After adding a second class, indicators of relative fit suggested that the two-class solution was little improvement over the one-class intercept-only model (see Table 2). In this two-class model, classification quality was mediocre and the Vuong-Lo-Mendell-Rubin test was not significant, suggesting that the two-class model does not provide significant improvement in model fit compared to the one-class model. Based on the results of these analyses, the one-class intercept-only model was selected as the best-fitting model for the data. This model suggests that participants entered treatment with FAD scores near the midpoint of the scale, and experienced no significant linear change across eight weeks of treatment. Furthermore, within this sample, sub-populations of growth were not apparent.

**PT model.** Testing of the pain tolerance model began by examining the pattern of group means across the eight weeks of data. Visual inspection of the group means across eight weeks of data showed little change over time (see Figure 1), suggesting that fitting an intercept-only model would be an appropriate first step, as with the FAD model.

The first model tested was a one-class intercept-only model, in which the only latent parameter estimated was an intercept (see Figure 3). According to traditional measures of model fit, this model provided acceptable fit to the data (see Table 3). Note that although RMSEA and SRMR were above the values that are typically considered acceptable, other indicators suggested that this model provides acceptable fit. The intercept latent variable parameter estimate in this model was 3.10 \((SE = 0.10, p < 0.001)\), with significant individual variance around this intercept \((p < 0.001)\). The parameter estimates provided are in the scale of the original measure which ranges from 1-5, indicating that participants entered treatment with pain tolerance scores near the midpoint of the scale.

The next model tested was a one-class linear growth model in which the zero point for time was specified as baseline, and factor loadings for the slope were set to 1, 2, 3, 4, 5, 6, and 7 for the remaining weeks of data. According to traditional measures of model fit, this model provided acceptable fit to the data (see Table 3). As was the case for the intercept-only model, values of RMSEA and SRMR were slightly higher than is conventionally considered acceptable, but other measures of model fit indicated that this model provides acceptable fit to the data. This model had an intercept of 3.22 \((SE = 0.10, p < 0.001)\) and slope of \(-0.04 \((SE = 0.01, p = 0.001)\), with significant variance around both the intercept \((p < 0.001)\) and slope \((p = 0.03)\). The chi-square difference test of model fit was significant: \(135.89(41) - 108.13(38) = 27.76(3)\), indicating that the intercept-only model provides a better fit to the data than the linear model. Therefore, the one-class intercept-only model
was selected as the best-fitting baseline model for the class enumeration process.

Next, a second class was added to the intercept-only model, and indicators of relative fit suggested that the two-class solution provided little improvement over the one-class intercept-only model (see Table 3). In this two-class model, classification quality was mediocre and the Vuong-Lo-Mendell-Rubin test was not significant, suggesting that the two-class model does not provide significant improvement in model fit compared to the one-class model. Based on the results of these analyses, the one-class intercept-only model was selected as the best-fitting model for the data. This model suggests that participants entered treatment with pain tolerance scores near the midpoint of the scale, and experienced no significant linear change across eight weeks of treatment. Furthermore, within this sample, sub-populations of growth were not apparent.

Because neither model identified meaningful classes of change over time, no analyses were conducted to test for predictors of class membership. However, post-hoc analyses were conducted to examine how baseline measures of FAD and pain tolerance were associated with number of previous suicide attempts as well as scores on the PPES and EPPES. Results indicated that baseline FAD was significantly positively associated with PPES ($r = 0.25, p = 0.01$) and EPPES ($r = 0.21, p = 0.04$) but not suicide attempts ($r = 0.17, p = 0.10$) and baseline pain tolerance was significantly positively associated with PPES ($r = 0.44, p < 0.01$) and suicide attempts ($r = 0.29, p < 0.01$) but not EPPES ($r = 0.16, p = 0.12$). Thus within this sample, painful experiences people experienced were related to both aspects of ACS. Lifetime ED-related painful experiences were related only to FAD, and suicide attempts were only related to pain tolerance.

Discussion
The purpose of the current study was to examine the nature of change in ACS over eight weeks of treatment in a sample of individuals receiving residential treatment for an eating disorder, and to identify latent classes of change in ACS in this sample. Separate growth mixture models were tested for FAD and pain tolerance, and in both cases a one-class intercept-only model was determined to be a better-fitting model than either a linear growth model or a 2-class intercept-only model. These findings indicate that, within this sample of eating disorder patients, there was no significant linear growth of either facet of ACS over time, nor were there meaningful sub-populations, in spite of significant variance around the intercept for both models. These results provide moderate support for the hypotheses of the
The IPTS predicts that ACS should increase monotonically over time, and therefore the finding that ACS remains stable across eight weeks, with neither growth nor decrease, does not directly contradict predictions. Whereas two previous studies have found evidence of decreasing ACS over time (Bryan, Sinclair, & Heron, 2015; Zuromski, Cero, & Witte, 2015) in direct contradiction to the IPTS, the present analyses did not identify classes with decreasing ACS. However, the absence of growth in the current sample was surprising, given that a core hypothesis of the IPTS is that ACS should increase incrementally with each subsequent painful or frightening experience. Critically, these results point to the need for further study regarding the nature of change in ACS. These findings suggest that ACS may show more stability over time than has previously been hypothesized, or may only show measureable change across time frames that are larger or smaller than that of the current study. Additionally, researchers should develop more fine-grained predictions about the time-frame in which ACS develops, including identifying whether there are particular "critical events" that have a disproportionate effect on the growth of ACS over time or critical periods in which ACS is sensitive to development in response to painful and frightening experiences. This study and others (Bryan, Sinclair, & Heron, 2015; Zuromski, Cero, & Witte, 2015) suggest that refinement of the IPTS’s predictions about ACS development is critically needed.

There are several possible explanations for the absence of growth within this sample. First, the items used to measure FAD represented only a subset of the items on the validated FAD scale (Ribeiro et al., 2014), and scale internal reliability varied in quality across time points. Additionally, pain tolerance was measured subjectively using a single self-report item, rather than objective measures of pain tolerance. Future research should use the 7-item validated FAD subscale and objective measures of pain tolerance in order to best study change in these constructs over time.

Second, the participants in this sample were all individuals seeking treatment for an ED, which presents unique challenges to the study of change in ACS. As noted before, the ED behaviors in which these individuals engage are the sort of painful experiences that contribute to ACS (Smith et al., 2013; Witte et al., 2016). Therefore, a reduction in these behaviors during treatment may result in minimal change in ACS over the study period. Furthermore, in previous research (Witte et al., 2016; Zuromski & Witte, 2015), ED-related painful experiences have not always demonstrated the expected association with ACS, so it may be the case that even if these participants continue to engage in some painful ED
behaviors during treatment, these are less potent contributors to ACS compared to other painful experiences such as NSSI.

Finally, the previous studies that have examined change in ACS have done so over very different time scales, either over the span of years with long gaps between measurement (Bryan, Sinclair, & Heron, 2016) or with frequent measurement over a short time period (Zuromski, Cero, & Witte, 2015). It may be the case that ACS change can be detected over either very short or long periods of measurement. The diathesis-stress model of ACS (Smith & Cukrowicz, 2010) proposes that the general trend of increasing ACS should be evident when examined on a larger time scale of months or years, whereas greater fluctuation between increases and decreases in ACS will appear in a shorter time scale of minutes, hours, or days. Thus, there are two alternate hypotheses for how the schedule for data collection for the current study may have been insufficient in capturing the shape of change in ACS over time. On the one hand, ACS may only show meaningful increase across a timespan larger than two months, and therefore eight weeks of data collection was insufficient to capture this growth. Alternatively, it may be the case that fluctuations, including decreases, in ACS can only be captured with measurements that happen more frequently than once a week. Therefore, it may be necessary to assess ACS with methods to capture both of these time scales, for example by conducting intensive data collection (i.e., two or three measurements a day for two weeks) during multiple periods separated by large increments of time (i.e., separated by six months).

The current study represents a significant addition to the field of suicide research, as it is only the third study to directly examine the nature of change in ACS across time, and the first to do so among individuals with eating disorders. This study had a number of strengths, including its theory-driven approach and longitudinal design. Furthermore, the use of a person-centered approach to data analysis in GMM allows for a strong test of the hypotheses of the IPTS.

Limitations and Future Directions

In spite of its strengths, this study has limitations which must be considered when interpreting results. First, the measurement of ACS in the current study was not ideal; future studies should use the validated FAD scale (Ribeiro et al., 2014) and objective pain tolerance. Additionally, the sample was homogenous in a number of ways, including the inclusion of only ED patients in treatment and the limited racial and ethnic diversity of the sample. It will be necessary for future research to examine the nature of change within samples that
are more representative of the population in terms of race, ethnicity, and mental health characteristics. Furthermore, future studies will need to account better for the way individuals experience painful experiences. Studies attempting to capture change in ACS should also measure participants’ painful and frightening experiences, and should consider testing whether certain experiences (e.g., those that are particularly frightening or painful, such as car accidents or surgery, or those that are closer approximations of suicide, such as NSSI or non-lethal suicide attempts) are more strongly associated with increases in ACS compared to less frightening or painful experiences. Finally, future research should test the hypotheses of the diathesis-stress model of ACS (Smith & Cukrowicz, 2010) to determine the validity of the hypothesis that short-term fluctuations in ACS can be observed even within a long-term trend of growth.

Conclusions

The present study examined between-person variability in within-person change in ACS over the course of eight weeks of ED treatment. Results indicated that for both FAD and pain tolerance, the best-fitting model was a one-class intercept-only model, suggesting that individuals enter treatment with mid-level ACS and experience little change across the course of eight weeks of treatment. These findings suggest that ACS may remain more stable than previously hypothesized, and point to important directions for future study.
References


Smith, A. R., Fink, E. L., Anestis, M. D., Ribeiro, J. D., Gordon, K. H., Davis, H., ... &


Table 1
Descriptive statistics for weekly measures of fearlessness about death and pain tolerance

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
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Table 2

*Model fit statistics for fearlessness about death growth mixture models*

### One-class models

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<th>Df</th>
<th>p-value</th>
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<th>SRMR</th>
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<th>TLI</th>
<th>AIC</th>
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### Two-class models

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Table 3

*Model fit statistics for pain tolerance growth mixture models*

**One-class models**

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**Two-class models**

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<th>Model</th>
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Figure 1: Group mean values of fearlessness about death and pain tolerance across 8 weeks.
Figure 2: One-class intercept-only model for fearlessness about death.
Figure 3: One-class intercept-only model for pain tolerance.