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Dynamic change patterns in suicidal ideation differ in brief cognitive behavioral therapy (BCBT) and present-centered therapy (PCT)

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Abstract

Objective: Although Brief Cognitive Behavioral Therapy (BCBT) is more effective than Present-Centered Therapy (PCT) for preventing suicide attempts, the two treatments have similar efficacy for reducing suicidal ideation severity. Traditional severity scores may obscure meaningful differences in how specific dimensions of suicidal ideation actually change during treatment. This study examined how quickly and consistently different dimensions of suicidal ideation changed during BCBT and PCT.

Method: The first five items of the Scale for Suicidal Ideation (wish to live, wish to die, reasons for living versus dying, suicidal desire, and passive desire for death) were administered at every scheduled therapy session during a randomized clinical trial comparing BCBT to PCT among high-risk U.S. military personnel and veterans. We estimated separate continuous-time multivariate change models for each item and applied eigen-decomposition to the matrix of regression coefficients to characterize dominant change patterns.

Results: In both treatments, some dimensions of suicidal ideation changed quickly while others changed slowly, and change was not evenly distributed across all five dimensions. Dimensions of suicidal ideation changed faster and in greater synchrony during BCBT than PCT.

Conclusions: Suicidal ideation reductions may arise through qualitatively different change processes across treatments even when the overall magnitude of change is similar. BCBT appeared to produce faster, more coordinated change across dimensions of suicidal ideation whereas PCT produced slower change that was less consistent across dimensions. These findings highlight the value of dynamical systems approaches for understanding mechanisms of therapeutic change that go beyond mean-level severity scores.

Key Words: suicide; brief cognitive behavior therapy; suicidal ideation; clinical trial

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Introduction

Suicide remains a major global public health problem. More than 700,000 people die by suicide worldwide each year (World Health Organization, 2025), and in the United States the suicide rate has increased by over 33% since 1999 (U.S. Centers for Disease Control and Prevention, 2025). Rates among U.S. military personnel and veterans have also risen during this same timeframe (Department of Defense, 2024; Department of Veterans Affairs, 2024). Death by suicide represents only one component of a much larger burden of suicide-related morbidity, however. In the U.S., for instance, approximately 48,000 people died by suicide in 2024 but an estimated 17 million experienced serious thoughts about suicide (Substance Abuse and Mental Health Services Administration, 2025). Suicidal ideation is a leading risk factor for suicide death and is associated with poorer physical health, impaired functioning, and reduced quality of life (Franklin et al., 2017; Goldney et al., 2001; Jobes & Joiner, 2019; Reinherz et al., 2006). At the same time, accumulating evidence suggests that suicidal ideation often fluctuates (Bryan, Tabares, et al., 2025; Coppersmith et al., 2023; Kivelä et al., 2022; Kleiman et al., 2017; Wang et al., 2021), following time courses characterized by discrete episodes of heightened activation and subsequent recovery that occur even in the absence of intervention, indicating some reductions in ideation reflect natural change processes. Despite its clinical importance, relatively little is known about how suicidal ideation changes during psychotherapy, or whether different treatments reliably alter the way different dimensions of suicidal ideation interact with each other over time .

Results from multiple randomized clinical trials (RCTs) support the efficacy of Brief Cognitive Behavioral Therapy (BCBT) for reducing suicide attempts among high-risk patients relative to treatment as usual and active comparators (Baker et al., 2024; Bryan, Khazem, et al., 2025; Diefenbach et al., 2024; Rudd et al., 2015; Sinyor et al., 2020). Patients receiving BCBT also report reductions in suicidal ideation that are larger than those observed in treatment as usual (Diefenbach et al., 2024; Rudd et al., 2015). By contrast, reductions in suicidal ideation among patients receiving BCBT are similar in magnitude to those

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observed among patients receiving Present-Centered Therapy (PCT; Baker et al., 2024; Bryan, Khazem, et al., 2025), an active treatment comparator. Notably, studies of the Collaborative Assessment and Management of Suicidality (CAMS; Jobes, 2023) demonstrate the reverse pattern: CAMS is associated with larger reductions in suicidal ideation relative to treatment as usual, yet does not consistently prevent suicide attempts (Swift et al., 2021; van Ballegooijen et al., 2025). Taken together, these findings highlight a seeming paradox—treatments that are relatively better at preventing suicidal behavior may be no better or worse at reducing the severity intensity of suicidal ideation, and vice versa.

One possible explanation for this paradox is that differences across treatments in suicidal ideation as an outcome reflect differences among the comparators used in clinical trials. Treatment as usual, when used as a comparator in clinical trials, can encompass a wide range of procedures and interventions and is therefore inherently heterogeneous. In contrast, active comparator conditions offer greater standardization, allowing for more precise interpretation of what therapeutic components are present or absent. Beyond the effects of suicide-focused psychotherapies on suicidal ideation (Fox et al., 2020; van Ballegooijen et al., 2025), structured and well-defined psychotherapies for a wide range of psychological conditions and problems including depression (Weitz et al., 2014), posttraumatic stress disorder (Rozek et al., 2022), and insomnia (Trockel et al., 2015) have also been shown to report reductions in suicidal ideation. Taken together, these findings suggest that, in general, psychotherapies that reduce emotional distress often reduce suicidal ideation as well, an interpretation that aligns with contemporary theories of suicide that conceptualize suicidal ideation as a largely state-like phenomenon that emerges in the context of intense emotional distress (Klonsky et al., 2021; O'Connor & Kirtley, 2018; Van Orden et al., 2010). These same models assume that suicide attempts require additional suicide-specific processes (e.g., fearlessness of death, access to means, or deficits in self-regulation) that are distinct from emotional distress and are not necessarily targeted by distress-focused treatments. Distinguishing between these processes provides a useful framework for understanding why reductions in suicidal

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ideation are commonly observed across diverse psychotherapies, even when effects on suicide attempts are more variable.

An alternative possibility is that different psychotherapies influence suicidal ideation in ways that are not readily captured by traditional assessment methods. Clinical trials have traditionally relied on assessment tools and measures that combine multiple dimensions of suicidal thinking into composite scores reflecting overall severity of suicidal ideation. Although practical and clinically intuitive, mounting evidence suggests this approach may not reflect the true nature of suicidal ideation. For example, Coppersmith et al. (2023) showed that different dimensions of suicidal thinking operate on markedly different timescales, with some components (e.g., suicidal desire) persisting for many hours while others (e.g., suicidal intent) fluctuate rapidly during much shorter periods. Similarly, Bryan et al. (2025) identified multiple distinct change patterns underlying five distinct dimensions of suicidal ideation, specifically the wish to live, wish to die, reasons for living and dying, suicidal desire, and passive desire for death. Identified change patterns included those that tended to return to equilibrium and cyclical patterns in which ideation alternated between moving toward and moving away from equilibrium. Other work has further shown that the wish to live and wish to die typically move in opposing directions but can temporarily desynchronize, reflecting a shift in the underlying dynamics that has been associated with near-term increases in suicidal desire and the emergence of suicidal behavior (Bryan, Bozzay, et al., 2025; Bryan, Daruwala, et al., 2025).

Collectively, these findings highlight the potential value of a dynamical systems perspective on suicidal ideation and treatment effects. A dynamical systems framework views suicidal ideation as a set of interacting thoughts and motivations that can change over time (cf. Goldstein, 1999). From this perspective, durable and clinically meaningful change in suicidal ideation is reflected not only in reductions in overall severity but also in changes to the underlying dynamics of the system itself, which can manifest as variability in the organization, coordination, and stability of change patterns over time

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(Butner, Bryan, Munion, et al., 2021; Butner et al., 2015). From a practical standpoint, reductions in suicidal ideation severity can be temporary or highly context dependent. For example, suicidal ideation may reemerge once treatment ends or stressors recur. In contrast, changes in system dynamics indicate that the relationships among ideation components have been altered, such that suicidal ideation behaves differently over time and across situations, reflecting a more durable shift in how the system responds to stress. Preliminary support for this distinction is implicated by prior RCTs of BCBT and PCT, which showed evidence of suicidal ideation "rebounds" after PCT as compared to sustained reductions in suicidal ideation after BCBT (Baker et al., 2024; Bryan, Khazem, et al., 2025). Rebounds in suicidal ideation after PCT have also been reported in clinical trials of PTSD-focused psychotherapies (Brown et al., 2019). These findings raise the possibility that BCBT and PCT produce similar short-term reductions in ideation *severity* while differing in their capacity to produce durable change in ideation *dynamics*.

Figure 1 depicts two landscapes to illustrate this distinction. If a ball sitting at the bottom of a valley is pushed, gravity pulls it back down. This represents a self-correcting or stable state. By contrast, if a ball sitting on a hilltop is pushed, that force sends it rolling away. This represents a self-amplifying or unstable state. Within this landscape, mental health treatment can be understood as the hilltop, representing the potential for change in suicidal ideation, which is represented by the ball. In landscape A, the slopes are steep, so change occurs rapidly. In landscape B, the slopes are shallow, so m change unfolds more slowly. In both landscapes, the overall distance between the hilltop and valley floors are the same, representing an equal magnitude of change in suicidal ideation. However, deeper and steeper slopes generate stronger destabilizing forces than shallower ones. Note that deeper and steeper valleys also produce stronger *stabilizing* forces once the ball comes to rest on the valley floor. After the ball has moved, it is more likely to remain in its new position when surrounded by deeper and steeper slopes. Thus, two treatments may produce similar reductions in suicidal ideation severity (i.e., the same overall amount of change) yet differ qualitatively in how that change unfolds over time and the durability of that change.

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The present study tested this possibility by applying a dynamical systems framework to examine and compare patterns of change in suicidal ideation during BCBT and PCT. Rather than focusing solely on mean-level changes in ideation severity, we modeled suicidal ideation as a multidimensional system and characterized the structure, speed, and synchrony of change across five ideation dimensions within each treatment. We hypothesized that BCBT and PCT would differ in both the organization and content of their underlying change patterns. Specifically, we expected BCBT to produce more tightly coordinated change patterns that returned to equilibrium faster than PCT—patterns that are indicative of more durable change (Butner, Bryan, Munion, et al., 2021).

Method

Participants and Procedures

This manuscript is a secondary analysis of data collected during an RCT comparing the efficacy of two psychotherapies for the prevention of suicide attempts (Bryan, Khazem, et al., 2025). The parent RCT was conducted at three study sites: a U.S. military medical center, a Department of Veterans Affairs (VA) outpatient clinic, and an academic medical center. Study procedures and methods were reviewed and approved by institutional review boards at each site and preregistered at www.clinicaltrials.gov (#NCT03769259). Participants were recruited from December 2020 to April 2022 at the military site and from September 2023 to February 2025 at the VA and academic medical center sites. A full description of study procedures can be found in the parent trial's published protocol (Khazem et al., 2021).

Participants were U.S. military personnel and veterans between 18-64 years old with suicidal ideation with intent to die within the past week or a suicide attempt within the past month. Exclusion criteria were having a psychiatric or medical condition that precluded the ability to provide informed consent or participate in outpatient therapy and being scheduled to deploy or otherwise have a change in the military status that precluded completion of the treatment protocol. Participants self-referred or were referred to the study team by their mental healthcare team to complete informed consent

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procedures. Individuals providing consent to participate were next assessed for eligibility. Eligible participants completed a baseline assessment and were randomized to one of two treatment groups using a computerized randomization algorithm. Randomization was conducted in blocks of 6 and 8, stratified by biological sex (male or female) and number of prior suicide attempts (none, 1, or 2+). Participants completed self-report measures prior to each scheduled therapy session. The present study used assessments of suicidal ideation collected at these therapy sessions.

Treatments

Participants were allowed to continue receiving medications and participate in other mental health treatment services while enrolled in the study. In addition to usual care, participants were randomly assigned to receive either BCBT or PCT. Both treatment conditions included recommended suicide prevention care practices like suicidal ideation screening, suicide risk assessment, and a safety planning-type intervention (Brodsky et al., 2018; National Action Alliance for Suicide Prevention, 2018).

Brief Cognitive Behavioral Therapy (BCBT). BCBT (Bryan & Rudd, 2018) is a 10- to 12-session outpatient psychotherapy that begins with a narrative assessment, collaborative case conceptualization, and crisis response planning procedures. Subsequent sessions focus on teaching behavioral and cognitive self-regulation skills. BCBT concludes with the relapse prevention task, a visualization activity in which patients imagine past crises and possible future crises and then imagine themselves using skills learned in BCBT to effectively respond to these situations.

Present Centered Therapy (PCT). PCT (Belsher et al., 1996) is a 10- to 12-session outpatient psychotherapy that provides education about mental health symptoms, suicidal thoughts, and suicidal behaviors; emotional support; and assistance with problem-solving of stressful life situations. Participants keep a journal of daily stressors to guide the content of therapy sessions. PCT did not include active skills training components.

Measures

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Suicidal Ideation. The first five items of the Scale for Suicidal Ideation (SSI; Beck et al., 1988) were administered at the start of every therapy session. The items assess wish to live, wish to die, reasons for living and dying, suicidal desire, and passive desire for death using a 3-point ordinal scale with higher scores indicating more severe suicidal thoughts and urges. These first five items also represent the respective ideation dimensions that form the system of ideation under study. To reduce participant burden, the remaining 14 items of the SSI, which are administered when respondents positive endorse item 4 (suicidal desire) or item 5 (passive desire for death), were not administered in this study. In this study, each item was modeled as an indicator of a distinct dimension of suicidal ideation instead of being summed to produce a composite metric of suicidal ideation.

Psychiatric Diagnosis. For descriptive purposes, psychiatric diagnosis at baseline was assessed using the Composite International Diagnostic Interview Screening Scales (CIDI-SC; Kessler et al., 2013), a set of brief, standardized self-report instruments designed to identify individuals who are likely to meet diagnostic criteria for common mental disorders. Derived from the full Composite International Diagnostic Interview (Wittchen, 1994), the CIDI-SC assess symptoms of conditions such as major depressive disorder, generalized anxiety disorder, panic disorder, bipolar disorder, and substance use disorders, providing strong sensitivity and acceptable specificity relative to full diagnostic interviews.

Data Analyses

To examine patterns of change in suicidal ideation during psychotherapy, we estimated multilevel, continuous-time change models with repeated assessments nested within individuals (Boker, 2012). Because repeated assessments were not evenly spaced (e.g., due to rescheduled or missed sessions), change scores between consecutive assessments were scaled by dividing by the number of days between assessments, yielding rate-of-change estimates ($\Delta x/\Delta t$) that allowed comparisons across unequal intervals (Boker & Nesselroade, 2002). At each time point, scores on all five suicidal ideation items were entered simultaneously as predictors of change in each item from the current time point to

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the next, resulting in a system of five coupled linear equations. Usable data were available from 701 assessments (mean=6.7 [range=1 to 12] assessments per participant).

The estimated regression coefficients from this set of equations—one set per treatment group—were assembled into a system matrix that characterizes how change in each item depends on the previous state of all items (Strogatz, 2015; Thelen & Smith, 1994). To summarize and compare the dynamic properties of each treatment, we applied eigen-decomposition to both system matrices, a procedure that identifies distinct change patterns within each treatment (Nowak & Vallacher, 1998; Strogatz, 2015). The total number of possible change patterns within each system is determined by the number of predictor variables. With five dimensions of suicidal ideation (i.e., wish to live, wish to die, reasons for living and dying, suicidal desire, and passive desire for death), each treatment could thus have up to five different change patterns. Features of these change patterns are characterized by eigenvalues, traces, determinants, time constants, and eigenvectors. Together, these metrics allowed us to compare not only whether suicidal ideation changed during treatment, but how the underlying dynamics of change differed across treatment conditions.

Eigenvalues represent distinct change patterns within the system (Strogatz, 2024). Positive eigenvalues indicate change patterns that move away from the system's local equilibrium point whereas negative eigenvalues indicate change patterns that move toward the system's equilibrium. The magnitude of the real part of the eigenvalue reflects the speed of change, with larger absolute values (i.e., farther from zero) indicating faster change. Complex eigenvalues containing real and imaginary parts[1] indicate oscillatory or cyclical change patterns, with the real part indicating the rate at which oscillations grow or shrink and the imaginary part indicating oscillation frequency. The sum of each

[1] In mathematics, a complex number is a two-dimensional number made from the combination of a real number and an imaginary number. Complex numbers are written in the form $a + bi$, where a represents the real part and bi represents the imaginary part. A real number is any ordinary, everyday number whereas an imaginary number is a real number multiplied by i, the square root of -1.

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system's eigenvalues produces the trace, which characterizes the system's overall tendency toward change. Larger trace values indicate movement away from equilibrium while smaller trace values indicate movement toward equilibrium. The product of each system's eigenvalues produces the determinant, which reflects the distribution of change across system patterns. Determinants near zero indicate change is dominated by a small number of patterns instead of being distributed across multiple patterns. For each identified change pattern, a time constant was computed from the real part of the eigenvalue as $\tau = 1 / |\mathrm{Re}(\lambda)|$. The time constant ($\tau$) represents the timescale over which a change pattern meaningfully changes from its current level. Smaller time constants indicate faster change whereas larger time constants indicate slower, more persistent dynamics.

Finally, eigenvectors describe the specific configuration or structure of coordinated change within each pattern (Strogatz, 2024). To facilitate interpretation, eigenvectors were rescaled so absolute values ranged from 0 (no contribution to change) to 1 (strong contribution to change). Eigenvector elements with shared signs (either positive or negative) move together in the same direction (e.g., increasing or decreasing together) whereas eigenvector elements with opposite signs move in opposing directions (e.g., one increases when the other decreases, and vice versa). Clinical interpretation of these metrics requires consideration of pretreatment states and the overall direction of movement relative to that beginning state. As noted by Butner et al. (2021), treatments designed to disrupt high-risk states may initially weaken existing equilibria by increasing repelling dynamics, producing faster or more variable change. For patients beginning treatment in heightened risk states, more positive eigenvalues, shorter time constants, and larger positive trace values could reflect intentional destabilization of entrenched patterns that sustain high risk states, especially when followed by movement toward more protective configurations.

Regression modeling was conducted using the SAS 9.4 software. Eigen-decomposition was conducted using the WolframAlpha online eigenvalue calculator available at

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https://www.wolframalpha.com/calculators/eigenvalue-calculator. Consistent with the recommendations of the American Statistical Association (Wasserstein & Lazar, 2016), we interpreted p-values as continuous instead of binary measures of statistical evidence.

Results

Of 154 individuals assessed for eligibility, 108 were enrolled. As reported in Bryan et al. (Bryan, Khazem, et al., 2025) 46 participants were excluded because they did not meet eligibility criteria (n=21), declined to participate (n=6), were lost to follow-up (n=6), were referred to other programs (n=3), or other reasons (n=10). Participants included 29 (26.9%) women and 79 (73.1%) men ranging from 19-64 years (M=32.8, SD=12.8), of which 74 (68.5%) self-identified as White, 16 (14.8%) as Black, and 9 (8.3%) as "other" (Table 1). At baseline, 87 (80.6%) reported suicidal ideation within the past week and 21 (19.4%) reported a suicide attempt within the past month. The mean sum score of all SSI items at session 1 was 3.0 (95% CI=2.5 to 3.5). SSI sum scores significantly decreased over time in both treatment groups (B=-0.10, 95%=-0.17 to -0.02, p=.018) and the slopes did not significantly differ between treatments (B=0.02, 95% CI=-0.09 to 0.13, p=.715).

Change dynamics in suicidal ideation across treatment groups

Results of the continuous time differential equation model are summarized in Table 2. Multiple regression coefficients differed between BCBT and PCT, indicating the underlying change dynamics of suicidal ideation differed across treatment groups: SSI1→ΔSSI1, $F_{1,2180}$=4.2, p=.042; SSI5→ΔSSI1, $F_{1,2180}$=2.7, p=.100; SSI1→ΔSSI2, $F_{1,2180}$=7.3, p=.007; SSI4→ΔSSI2, $F_{1,2180}$=4.1, p=.042; SSI1→ΔSSI3, $F_{1,2180}$=4.3, p=.038; SSI3→ΔSSI3, $F_{1,2180}$=18.0, p<.001; SSI1→ΔSSI4, $F_{1,2180}$=15.1, p<.001; SSI2→ΔSSI4, $F_{1,2180}$=3.5, p=.061; SSI4→ΔSSI4, $F_{1,2180}$=9.2, p=.002; and SSI5→ΔSSI4, $F_{1,2180}$=2.7, p=.100. The regression coefficients estimated by this model are presented in Table 3 as two matrices, one per treatment group.

Results of the eigen-decomposition are summarized in Table 4. Both treatments were characterized by a mixture of positive eigenvalues (i.e., movement away from equilibrium) and negative eigenvalues

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(i.e., movement toward equilibrium) patterns, with patterns that moved away from equilibrium generally operating on faster timescales than patterns that moved toward equilibrium. The dominant patterns in BCBT operated on shorter timescales ($\lambda_1 = 0.132$, $\tau_1 = 7.6$; $\lambda_2 = 0.105$, $\tau_2 = 9.6$; $\lambda_3 = 0.096$, $\tau_3 = 10.4$) than those observed in PCT ($\lambda_1 = 0.070$, $\tau_1 = 14.3$; $\lambda_2 = 0.043$, $\tau_2 = 23.2$), indicating change was faster in BCBT than PCT. Consistent with this pattern, the trace was larger in BCBT (0.337) than in PCT (0.103), indicating BCBT was associated with greater overall change facilitation.

Determinants were near zero in both treatments (BCBT: -2.8×10^{-7}; PCT: -8.1×10^{-9}), indicating that change dynamics were dominated by a small number of fast change patterns rather than being distributed evenly across fast and slow processes. The strength of these change patterns doubled every 5.3 to 7.2 days on average, corresponding closely to the spacing of weekly psychotherapy sessions. In BCBT, the fastest pattern was characterized primarily by coordinated change in the wish to die, suicidal desire, and passive desire for death moving together strongly. The second-fastest pattern was characterized primarily by coordinated change in passive desire for death moving together modestly with the wish to die. The third pattern reflected coordinated change in reasons for living and dying moving together weakly with suicidal desire and in moderate opposition to passive desire for death. The remaining two patterns operated on much slower timescales, indicating minimal contribution to change in suicidal ideation over clinically meaningful timeframes.

In PCT, the fastest pattern was driven primarily by passive desire for death moving in weak opposition to the wish to die and the second-fastest pattern was driven primarily by the wish to die moving together modestly with all other ideation dimensions. The magnitude of change in these modes doubled every 9.9 to 16.1 days on average, indicating their influence on suicidal ideation increased over time. The remaining three pattern were markedly slower, indicating limited contribution to change during clinically meaningful timeframes.

Discussion

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Although BCBT reduces suicide attempts to a greater extent than PCT, the two treatments differ only modestly in their overall effects on severity of suicidal ideation (Baker et al., 2024; Bryan, Khazem, et al., 2025). This apparent paradox suggests that BCBT and PCT may influence suicidal ideation through different dynamic processes even when aggregate reductions in suicidal ideation appear similar. The results of this study support this hypothesis and provide a mechanistic explanation for previous findings that short-term improvements in suicidal ideation often "rebound" after PCT relative to the more durable gains observed in BCBT (Baker et al., 2024; Bryan, Khazem, et al., 2025).

Across both treatments, suicidal ideation exhibited a mixture of patterns that moved away from and toward equilibrium. Change was not uniformly distributed across all dimensions of ideation, however; instead, near-zero determinants in both systems indicated that change was dominated by a limited number of modes rather than being evenly distributed across all modes. These findings converge with prior work showing that suicidal ideation is best understood as a multidimensional dynamic system, with distinct dimensions operating on different timescales (Bryan, Bozzay, et al., 2025; Bryan, Daruwala, et al., 2025; Butner, Bryan, Tabares, et al., 2021; Coppersmith et al., 2023). Despite these shared properties, patients in the two treatments differed meaningfully in their overall capacity for change and the speed at which change unfolded. BCBT showed a greater overall tendency toward change as compared to PCT, which was closer to neutral or movement toward equilibrium on average. Also, patterns that moved away from equilibrium in BCBT operated on shorter timescales than those in PCT, indicating that coordinated patterns of ideation change emerged and intensified more rapidly in BCBT. This faster, more coordinated change in BCBT is consistent with the process of system reorganization described previously by Butner et al. (2021) and is broadly consistent with the parent trial's primary finding that BCBT was associated with significantly lower rates of subsequent suicide attempts than PCT (Bryan, Khazem, et al., 2025). The present study's session-level dynamics offer a plausible within-treatment account of these between-treatment differences, though the two were not directly statistically linked in this analysis.

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The organization of dominant change patterns further distinguished the two treatments. In BCBT, fast change patterns were tightly organized around death-oriented dimensions of ideation (wish to die, suicidal desire, and passive desire for death) and were more strongly coupled with reasons for living and dying. This pattern reflects a more integrated change process wherein multiple ideation dimensions moved together along a shared trajectory. In contrast, dominant change patterns in PCT were more diffusely distributed across dimensions, indicating weaker coordination and slower propagation of change through the system. These differences align closely with the dynamical systems framework of treatment efficacy previously described by Butner et al. (2021), who noted that durable treatment effects are more likely when change is both rapid and coordinated across multiple system components because these features implicate a reorganization of system dynamics rather than isolated or transient symptom fluctuations. In contrast, slower and less coordinated dynamics like those observed in PCT are less likely to produce enduring change, even when short-term symptom reductions occur, because the system's underlying organization remains intact. In this way, our findings implicate a mechanistic explanation for previously reported "rebound" effects after PCT relative to the more durable gains observed in BCBT (Bryan, Khazem, et al., 2025). Similar patterns have been seen in other clinical trials of suicide-focused treatments (Bryan, Simon, et al., 2025) and trauma-focused treatments (Brown et al., 2019), suggesting the possibility that these findings may not be specific to this study. If replicated in other studies, the present findings could implicate an alternative method for assessing treatment effects without lengthy (and expensive) follow-up periods that can have high attrition and require statistical corrections to properly interpret data.

Clinically, these findings provide insight into how BCBT and PCT influence suicidal ideation and, potentially, suicide risk more broadly. In this study, change in suicidal ideation during BCBT was more integrated, with multiple ideation dimensions changing together rather than in isolation. Of note, reasons for living and dying were more directly involved in faster change processes, a pattern consistent

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with several BCBT components designed to increase the salience and accessibility of reasons for living and other life-affirming memories and cognitions (e.g., crisis response planning, reasons-for-living cards, and survival kits). Previous research found that the addition of interventions and activities focused on identifying and remembering personal reasons for living led to rapid improvement in positive cognitive-affective states and accelerates change in suicidal ideation (Bryan et al., 2019; Rozek et al., 2019). According to the broaden and build theory (Fredrickson, 2001), positive cognitive-affective states improve access to coping mechanisms and reinforce psychological resources that counteract the constricting effects of negative cognitive-affective states. Future research is needed to understand how BCBT and other psychotherapies shape interactions among thoughts, emotions, and suicidal ideation; such research could reveal additional mechanisms underlying BCBT's efficacy.

The present findings also have implications for the assessment and measurement of suicidal ideation. Composite ideation scores are commonly used for screening, assessment, and risk monitoring purposes in clinical and research settings. Although this approach offers clear practical advantages (e.g., simplicity and efficiency), our results suggest it may obscure clinically meaningful change processes that limit optimal clinical decision-making. Our results may also contextualize previous findings showing that people inconsistently endorse suicidal ideation across assessment tools and measures (Ammerman et al., 2021; Millner et al., 2015; Valtonen et al., 2005; Vuorilehto et al., 2014) and so often deny suicidal ideation prior to attempting suicide (Bjureberg et al., 2022; Simon et al., 2016; Simon et al., 2013a, 2013b; Simpson et al., 2021). Often attributed to measurement error or response bias, another interpretation is that subtle differences in language reflect different latent dimensions of suicidal ideation that follow different time courses. The wish to live and wish to die, for instance, might appear to be opposing valences of the same underlying concept. However, our findings and the findings of others (Bryan, Bozzay, et al., 2025; Bryan, Daruwala, et al., 2025) show these two dimensions behave differently and interact with other dimensions of suicidal ideation in unique ways. Inconsistent reporting

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of suicidal ideation across items and measures may therefore reflect the multidimensional nature of suicidal ideation rather than measurement error or response bias. This possibility converges with the perspectives of patients who often note that the language used in screening and assessment tools do not always reflect their subjective experience of suicidal ideation (Richards et al., 2019), implicating the likely superiority of multidimensional screening and assessment methods over unidimensional and narrowly focused methods that prevail in clinical and research settings.

Finally, these results suggest several directions for future research. One possibility is that coordinated, rapid change across multiple ideation dimensions is a better indicator of remission processes associated with reductions in suicide attempt risk than severity scores alone. Alternatively, overall speed of change, irrespective of coordination, may serve as an indicator of changing risk status. Longitudinal studies that directly link dynamic change patterns to subsequent suicidal behavior will be needed to test these hypotheses. If supported, dynamic markers such as dominant change pattern speed and cross-dimensional coordination could provide early indicators of durable treatment response during psychotherapy leading to the development of innovative treatment decision tools that can help clinicians know when and for whom treatments should be adjusted or sustained.

Strengths of this study include the use of a manualized active comparator rather than treatment as usual, allowing for more precise interpretation of treatment-specific effects, and the assessment of suicidal ideation assessments at the item level at every therapy session, providing greater nuance information than composite scores assessed only at the start and end of therapy. Several limitations should also be considered when interpreting these findings. First, the sample was restricted to U.S. military personnel and veterans, which may limit generalizability to civilian populations or to individuals with different demographic or clinical profiles. Second, although suicidal ideation was modeled as a multidimensional construct, the analyses were necessarily limited to the five ideation dimensions assessed in this study. Other clinically relevant dimensions such as suicide planning, perceived courage to

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attempt suicide, suicidal intent, and perceived controllability of suicidal thoughts were not included and may participate in distinct change processes that were not captured here. The three-point rating scale used for each SSI item could also restrict measurement variance. Third, suicidal ideation was assessed at each therapy session, typically scheduled on a weekly basis. Although this sampling frequency is well suited to capturing change during the typical course and pace of psychotherapy, prior work (Bryan, Bozzay, et al., 2025; Coppersmith et al., 2023; Kivelä et al., 2022; Kleiman et al., 2017) shows that some dimensions of suicidal ideation can fluctuate over much shorter timescales (e.g., hours or days). As a result, the present models may underestimate the contribution of very fast dynamics or transient change processes that occurred between sessions and may not reflect change patterns occurring within shorter timescales. Fourth, our continuous-time models relied on linear approximations of local dynamics, which provide useful summaries of change patterns but may not fully capture nonlinear or state-dependent processes. Moreover, eigen-decomposition characterizes the structure and speed of change patterns but does not identify causal mechanisms. Future work using denser time sampling, additional ideation dimensions, and nonlinear or state-dependent modeling approaches will be important for extending and refining these findings.

Despite these limitations, the present findings add to our conceptual and clinical understanding of suicidal ideation and how different psychotherapies influence this outcome. Although mean-level changes in suicidal ideation are similar across BCBT and PCT, BCBT produced faster and more coordinated system-level change dynamics, indicators of more durable change patterns and treatment effects.

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AI Declaration Statement

The authors used ChatGPT (OpenAI) during manuscript preparation to assist with language refinement and organization of text. The AI tool was used solely to improve clarity, coherence, and readability of the manuscript and to help draft alternative phrasings. All content produced with the assistance of the AI tool was reviewed, edited, and verified by the authors, who take full responsibility for the accuracy and integrity of the manuscript.

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Data Availability Statement

Deidentified participant data from this study will be shared with qualified researchers whose proposed use of the data has been approved for a specified purpose and have executed a data access agreement. Requests for access to the data may be directed to craig.bryan@uvm.edu.

CRediT Statement

Concept and design: Bryan, Khazem, Rudd. **Acquisition, analysis, or interpretation of data:** Acierno, Baker, Brown, Bryan, Pruiksma, Tabares, Taylor. **Drafting of the manuscript:** Bryan

Critical review of the manuscript for important intellectual content: All authors. **Statistical analysis:** Bryan, Tabares. **Obtained funding:** Brown, Bryan, Pruiksma, Taylor. **Administrative, technical, or material support:** Acierno, Baker, Brown, Bryan, Khazem, Pruiksma, Rudd, Tabares. **Supervision**: Acierno, Baker, Brown, Bryan, Taylor

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Table 1

Sample characteristics

	PCT (n=55)	BCBT (n=53)
Sex, n (%)		
Female	13 (23.6)	16 (30.2)
Male	42 (76.4)	37 (69.8)
Race, n (%)		
American Indian	3 (5.5)	1 (1.9)
Asian	1 (1.8)	2 (3.8)
Black	7 (12.7)	9 (17.0)
Pacific Islander	2 (3.6)	0 (0.0)
White	39 (70.9)	35 (66.0)
Other	3 (5.5)	6 (11.3)
Hispanic/Latino, n (%)		
No	46 (83.6)	41 (77.4)
Yes	9 (16.4)	12 (22.6)
Site, n (%)		
Department of Defense	26 (47.3)	24 (45.3)
Department of Veterans Affairs	6 (10.9)	8 (15.1)
Academic medical center	23 (41.8)	21 (39.6)
Military/Veteran status, n (%)		
Military	27 (49.1)	28 (52.8)
Veteran	28 (50.9)	25 (47.2)
Prior Attempts, n (%)		
0	18 (33.3)	20 (38.5)
1	20 (37.0)	14 (26.9)
≥2	16 (29.6)	18 (34.6)
Psychiatric Diagnosis, n (%) [a]		
Major depressive disorder	21 (41.2)	26 (48.1)
Bipolar disorder	16 (31.4)	12 (22.1)
Panic disorder	16 (31.4)	27 (50.0)
Generalized anxiety disorder	14 (27.5)	23 (42.6)
Posttraumatic stress disorder	10 (19.6)	11 (20.4)
Attention deficit hyperactivity disorder	26 (51.0)	34 (63.0)
Intermittent explosive disorder	10 (19.6)	9 (16.7)
Substance use disorder	14 (27.5)	17 (31.5)
Age, M (SD)	33.4 (12.3)	32.2 (13.3)
Treatment Format, n (%)		
In-person	26 (47.3)	24 (45.3)
Remote / telehealth	29 (52.7)	29 (54.7)

[a] Data were missing from 3 cases, so percentages are based on n=105 participants

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Table 2

Results of the continuous time differential equation model

Outcome	Effect	F	p
ΔSSI1/Δt	Intercept	0.1	0.748
(WTL)	WTL	48.4	<.001
	WTD	0.2	0.692
	RFL/RFD	2.0	0.153
	Suicidal desire	3.3	0.072
	Passive death	6.6	0.010
	Treatment	0.2	0.699
	Interactions		
	Treatment * WTL	4.2	0.042
	Treatment * WTD	0.4	0.506
	Treatment * RFL/RFD	0.1	0.707
	Treatment * Suicidal desire	0.8	0.384
	Treatment * Passive death	2.7	0.099
ΔSSI2/Δt	Intercept	7.7	0.007
(WTD)	WTL	195.4	<.001
	WTD	15.0	0.000
	RFL/RFD	1.8	0.185
	Suicidal desire	36.8	<.001
	Passive death	3.0	0.083
	Treatment	0.6	0.455
	Interactions		
	Treatment * WTL	7.3	0.007
	Treatment * WTD	1.8	0.176
	Treatment * RFL/RFD	0.8	0.372
	Treatment * Suicidal desire	4.1	0.042
	Treatment * Passive death	0.0	0.904
ΔSSI3/Δt	Intercept	0.0	0.843
(RFL/RFD)	WTL	144.1	<.001
	WTD	0.0	0.877
	RFL/RFD	42.7	<.001
	Suicidal desire	8.6	0.003
	Passive death	2.5	0.114
	Treatment	1.2	0.279
	Interactions		
	Treatment * WTL	4.3	0.038
	Treatment * WTD	1.2	0.270
	Treatment * RFL/RFD	18.0	<.001
	Treatment * Suicidal desire	1.3	0.260
	Treatment * Passive death	1.3	0.263
ΔSSI4/Δt	Intercept	0.9	0.355
(Suicidal desire)	WTL	202.4	<.001
	WTD	6.4	0.012
	RFL/RFD	1.1	0.287
	Suicidal desire	46.2	<.001
	Passive death	1.2	0.277
	Treatment	0.1	0.818
	Interactions		
	Treatment * WTL	15.1	<.001
	Treatment * WTD	3.5	0.061
	Treatment * RFL/RFD	0.0	0.844
	Treatment * Suicidal desire	9.2	0.002
	Treatment * Passive death	2.7	0.100

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ΔSSI5/Δt	Intercept	3.2	0.078
(Passive death)	WTL	177.5	<.001
	WTD	0.3	0.562
	RFL/RFD	0.1	0.733
	Suicidal desire	6.5	0.011
	Passive death	112.4	<.001
	Treatment	0.8	0.388
	Interactions		
	Treatment * WTL	0.8	0.386
	Treatment * WTD	0.0	0.871
	Treatment * RFL/RFD	0.6	0.436
	Treatment * Suicidal desire	1.5	0.228
	Treatment * Passive death	0.2	0.656

Note: WTL = Wish to Live, WTD = Wish to Die, RFL/RFD = Reasons for Living and Dying

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Table 3.

Regression coefficients from continuous-time differential equation modeling

Outcome	Predictor				
	SSI1 WTL B (SE)	SSI2 WTD B (SE)	SSI3 RFL/RFD B (SE)	SSI4 Suicidal desire B (SE)	SSI5 Passive death B (SE)
PCT					
ΔSSI1/Δt: WTL	-0.091 (0.015)	-0.010 (0.014)	0.011 (0.015)	0.027 (0.015)	0.037 (0.014)
ΔSSI2/Δt: WTD	-0.129 (0.016)	0.027 (0.016)	0.025 (0.016)	0.046 (0.016)	0.017 (0.016)
ΔSSI3/Δt: RFL/RFD	-0.101 (0.015)	-0.009 (0.014)	0.023 (0.015)	0.042 (0.015)	0.024 (0.014)
ΔSSI4/Δt: Suicidal desire	-0.122 (0.017)	0.007 (0.016)	0.010 (0.017)	0.043 (0.017)	0.030 (0.017)
ΔSSI5/Δt: Passive death	-0.138 (0.016)	-0.008 (0.015)	-0.005 (0.016)	0.015 (0.016)	0.101 (0.015)
BCBT					
ΔSS1/Δt: WTL	-0.050 (0.014)	0.003 (0.014)	0.018 (0.013)	0.010 (0.014)	0.008 (0.011)
ΔSSI2/Δt: WTD	-0.191 (0.016)	0.056 (0.015)	0.005 (0.015)	0.091 (0.016)	0.020 (0.014)
ΔSSI3/Δt: RFL/RFD	-0.143 (0.014)	0.012 (0.014)	0.108 (0.013)	0.019 (0.014)	0.004 (0.011)
ΔSSI4/Δt: Suicidal desire	-0.213 (0.017)	0.048 (0.015)	0.014 (0.016)	0.113 (0.016)	-0.006 (0.014)
ΔSSI5/Δt: Passive death	-0.157 (0.015)	-0.004 (0.014)	0.012 (0.015)	0.041 (0.015)	0.110 (0.013)

Note: Shaded cells are statistically significant at p<.1, with darker shading reflecting smaller p values. WTL = Wish to Live, WTD = Wish to Die, RFL/RFD = Reasons for Living and Dying

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Table 4

Eigenvalues (λ), time constants (τ), half-lives and doubling times (t), and rescaled eigenvectors for each change pattern by SSI dimension within BCBT and PCT

					Rescaled eigenvectors				
Group	Pattern	λ	τ	t [a]	Wish to live	Wish to die	Reasons for living/dying	Suicidal desire	Passive desire for death
BCBT	1 (fastest)	0.132	7.6	5.3 d	-0.152	1.000	0.486	0.951	0.784
trace = 0.337	2	0.105	9.6	6.6 d	-0.109	0.484	0.267	0.252	1.000
det=-2.8 x 10^{-7}	3	0.096	10.4	7.2 d	-0.126	0.091	1.000	0.341	-0.421
	4	0.017	58.5	40.6 d	-0.023	-1.000	0.069	0.526	-0.245
	5 (slowest)	-0.012	81.2	56.3 d	-0.724	0.486	0.636	1.000	0.548
PCT	1 (fastest)	0.070	14.3	9.9 d	-0.241	-0.431	-0.007	-0.092	1.000
trace = 0.103	2	0.043	23.2	16.1 d	-0.210	1.000	0.317	0.576	0.517
det=-8.1 x 10^{-9}	3	-0.014	71.3	49.4 d	-0.579	0.287	0.511	1.000	0.750
	4/5 [b] (slowest)	0.002 ± 0.014i	492.6	341.5 d	-0.744	0.571	0.499	1.000	0.823

Note: Within each row, shaded ideation dimensions that move together in the same direction and in opposition to unshaded ideation dimensions.

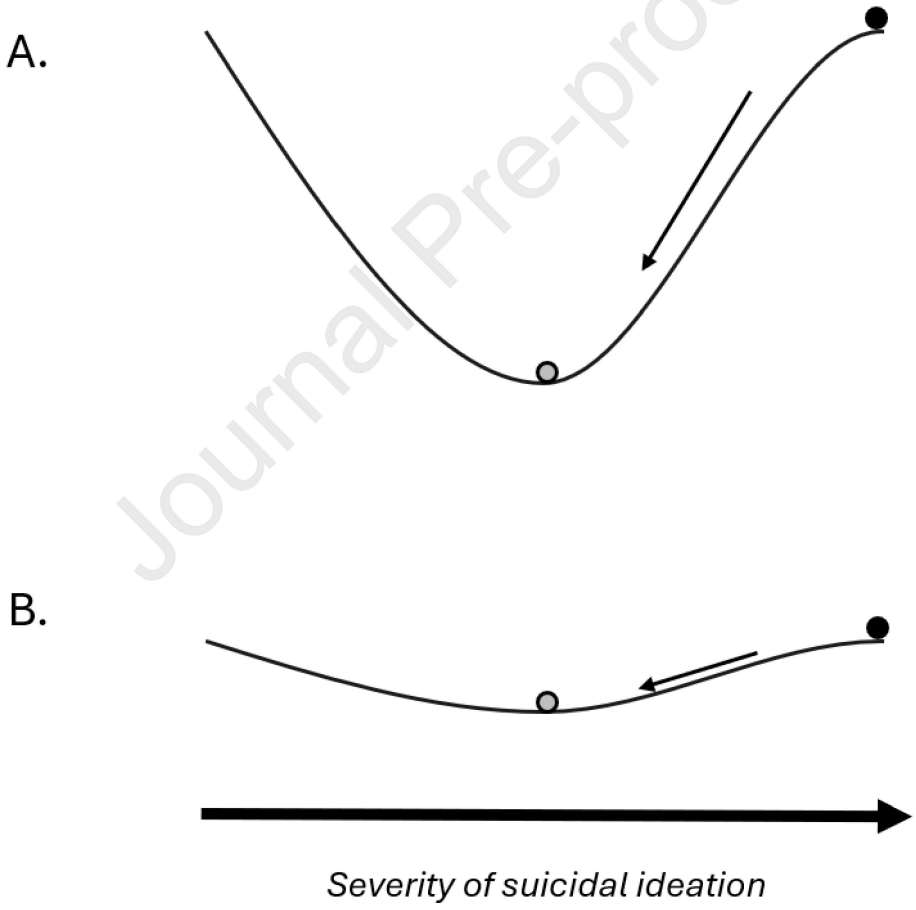
[a] t is calculated using the formula τ * ln(2). For patterns moving toward equilibrium (negative eigenvalues), t reflects half-life, or the number of days on average that pass for the pattern to lose half of its influence on overall change. For patterns moving away from equilibrium (positive eigenvalues), t reflects doubling time, or the number of days on average that pass for the pattern to gain twice as much influence on overall change.

[b] The oscillatory pattern involves a complex conjugate pair (0.002 + 0.014i and 0.002 - 0.014i). It is common to combine complex conjugate pairs because they represent a single oscillating pattern.

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Figure 1

Two landscapes characterized by valleys of varying depth illustrate different properties of change in suicidal ideation. Suicidal ideation is represented as a ball placed atop a hill, which represents the destabilizing nature of mental health treatment. Suicidal ideation moves away from this unstable position when disturbed by treatment and rolls downhill to the left, toward the valley floor, where it settles. The depth and steepness of the hill's slope determines how quickly this movement occurs. In Panel A, the valley is deep and steep, so movement away from the hilltop occurs rapidly and suicidal ideation quickly settles at the valley floor. In Panel B, the valley is shallow, so movement is slower and the pull toward the valley floor is weaker. In both landscapes, the overall distance between hilltop and valley floor is the same, representing an equal magnitude of change in severity of suicidal ideation. However, the speed of that change differs qualitatively. Also owing to the differences in slopes, suicidal ideation is more likely to remain in its new position in Panel A than in Panel B, indicating greater durability of change.



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Highlights

- BCBT and PCT reduced suicidal ideation severity similarly
- Dynamical systems analyses revealed distinct change modes for each treatment
- BCBT showed faster, coordinated change dynamics
- PCT dynamics were slower and less centralized
- Dynamic metrics may signal durable treatment response when mean change is similar

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Declaration of Interest Statement

Dr. Acierno reported receiving grants from the Department of Defense during the conduct of the study. Dr. Baker reported receiving personal fees from Anduril LLC and grants from the Department of Defense and Greater Plains Collaborative outside the submitted work. Dr. Brown reported grants from the Department of Defense and the National Institute of Mental Health during the conduct of the study. Dr. Bryan reported grants from the Department of Defense, the National Institute of Mental Health, the New Jersey Gun Violence Research Center, and the American Foundation for Suicide Prevention during the conduct of the study; royalties from Guilford Press, Oxford University Press, Springer Publishing, Taylor & Franics, and PESI; and ownership of Anduril, LLC. Dr. Khazem reported grants from the American Foundation for Suicide Prevention and Greater Plains Collaborative during the conduct of the study and consultant fees from Oui Therapeutics and Anduril, LLC. Dr. Pruiksma reported grants from the Department of Defense during the conduct of the study; and consulting fees outside the submitted work. Dr. Rudd reported grants from the Department of Defense during the conduct of the study. Drs. Tabares and Taylor reported no relevant financial interests.

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